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In response to need, a history of the Western Australian Department of Agriculture - 1894 to 2008

E N. Fitzpatrick

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In Response to Need

A History of the Western Australian Department of Agriculture – 1894 to 2008

EN Fitzpatrick
About the author

Noel Fitzpatrick
AM, MSc(Agric), FTSE, FAIAS

A farmer's son, Noel Fitzpatrick was born in the eastern wheatbelt town of Narembeen in 1929. He completed his primary education at a one-teacher, eleven-student school. Having won a scholarship, he completed his secondary education at Northam High School. He graduated with a BSc in Agriculture from the University of Western Australia in 1951 and joined the Department of Agriculture. He was awarded a MSc(Agric) degree in 1957.

Noel worked for 12 years on problems of pasture nutrition and legume establishment in the higher rainfall districts and the South Coast. In 1963 he moved to administration as the first Scientific Liaison Officer. He was appointed Deputy Director in 1969 and Director of Agriculture in 1971.

In 1984 he became Deputy Secretary of the Commonwealth Department of Primary Industry. A highlight of this period was the establishment of the Bureau of Rural Science. In 1988 he was invited to become the first President of the Murray-Darling Basin Commission, a position he held until he retired in 1994.

He is a Member of the Order of Australia, a Fellow of the Academy of Applied Science and Engineering, a Fellow and Medallist of the Australian Institute of Agricultural Science and Technology. He was awarded the Farrer Medal in 1995 and inducted into the Royal Agricultural Society's Hall of Fame in 2006. A sidelight of his career was being one of the three people who organised a successful salary appeal in 1963 which resulted in a major increase in the salaries of agricultural scientists across Australia.
Acknowledgments

I have not used many names in the book because an organisation of the size of the Department of Agriculture had to be a team to function properly. The technicians, laboratory assistants, instructors, inspectors, clerks in their many roles, typists, mechanics, and men in grey cardigans who knew where everything was, all made the organisation function, yet can only be recognised as unsung heroes.

My primary reference has been the annual reports and other publications of the bureau and department. Where these were not published in the first years when it was part of the Lands Department, details were obtained from the records of Parliamentary Proceedings.

I have also had the benefit of discussions with serving and retired officers and of some editing by officers more expert than I could hope to be. I am very grateful for all the assistance I have received. I must also thank the library staff for their assistance. However, the errors which will be found in the text are my responsibility and I apologise for them.

**Note:** The units of measurement have been generally those used at the time being discussed with metric conversions included for clarity. In other cases only the metric units are used, particularly when discussing money, to make the values easier for younger readers to understand.

EN Fitzpatrick
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Introduction

The Department of Agriculture in mid-2008 was an organisation of some 1650 people employed in five Perth Metropolitan Area locations, 22 regional rural offices, 13 Community Advisory Centres and 13 District Agricultural Protection offices. It also controlled 14 research stations and had research centres at Bunbury, Albany, Esperance, Katanning, Northam, Merredin, Geraldton and Kununurra. In addition there were quarantine checkpoints at Eucla and Kununurra and quarantine stockyards at Halls Creek and Parkston.

The department was not always such a significant organisation; it came from very small beginnings. However, it has been a major component of the engine which has produced an agricultural industry in a Mediterranean climate zone which is superior to all others operating in this zone. This book is a summary of its work.

There are many more fascinating chapters to be recorded of work on specific issues of development, investigation or conservation. I hope they will be written by someone one day. With this in mind the department has decided to put the book on a web page where further chapters can be added by other authors to produce a more complete history.

Western Australia’s modern agriculture has been built in a little more than 100 years on the foundation of a hard-working and innovative farming community aided by advances in science and engineering. These innovative hard-working men and women established a tradition for innovation and seeking new ideas which has been followed by their sons, daughters, grandsons, granddaughters, great grandsons and great granddaughters who have always been ready to adopt new ideas or innovations.

Science and engineering have been essential components of this development because there are few, if any, parts of the world where science and engineering have been as important in the development of modern agriculture as in Western Australia. Engineering kicked in to help from the mid-1800s and from about 1900 science started to help, but its real contribution came after 1920.

The department has played a vital part in this development since its establishment in 1894. Before World War II, it was the only significant agricultural research organisation in WA. The University of Western Australia developed in the post-war years, as did CSIRO. The organisation was initially established as the Bureau of Agriculture with an independent board, but became a department four years later.

In the very early days the Department of Agriculture’s role was largely to distil and distribute information from around Australia and overseas and to maintain a barrier at ports of entry against the incursion of unwanted pests, weeds or diseases of plants and animals. However it also had a range of other roles in rural areas.

At various times it provided finance to farmers who started up without significant resources, built dams (earth tanks) for water reserves, cleared roads in new farming areas, and cleared heavily vegetated areas with stationary steam engines.

It was also charged with the maintenance of the rabbit-proof fence and the control of rabbits that got past that barrier. In the Perth Metropolitan Area and some country towns it variously maintained the State cold storage works, abattoirs, butter factories, a horse breeding operation for the State public service, a farm to provide meat for government meat outlets in the city, and central stables for government departments.

Its research capacity developed very slowly until the 1920s, when trained graduate staff, many trained under an innovative cadetship scheme, became available.
At the beginning of the Colony of Western Australia in 1829 the first challenge was to produce enough food to maintain the small population. Agriculture was very important because the cost of imports was very high. History shows that dairying, poultry and pig industries were very slow to develop.

Wheat production also developed slowly until 1904, with the last wheat imported to WA in 1910. In the early days the cost of production of wheat was estimated at 10 shillings ($1) a bushel (equivalent to 60 pounds or 27.2 kilograms). Fourteen shillings ($1.40) per bushel was the normal price. However, when a shortage developed the price reached 40 shillings ($4) per bushel.

Sheep grazing on the shrublands of the Gascoyne, Murchison and Pilbara, and cattle grazing on the grasslands of the Kimberley were important industries. The horticultural industries developed quite well along European lines.

During the latter part of the 19th century major changes were taking place in South Australia and Victoria with the development of machines for grain production. These are dealt with in some detail later. It is enough here to say that the Ridley stripper, the stump-jump plough, the harvester and the manufacture of superphosphate were all fundamental to the development of agriculture in WA in the early days. These inventions and further developments in the early 1900s and through the 20th century made possible an extensive agriculture which is the hallmark of WA agriculture today. However, without major contributions from science and engineering this promise would not have been realised.

It is remarkable that after 5000 years such major changes were made in a period of 150 years. Unfortunately the work of the department has not always been fully appreciated by either the farming community or the government. This latter attitude is reflected in the falling funding from State sources over the past 20 years.

I believe the Department of Agriculture has been an outstanding organisation. I was privileged to lead it from 1971 to early 1984. I undertook the task of writing this history because I also believed that its contribution should be recorded.

To some degree the work has been a labour of love. I must thank the then Director General, Ian Longson, for inviting me to write this history and the current Director General, Rob Delane, for approving its completion and publication.

The book is dedicated to those men and women, four of whom were my grandparents, who pioneered this harsh environment through drought, flood and fire and to the scientists and engineers who made it possible.
Chapter 1

1894 to 2008: one hundred and fourteen years in summary

Agriculture in Western Australia had a very slow beginning. In 1890, 60 years after European settlement, there were only 50,000 hectares cleared of the 2.2 million hectares which had been allocated for farming. The area sown to wheat was 14,000 hectares, which produced 13,000 tonnes—less than a tonne per hectare. A similar area would have been sown for hay. Farming areas were restricted largely to soils which gave some production without the addition of artificial fertiliser. There was little evidence of machinery use such as the stripper and the stump-jump plough, or of superphosphate.

Important advances followed the first combined conference of pastoralists, agriculturists and fruit grower associations in April 1893. A major request was for the establishment of a Bureau of Agriculture, to which the Premier, Sir John Forrest, agreed in 1894.

Some of the bureau’s main aims on establishment were to:

- establish experiment stations throughout the Colony and quickly disseminate the results of work done there to the community
- import new crop varieties, fruit trees and fodder plants
- prevent the introduction of noxious weeds and eradicate weed species
- encourage the introduction of new mechanical appliances and carry out field trials to demonstrate their use.

Land was surveyed for agricultural development in about 40 locations from Northampton to Albany and from Jandakot to Southern Cross in the decade following 1889.

Railways had a marked impact on where agriculture could be developed. As the easily-won gold was exhausted and the Government opened land along the railway lines for settlement, many miners turned to farming. The new land also attracted settlers from the city. However, these new farmers generally had little knowledge of farming, little equipment and often few other resources. The bureau became a major agency for providing advice and assistance.

The bureau was gazetted in January 1894 and almost immediately published a fortnightly journal “in order to place it in direct and frequent contact with the agriculturists”. In the first six months more than 16,000 copies were distributed.

A major activity was inspections under the Insect and Destructive Substances Act. A new Insect Control Act was passed in the following year, 1895. With few staff, activities were largely limited to inspection of ports and orchards under this Act.

Other early activities of the bureau:

- Viticultural and horticultural expert, Adrian Despeissis, came from the NSW Department of Agriculture and prepared a book of 350 pages on horticulture and viticulture.
- The bureau imported seeds of a range of crops and fodder plants for possible use.
- The first field station was established at Hamel in 1898 and used for testing introduced fodder crops, potato and cereal varieties. The first certified virus-free potato seed was produced there.
- The bureau attempted, but failed, to eradicate Mediterranean fruit fly.
Bureau becomes a department

The bureau became the Department of Agriculture in 1898, when it was placed under the control of the Minister for Lands, Forests and Agriculture. Over the next decade the staff increased gradually, as did its responsibilities.

In 1902 the State Government decided to build a rabbit-proof fence, following reports that rabbits had reached Eucla. The work was started by the department, but following a dispute over a contract, was transferred to the Public Works Department. Maintenance of the fence was a major undertaking for the department for many years.

In 1902 the Chief Rabbit Inspector and six other inspectors were transferred to the department along with the Chief Veterinarian and his assistant, and a number of stock inspectors.

From 1905 to 1911 the department had two senior positions of Under Secretary and Director. Before this, the senior position was titled either Secretary (1898–1902) or Director (1902–1905).

HC (Hubert Charles) Trethowen was appointed as Under Secretary in 1920. At that time there were 36 general division and 57 clerical officers. The number of clerical officers reflects a big accounting section in that year which did not appear before or afterwards.

The Chapman State Farm and the Narrogin Experiment Farm were established in 1903. In 1906 land in the Brunswick area was vested in the department “for the purpose of creating a Dairy Farm”. In 1907 the Nangeenan (Merredin) State Farm was transferred from the Lands Department to Agriculture. In 1913 the Commissioner for the South West was instructed by the government to establish a model dairy farm at Denmark.

In 1909 the department took on the responsibility of providing water supplies and road clearing in advance of settlement and as an aid to settlement in the new ‘outlying’ areas.

The clearing of land for cropping was slow and difficult before the advent of tractors and new machinery.

The department also provided initial capital to civil servants who were allocated blocks in the Tammin area.

In 1911 a new branch with eight stationary traction engines was established to pull trees.

In that dry year many settlers who had taken up land only a few years before, lost their crops, including their seed. The government decided to supply seed from the State farms, another major activity for the department.

Other activities were added to the department’s responsibilities. For example, it managed a project at Jigalong Station breeding horses for public service use. A farm at Yandanooka produced meat for city markets.
In 1910 the Minister decided that, because of the vast area, the diversity of agriculture and the multitude of problems facing the new settlers, it was appropriate to divide the work of the department and secure senior specialists in three distinct spheres. To meet this need he appointed three new Commissioners:

- Mr GL (George Lowe) Sutton as Commissioner for the Wheat Belt
- Mr JMB (James Millar Brook) Connor as Commissioner for the South West
- Mr JF (James Frederick) Moody as Commissioner for the Fruit Industries.

At the same time the expert staff was further strengthened by the appointment of a botanist and pathologist, two new veterinarians, and a sheep and wool instructor.

The reports of Sutton, Connor and Moody and their subsequent work, coupled with the increased professional capacity provided, resulted in a major shift in the work of the department. The arrangement appeared to work well, particularly for the wheatbelt where Sutton proved to be both innovative and decisive, and the problems and solutions were much clearer.

GL Sutton, Director of Agriculture from 1921 to 1937. Sutton brought science to agriculture and established the department as a highly professional body.

In 1912/13 the WA Government decided to establish an implement manufacturing factory, and gave the responsibility for its development to the Department of Agriculture.

In 1918 Sutton suggested that consideration be given to settlement east of Merredin, which was then regarded as the eastern margin of the wheatbelt. He went further and recommended that the department should develop a cadre of graduate agricultural scientists to advise potential settlers.

**The 1920s**

World War I finished in late 1918 and the settlement of ex-servicemen onto farms was a major post-war reconstruction initiative around Australia. In Western Australia some were settled in new districts while others were settled on farms created by the government buying up and subdividing large estates. Virtually all these properties were uncleared. Their development, coupled with the further expansion of existing properties, saw the State’s agricultural industry launched on another period of rapid expansion. This continued until the start of the Great Depression late in 1929.

Concerned at the continued large dairy imports, the State signed an agreement with the British Government in 1919 to develop dairy farms in the heavily timbered high rainfall districts of the South West. This was known as the Group Settlement Scheme and continued to the early 1930s. The department was heavily involved with its implementation, particularly in planning and pasture development.

In June 1921 the department Under Secretary HC Trethowen outlined a new policy. While the functions of the department were primarily advisory, educative and protective to the agricultural industries, an agricultural expert was to be appointed as permanent head and to employ a limited number of highly qualified technical officers “whose duties will keep them entirely in the field advising farmers”.

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Despite expectations that the business functions would be transferred to another department to manage, the department retained the Metropolitan Abattoirs and Saleyards, Kalgoorlie Abattoir, the City Markets, Cold Stores and Butter Factories.

GL Sutton was appointed Director of Agriculture in July 1921. He proceeded to appoint available graduates and to implement a cadetship scheme for training young men at university.

Sutton arranged for field officers to work closely with Agricultural Bank inspectors. He employed two veterinary graduates, one of whom was a veterinary pathologist. In 1922 he negotiated the return of the botanist and pathologist and his assistant. In general, Sutton took the first steps to establishing the department as a professional body. He also established the branch structure that would largely endure until the 1970s.

In 1923 a particularly serious animal health crisis occurred with an outbreak of rinderpest among dairy cattle. Through immediate and firm action the disease was successfully dealt with, to the great credit of the professional veterinarians on the ground at the time.

Sutton started the field service of the Department of Agriculture by posting four graduates and a diplomate to country towns as advisers. A viticulturist and an apiculturist were also appointed. Most future senior staff were appointed as graduates or cadets in the first five years of Sutton’s directorship.

The appointment of veterinary pathologist Bill Bennetts was a significant increase in the department’s research capacity. Bennetts had an outstanding career. Mr JF (John Francis) Filmer, was important in resolving nutritional problems of cattle in the Denmark area.

In order to improve the genetic base of the dairy industry the government enacted the Dairy Cattle Improvement Act in the mid-1920s.

Mr HJ Hughes was appointed as the first Principal of Muresk Agricultural College in November 1925 and took over management of the development of the college, which opened in 1926.

A special development, starting in 1924, was an arrangement for officers to give talks every second Monday on radio through Westralian Farmers Cooperative Limited’s new broadcasting station (6WF) in Perth. This was at the invitation of the company and the arrangement continued for many years.

During the mid-1920s, new experiment stations were opened at Avondale (1924), Wongan Hills (1925), and Salmon Gums, Ghooli and Dampawah (1925/26).

In the late 1920s and early 1930s, new veterinary appointments and officers returning from overseas tertiary studies began to make a significant contribution to the department and Western Australian agriculture.

Overall, the decade from 1921 to 1930 was a good one for the department in terms of building resources. It also saw a shift to a professional scientifically-trained cadre who would drive the organisation in the years ahead. The major downsides were the start of the Great Depression as the decade closed and that by 1925 the fight to keep rabbits out of WA had been lost.

**The Depression and following decade**

There was probably no real beginning or end of the Great Depression from a State agricultural point of view. It depended on which industry or part of the industry was concerned. The big industries of wheat and wool were the worst hit. The dairy, pig and fruit industries did not suffer the same severe price depression. Many returned servicemen who had taken up new land in 1921 or 1922 faced prices below the cost of production.

Results through the decade were also affected by seasonal conditions. It was not until 1939 when a yield of 13.8 bushels per acre was recorded that the crop equalled
1933. An important feature was the move to sown pasture.

The major changes in professional capacity of the department, started in the 1920s, continued slowly. Sutton, in his 1935/36 report written about 12 months before he retired, reviewed the development of the department in his 15-year term. His general comment was that “it is apparent that there has been a complete change in the organisation through the establishment of a scientifically trained advisory staff and a strong team of specially trained research officers”.

In 1935 the department was asked to help the University of WA with lectures pending the arrival of a new professor.

Sutton was concerned at suggestions that a University of WA agricultural research institute should be established. He felt that this arose from a misconception that departmental researchers were distracted by administrative requirements or that the department could not undertake long-term projects. His concern rested on the potential competition for scarce funds.

The overall organisation of the department was stable from 1930 to 1940. Sutton retired in 1937 and in 1941 Mr GK (George Kingston) Baron Hay took over as Under Secretary.

Initially, the problems brought on by the Depression created greater demand for departmental services. In 1931 Sutton bemoaned the fact that, even making every effort at reorganisation, it had not been possible to meet this increased demand.

As years passed, the department’s reports display increasing emphasis on experimental and advisory work. Plant breeding was continuing at the experiment farms; trace elements started to be used.

The major increase in pasture and its topdressing with superphosphate which had started in the high rainfall areas, caused growing interest in legume-based pasture in the medium rainfall areas. The work of TC (Thomas Charles) Dunne at Muresk provided the foundation for publication by Dunne and FL (Francis Leonard) Shier of An Alternative Rotation for the Wheatbelt in 1934. This became the basic text for the development of ley farming which was to be the crop rotation from the 1950s to the early 1980s.

In the mid-1930s a cereal research laboratory was set up in the department to examine the bread-making characteristics of flour from WA wheat varieties.

The 1930s was a period of dramatic success in the solution of serious health problems in sheep and cattle in the medium and higher rainfall districts.

By 1931 the research on ‘braxy-like’ disease, which Bennetts had started in the mid-1920s had been successfully completed and a vaccine prepared for commercial use to protect sheep. In 1933 ‘Denmark wasting disease’ was shown to be due to cobalt deficiency by EJ Underwood and veterinarian JF Filmer.

In 1937 HW Bennetts showed that the problem of enzootic ataxia in lambs at Gingin was due to deficiency of copper. This work resulted in extensive soil and plant surveys and analyses being carried out by the animal and plant scientists, together with field experiments. The results obtained progressively over the next decade provided the basis for the major expansion in WA agriculture during the three decades ahead.

The problem of botulism or toxic paralysis among sheep in the inner wheatbelt was shown to be due to a low protein diet resulting in a depraved appetite. The final solution came through a vaccine, prepared by CSIR, which was shown to protect sheep from the toxin under field conditions.

Tuberculosis in the dairy herds supplying milk for human consumption was a cause for serious concern at this time but a slaughter-out program did not start until after World War II.

During 1934/35 the first Dairy Products Marketing Board was set up. Its role was primarily to regulate and organise the
production, sale, distribution and storage of dairy products and related plant and equipment, and for plant inspections. The department was responsible for its implementation.

In 1936/37 the problem of ‘falling disease’ of cattle was identified in the Margaret River area, and shown to be cured by treatment with copper. ’Coast disease’, a name given to the very poor performance of cattle grazing pastures on the sandy soils of the south and west coast was controlled by providing stock with both copper and cobalt. In 1938/39 a test for contagious abortion was made available by the department’s veterinary pathologists.

There had been concern about poor crops in the Salmon Gums area from early in the settlement. Despite this knowledge, the government proceeded with an ambitious plan to develop 3500 farms between Salmon Gums and Lake King. Land west of Lake King was also encompassed in the scheme. Dr LJH (Laurence John Hartley) Teakle was asked to look at the soils of the area after his return from PhD studies, and in 1929 he identified the natural high salt content of the soil as the cause. This resulted in an extensive soil survey program. The combined effect of the soils data and the Depression led to the 3500 farm scheme being abandoned and the farms in the Salmon Gums area re-planned.

In 1936, in conformity with other states, a Soil Conservation Committee was formed within the department. No real action was taken until after World War II.

Insect and plant pathology problems were ever present. The primary sheep blowfly, *Lucilia cuprina*, which was first recorded in Australia in 1913, was found in WA in 1934. In 1937 concern was expressed about the predations of the bryobia mite.

The apple weevil had reappeared and was a source of concern. There were outbreaks of black spot or scab in apples in 1930, 1934, and early 1936. They were controlled and heavily infested nurseries in the eastern states were identified as the source.

Webworm continued to damage crops sown on land previously in pasture which were ploughed and sown after the first rains. Redlegged earth mite was a major pest of pastures for the whole decade. The little plague grasshopper (*Austroicetes cruciata*) occurred in plague proportions in 1937/38 for the fourth year in succession.

The Plant Pathologist responded to increasing demand for Rhizobial cultures.

The department’s Dairy Laboratory examined a large number of milk samples for bacteriological content, cream content and solids-not-fat. It also introduced improved cheese starters and distributed them to manufacturers.

The Botany Branch began its seed certification program in 1934. Outbreaks of codlin (sometimes called codling) moth occurred in Collie in 1935 and 1937 but were effectively eradicated by 1938/39. In 1938 apple scald was found in an orchard but eradicated by 1939.

A problem of ‘die back’ or ‘wither tip’ of apple trees, particularly in the Bridgetown district, was investigated. The conclusion was that copper deficiency was the cause.

Tropical fruit production at Carnarvon began in the early 1930s. While it was planned in 1938/39, a research station was not developed there until after World War II.

The Manjimup district became the focus for the developing tobacco industry during the decade.

In the early 1930s the irrigation areas based on dams at Harvey and Collie were beginning to take shape.

Although concern was expressed about vermin (rabbits, dogs, emus and eagles), in the early 1930s, no real control was achieved until the Agriculture Protection Board was formed in 1952.

**The 1940s**

The 1940s were dominated by two different issues, World War II and post-war adjustment. Germany and Italy were the
initial aggressors in 1939 but Japan joined them in December 1941. The war finally ended in September 1945 but it was the early 1950s before Australia got back to ‘normal’.

Throughout the war the department was required to do whatever was necessary to support the war effort and keep the economy running. The early part of the war saw many young officers enlisting and coupled with other war-caused difficulties requiring officers to undertake additional tasks, made it difficult to maintain normal services to industry. The management of war-caused shortages resulted in the appointment of 13 District War Agricultural Committees to manage issues at a local level, chaired by the department.

The department was also faced with additional work to meet the quality requirements of UK contracts initially and then the US armed forces. The American forces demanded high quality standards, which triggered the TB eradication program in WA after the war.

Outcomes included the establishment of fruit and vegetable processing, and egg powder production. Statutory marketing of many agricultural products was introduced during the war and continued afterwards.

The period saw continued investigation of the extent of trace element deficiencies across the agricultural areas.

In 1940 staff of the department recorded in the Public Service List was 146. By 1945 numbers reached 205 and in 1950 the total was 235.

In 1947 there were four country offices and three professional advisory officers stationed in the wheatbelt. One officer was at Geraldton, another at Beverley and the third had offices at both Kellerberrin and Merredin. This was the re-establishment of the department’s regional extension service.

In 1949/50 there was still a shortage of technical staff, and accommodation remained an issue at head office. Three new research stations were established at Bramley near Margaret River, Wokalup south of Harvey, and on the sandplain at Esperance.

In 1945/46 the department began a bacteriological and chemical survey of all butter coming forward. As more manpower became available, inspections at all levels were increased.

During 1947/48 the Commonwealth Government announced its intention to make $500 000 available for dairy industry improvement over five years, of which the allocation to WA was $32 250.

The decade proved challenging for the pig industry. In 1941 there was an outbreak of swine fever, which was eradicated on a slaughter-out basis. Losses to individuals resulted in a Pig Industry Compensation Act being passed in late 1942, and as a result of the outbreak swill feeding was prohibited. During the decade the demands of the UK contract changed, making production difficult. There were also major fluctuations in pig numbers influenced by the price of wheat.

Early in the decade the department began investigation into incidence of dystokia among lambing ewes. Subsequent work showed that the subterranean clover variety used contained an oestrogenic substance. By the end of the decade the problem was being managed in the field by added cropping and a focus on balanced pastures. Later, low oestrogen clover strains were found or bred which overcame this problem.

Malnutrition and sterility in dairy cows at Manjimup were also investigated. A similar problem in the Margaret River area was shown to be due to serious phosphorus deficiency. Bramley Research Station was the focus of future investigations to overcome this problem. Despite improved methods of treatment, mastitis continued to cause serious losses to the industry.

Maintenance of strength in export flour was an issue as the quantity of wheat delivered was only enough to provide for orders, with little opportunity to blend wheat of varying quality.
The annual cropping competitions continued and most were judged by departmental officers. Numerous trials were conducted on farmers’ properties.

The wheat industry was seriously affected by war production restrictions and fertiliser shortage. By the end of the decade, production was still well below the 1930 level.

In view of the fertiliser shortage a lot of work was done on the residual value of previous phosphate dressings, and on alternative fertilisers for market gardeners.

Reconnaissance east of Pingrup to Lake Magenta showed the heavy soils had high salt content and it was concluded that more detailed examination was needed before settlement could be recommended. Concern was also increasing among farmers about secondary salinisation in the agricultural areas.

In 1941/42 the Agriculture and Public Works departments established an experimental site at Carlton Reach on the Ord River and by 1942/43 the experimental areas were providing useful information. In the dry season of 1943 a soil survey was carried out on the irrigation potential of the Ord River Basin. Development of Kimberley Research Station began in 1948/49.

The Soil Conservation Act was passed through State Parliament and LJH Teakle was appointed the first Commissioner of Soil Conservation in 1945.

The apple industry was seriously affected by the war as there was very little export and acquisition of the crop. The department was responsible for estimating the crop through the war and to the end of the decade, which was a major undertaking.

During the war the government was pressed to maximise vegetable production and the department was heavily involved. Work included publication of a vegetable growing guide for home gardeners, which was reprinted many times and was still in demand 50 years later.

‘Vegetable Growing’ was first issued to encourage home gardeners to produce vegetables during World War II and became the reference book for them for many years.

Problems included shortages of fertiliser, shortages of seed, and inexperienced growers. Entomological and plant pathological problems were extensive, also requiring departmental involvement.

The Government Botanist made major advances in classification of species and preparation of the Flora of WA. In addition, in 1941/42 a list of plants with medicinal qualities, or the possible capacity to produce rubber, was prepared. A list of possible fibre plants was prepared and in 1943/44 investigations of the drug potential of a range of plants were carried out.

The Abydos and Woodstock pastoral properties were taken over for experimental purposes. They had to be substantially renovated and it was not until the early 1950s that work could start.

During the 1940s the area irrigated in the three main districts was consolidated, with heavy involvement of departmental personnel. Vermin continued to be a problem.
1951 to 1970

The period from 1950 to 1968 was one of the most seasonally favourable for agriculture in Western Australia's history. Large areas of scrubland and forested country were cleared with the large tractors that had become available. The development of light land for farming was made possible by the demonstration that when fertilised with superphosphate and the trace elements copper and zinc, it could be cleared and farmed profitably. This triggered the biggest land development in Western Australia's history.

Major development halted with the collapse of wool prices in 1968/69, the introduction of restrictions (quotas) on wheat production in 1968, and the drought of 1969.

In 1950/51 the demand for uniforms in the Korean War drove the price of wool to 1 pound and 9 shillings a pound. While tighter conditions developed in the mid-1950s, farming was still profitable. During the 1960s the push for development gained full pace. Most was driven by private farmers. The downturn in prices of the late 1960s was exacerbated in WA by drought in the medium and lower rainfall districts in 1969. In view of the general financial problems of the sector, particularly the wheat and sheep industries, the State and Federal Governments decided in late 1970 to introduce a Rural Reconstruction Scheme.

The dairy industry, which was not involved in the major expansion of the late 1950s and 1960s, started to adjust to poor market conditions in WA by drought in the medium and lower rainfall districts in 1969. In view of the general financial problems of the sector, particularly the wheat and sheep industries, the State and Federal Governments decided in late 1970 to introduce a Rural Reconstruction Scheme.

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The only notable change to departmental structure was the creation of the North West Branch in 1950/51 and recruitment of three new graduates to it. In early 1952 the department entered an agreement with the then Farmers' Union for the extension staff to cooperate closely with their branches in order to increase the efficiency of the extension effort.

In 1951/52 the Agriculture Protection Board (APB) was established under legislation and went through a period of establishment. Control of vermin and noxious weeds became its role, at arm's length from the remainder of the department.

Future accommodation was ensured with the new offices at South Perth completed progressively between 1957 and 1961. Most head office staff had transferred to South Perth by the end of 1959. A new research station was being developed at Badgingarra.

At this stage the department had 138 full time extension staff and 99 who combined advisory work with other duties. Extension staff dealt with all aspects of production except financial management.

Departmental services

The department provided a wide range of services, which included:

- Artificial breeding for the dairy industry, laboratory testing of milk quality and purity, milking machine testing, herd recording, land grading and irrigation, contour surveys, identification and classification of plants, grain and flour inspections, stock, produce, and seed inspections, seed testing and certification, pedigreed grain production and potato seed certification.
- Veterinary services covering tuberculosis testing, advice and control of a wide range of other diseases including vibriosis and leptospirosis, footrot eradication in sheep, lupinosis and white muscle disease research, identification and advice on pig diseases, and examination of samples for mastitis from dairy cows. Post-mortem and parasitological services were provided to the
poultry industry. Separately, the APB was an almost entirely service and regulatory organisation. Overall the department was responsible for administration of 50 Acts of Parliament.

Research stations
In the 1960s research stations in the north were at Kununurra, Carnarvon, Abydos Woodstock and Wiluna. Wheatbelt stations were at Chapman, Wongan Hills, Merredin, Badgingarra, Avondale, Mt Barker and Esperance. In higher rainfall areas they were established at Wokalup, Bramley, Manjimup and Denmark.

Research
Extensive research was carried out as numbers of specialist and general staff increased, reducing pressure from the farming community for immediate advice from individual specialists. Some major areas of research are listed below:

Soils
Soil structure issues, saltland vegetation studies, water run-off from catchments, nitrogen fertilisers on grassed waterways, land preparation for weed control and trash removal and ploughing comparisons between disc ploughs and scarifiers were all dealt with.

Cropping and development
Identification of the need for copper, zinc, molybdenum and occasionally manganese fertilisers across the State, studies of residual phosphate, nitrogen use in later crops in a multi-crop system, differences between copper ores, continuous cropping, nitrogen sources, nitrogen fertiliser on pastures in higher rainfall areas, rates of superphosphate on clover on new land, maintenance dressings on older clover pastures, the residual value of potash, legume species for deeper sands and *Rhizobium* strains for a range of legumes and environments were all included in the department’s work.

The effects of variety, climate and soils on the nitrogen status of plants were examined, as was the effect of nitrogenous fertiliser on grain quality and yield.

In the early 1960s the interaction between stocking rate and phosphate showed it was essential to test fertiliser rates for pastures under grazing. There was also widespread research on stocking rates.

Orchards
Fertiliser use on young fruit trees, further work on storage problems of fruit, fruit thinning, and rootstocks.

Viticulture
The focus was largely on the dried fruit and table grape industries. Currant pruning techniques, alternative packing material and technique for export grapes, use of gibberellic acid, and the possibility of using river or tributary water were investigated.

Early work began on establishment of a wine industry in the South West and studies continued on the established wine grape industry of the Swan Valley.

Vegetables
Variety trials were carried out on a range of vegetables. Potato variety trials pointed to Kennebec being the best for processing under WA conditions and the hybrid tomato Lakelend x Smoothskin showed great promise.

Pastoral areas
The Ord regeneration project started early in the 1960s. Buffel grass was tested on the Pindan and demonstration of the regeneration of denuded country in the Fitzroy Valley commenced. Work at Abydos Woodstock involving pasture and stock management continued.

Animal studies
Experiments were carried out on time of lambing and nutrition of ewes before mating. Studies showed that even in a ‘balanced’
pasture some varieties of subterranean clover could influence ewe fertility. Following the identification of major differences in isoflavone content of subclover cultivars, extensive work on the impact on livestock and breeding low isoflavone cultivars was carried out. Time of mating was tested in the more favoured areas and weaner nutrition studied.

A general 'ill-thrift' of sheep was attributed to marginal copper and cobalt levels and low selenium levels in pasture were identified throughout the South West. Lupinosis studies continued.

Resistance of mastitis to penicillin treatment was reported early in the period. Vibriosis was identified as the main source of infertility in the dairy herd.

In poultry, studies of the nutrition of both meat birds and layers showed that the energy to protein ratio was important.

Plant diseases
Root rots of cereals were shown to be a serious problem with initial crops following a period of clover ley. A new rust strain, 21-2, had removed Gabo from the list of recommended wheat varieties. Yellow dwarf virus of wheat was discovered in WA for the first time.

Work commenced to free important apple varieties of the apple mosaic virus. Virus indexing of plums commenced. Fumigation and the long-term impact of nematodes in orchards were tested.

Clover stunt virus was identified at Esperance. In a combined study with other organisations, Phytophthora cinnamomi was identified as the causative agent of Jarrah dieback. Control was found to be possible only through restricting access to clean areas.

Weeds
Work was carried out on weeds such as cape tulip and soursoob, together with control of weeds in vegetable gardens.

Vermin
The Agriculture Protection Board continued its cooperation with shire councils and farmers, reducing vermin to low levels compared with previous years.

1970 to 1994
Marketing issues
The 1970s was a period of difficult marketing conditions, due largely to the agricultural policies of the European Economic Community. These were exacerbated when the United Kingdom joined in it 1971. A large part of Australia's market for fruit, butter and lamb to the UK was lost as a result. The United States also decided to protect its markets against the European policy which compounded the effects.

Commodity prices fluctuated sharply. A board was established to acquire all lamb and equalise returns to growers according to the quality of the carcase produced for export and domestic markets.

The dairy industry continued the adjustment which had started in the mid-1960s. Despite these difficult conditions agriculture had a gross value of production of $2 billion for the first time by 1982/83. In that year the eastern states were affected by drought and WA produced 20 per cent of the total Australian gross agricultural product and supported about 25 per cent of Western Australia's work force.

Reorganisation of the department
In July 1977 the Department of Agriculture was reorganised. This consolidated the growing focus on regional services. The major district offices became separate branches, with the officer-in-charge (OIC) as the branch head. Staff at these offices became responsible to the officer-in-charge who directed their duties on a day-to-day basis.

A Regional Services Division was created to take over the district offices, which included the advisory staff and all the regional offices.
The officers-in-charge were responsible directly to an assistant director who was part of the senior administration. Modifications were also made to the divisional and regional research and extension structure. From the early 1980s there was a trend to reduce funding of agricultural research and extension across Australia. As a result, in 1980/81 some traditional services ceased and others were modified. This trend was emphasised in 1982/83 when suggestions were made at Commonwealth level that agriculture was over-funded. Subsequently CSIRO funding for agricultural research was reduced. Nevertheless the department continued to grow, largely due to increased funding from Rural Industry Research Funds.

In 1983 the regionalisation process was extended through the transfer of responsibility for most research stations from the Division of Plant Production to appropriate district or regional offices. Following an internal review in 1982 it was recognised that a re-organisation of the research stations was necessary.

The mid-1980s saw increased community awareness of environmental issues. This was supported by State and Commonwealth Governments with financial assistance provided to address land degradation problems.

During 1986/87, 80 per cent of agricultural income came from grain cropping, 11 per cent from fruit and vegetables and a further 9 per cent from other industries. The industry continued to be under price pressure and in real terms wheat prices were 62 per cent of those in 1976/77.

In 1987, after discussion with the Minister, further changes were agreed. This resulted in modification of the structure and renaming of the resultant positions. In the process the Western Australian Herbarium was transferred to the Department of Conservation and Land Management.

In a move seen to further strengthen the regionalisation initiative, directors were appointed to each of seven regions covering the State.

The department also moved into farm management extension, which proved successful. It complemented this initiative with development of a computer-based farm planning tool called Landman combining both the environmental and economic aspects of farming.

At the same time the pastoral land inspectors were transferred to the Department of Agriculture from the Department of Land Administration, integrating inspection staff with professional rangeland management staff for the first time.

A dairy farm model was developed to maximise income from dairy enterprises.

In 1987/88 the Animal Health Division established an Epidemiology Branch to provide a disease control planning and development service, a field-based veterinary research service and a specialist advisory service. Laboratory services were provided at South Perth, Bunbury and Albany.

The 1989/90 year was a turning point for the sheep industry. The reserve floor price was lowered to 700 cents per kilogram and subsequently abandoned. There was also a major disruption to the live sheep trade to the Middle East. Coupled with a fall in wheat prices, this produced substantial challenges for the department.

An outbreak of Queensland fruit fly, a substantial increase in footrot in the South West, a major spring outbreak of plague locust, and apple scab in the Pemberton–Manjimup region compounded the challenge.

On 1 July 1989 the approved average staffing level for the department was 1710 full-time and temporary equivalents (FTEs). This increased by June 1990 to 1810 FTEs. The 1990s proved to be another period of change in the structure and management. In 1990, the Minister for Agriculture approved a policy based on full recovery of the cost of those services to industry which were delivered on an individual basis without benefit to other persons or the State as a
whole. This was coupled with a continuing fall in departmental budgets in real terms both from State sources and from industry funds.

There had also been a change in the reporting framework across the Public Service. There was now a need to follow the ‘new age’ management structure of identifying objectives and reporting formally against those objectives. This changed the structure of the department’s reports and appeared to reduce the information provided to the public.

In 1991/92 a need to reduce staff appeared to trigger a further restructure. Operational divisions were cut from eight to four. The management change involved the development of full program management with a strong focus on industry and market development and continued progress towards sustainable production systems for all sectors of agriculture. Activities were packaged into four overall programs:

1. Industry and Market Development
2. Sustainable Agricultural Systems
3. Industry Support and Assistance

By 1 July 1993 the department had moved to full program management. All activities were directed through 33 operational programs, each with clear objectives, planned achievements and outcomes, with each subject to performance evaluation.

In the 1993/94 report the Director General stated that the future work of the department would be closely aligned to market opportunities. He commented that over the past two years the department had changed its emphasis from an organisation driven by a production-based research to one with a sharper focus on marketing.

**Issues for the period**

In May 1987 unacceptable levels of organo-chlorine pesticide residues were detected in consignments of beef exported to the United States, threatening the future of the major meat market. All organo-chlorine pesticides were deregistered for any agricultural or horticultural use and action was taken to avoid further problems. Problems occurred due to the historical use of organo-chlorine pesticides on potato crops. The department had the lead role in dealing with this problem.

Seasonally, while 1970 was satisfactory in the agricultural areas and greatly assisted the recovery from the 1969 drought, the remainder of the 1970s and the first half of the 1980s experienced more poor years than good ones in the cropping districts.

The period from 1975 to 1990 saw the greatest change in the methods of crop production.

In the early 1970s drought and reduced stock numbers, coupled with better returns from continuous cropping, resulted in a move away from the clover ley system of farming. Progressively, the industry moved to continuous cropping without a pasture phase.

In the mid-1970s it became commercially possible to selectively or totally control weeds by spraying with herbicides, and this progressively changed the method of planting crops. While this achieved effective weed control there remained issues such as how much cultivation was needed to provide the necessary seedbed. Within this new framework developments took place which totally changed the cropping process and the potential for yield, particularly in the medium rainfall districts.

From a research and development aspect there were new challenges. Cereal varieties had to suit the longer season, the new nutrient cycle needed to be understood, the level of cultivation for seedbed preparation and nutrient mobilisation needed study and the appropriate rotation to establish a sustainable agriculture had to be defined. Experimental work and farmer innovation resulted in further changes to the cropping system.
At the same time the first effects of climate change started to be felt. Towards the 1990s a major problem of frost damage developed. This was caused by the drier periods in spring having clear night skies which allowed rapid cooling of the landscape with temperatures falling to frost levels. The need to settle on a new crop rotation and to develop suitable varieties to match that rotation and the changed climate conditions was a major challenge.

In 1987/88 the first phomopsis-resistant narrow-leafed lupin was released. It had a higher protein and lower alkaloid content than previous lupins.

The Australian Wheat Board introduced a varietal control scheme for the 1980/81 harvest, based on a trial approach in the previous year. Growers were required to name the variety of wheat delivered for each load. Incorrect naming could attract a penalty. Differential prices were paid depending on the assessed quality of the varieties. A number of varieties targeted at different markets were introduced.

In 1987/88 the production of pedigree seed from research stations ceased and basic seed was supplied to 191 registered seed growers for production of commercially registered or certified seed. This was the end of a service which started in 1911.

There was particular interest in the field pea as a possible legume in the rotation for heavy soil types. Other crops such as chickpeas, lentils and faba beans and different lupins were also being investigated.

A problem of hardpan development in some light soils, resulting from the previous traditional cultivation methods, was identified. These soils gave substantial yield responses to deep ripping with specialised machinery which causes minimal surface disturbance.

A re-examination of the impact of stubble retention through the 1985/86 season showed that retained stubble assisted in moisture penetration and reduced evaporation on fine-textured soils, increasing yield substantially when compared to areas where stubble had been burned.

New medics, hard-seededness and resistance to attack from redlegged earth mite became important issues in legume breeding.

In 1993 a Cooperative Research Centre for Legumes in Mediterranean Agriculture (CLIMA) was approved. The department was a partner, and parts of the legume breeding programs were transferred to the new organisation.

The department developed a range of models to help farmers make decisions on cropping programs. During 1990/91 a technical manual for wheat producers called *The Wheat Book* was produced and sent to growers.

The entomology group was faced with a continuous challenge of insect damage to commercial crops, pastures, gardens and livestock. In the post-war years there was also a continuous flow of new synthetic insecticides which needed to be assessed for effectiveness.

The plant pathologists faced a continuing stream of enquiries about endemic diseases of crops, gardens and pastures. The scope for biological control was limited and the major tools were fungicides, management or breeding to avoid a particular problem.

Weed research was focused on the new cropping systems. The department was also heavily committed to biological control and the weed agronomists were working with other specialists in a number of programs to bring biological control agents into WA to help control specific weeds.

Fruit

The loss of European markets made the period difficult for pome fruits, which were the major fruit industries. The loss of markets was due to a combination of high freight rates, some dissatisfaction with the varieties supplied, competition from other southern hemisphere growers and stored fruit from European suppliers. It was a national
problem but WA and Tasmania were more affected than other states because of their reliance on export. Restructuring of the apple and pear industry was discussed at national level.

The department experimented with new trellised planting systems which reduced land costs and allowed for machine management of plantings.

A fruit variety improvement scheme was initiated under which trees were established at Stoneville Research Station as a source of true-to-type virus-tested rootstocks. Departmental officers continued their involvement with industry in the development and testing of machinery to reduce the costs of operations such as pruning and harvesting. One such machine was a mechanical harvester on the Tatura trellis production system.

In the mid-1980s there was limited distribution of the department’s new apple varieties Cripps Pink and Cripps Red for trial and evaluation purposes. These were seen as having excellent potential for export and proved highly successful. Their fruit is now internationally renowned by the trademarked brand names Pink Lady™ and Sundowner™.

50 containers were exported in 1987. Although there were some initial complaints further orders were placed for 1988.

In 1987/88 on-farm trials carried out using watering regimes during summer resulted in yield improvements of 100 to 200 per cent in avocados.

**Viticulture**

In 1977 the department piloted grape growing in the Manjimup district and this provided an alternative industry for growers. In 1985/86 fertiliser trials at Margaret River and Frankland River confirmed remarkable responses to both superphosphate and nitrogen in vineyards.

**Vegetables**

Most vegetables were consumed in WA, with about one-sixth of the gross income coming from exports to Asia. Vegetable research centred on reducing the cost of production. A major program to provide a blueprint for the production of French fry potatoes began, covering a range of varieties and species of vegetables considered to have export potential.

**Floriculture**

The department initiated several research projects on propagation, tissue culture, postharvest handling and nutrition. A successful home garden information section was established for the general public.

**Inspection**

While largely unnoticed, inspection continued to be one of the most important parts of the department’s activities, as prevention of pests and diseases entering WA was a key to long-term viability of the agricultural industries. The department maintained a plant quarantine facility to assist with the introduction of potentially improved genetic material to aid stock and plant production.
The importance of continued vigilance was illustrated when an extensive outbreak of apple scab was identified.

**Animal industries**

The Animal Health Division continued to maintain important services for the livestock industries. These included processing applications for cattle tags, processing claims under animal compensation arrangements, diagnosis and advice on a range of stock diseases, inspection of abattoirs, diagnosis of diseases or nutritional deficiencies based on laboratory analyses, and quarantine and export inspection. The footrot eradication campaign had been in place for some years and a new test for footrot, the protease test, fortuitously was developed and accepted nationally as the diagnostic yardstick. This ensured that the virulent form was accurately identified.

In 1982 the toxin produced in annual ryegrass toxicity (ARGT) was identified in work with CSIRO. A new test was developed for leptospirosis and a live vaccine was developed for salmonellosis. During the period brucellosis was eradicated under the national eradication program. The tuberculosis eradication program was started initially by the department with the market milk producers in the mid-1940s. The national program began in the south in 1970 and southern areas were declared provisionally free in 1976. The disease was subsequently eradicated from the remainder of the State.

**Dairying**

The 1970s was a period of rapid adjustment in the dairy industry. In March 1971 there were 815 dairy farmers producing milk and cream for manufacture and 558 producing milk for the domestic market. By March 1980 there were 38 dairy farmers producing milk or cream substantially for manufacture and 585 farmers producing market milk.

In 1979 a new laboratory was opened in Bunbury and farmers were offered a wider range of services, including owner-sampling for herd recording. Farmers using the scheme rose from 26 to 42 per cent over two years.

In February 1987 a price penalty was imposed for continued high cell counts, to improve milk quality. The Dairy Industry Authority also used price incentives when it became responsible for quality control in 1987/88.

The department continued to provide advice to factories, which was particularly important to smaller factories and milk processors. During the late 1980s and early 1990s dairy industry study groups developed in a number of centres as extension/discussion groups had a positive effect on production.

**Food technology**

The Food Technology Branch covered a wide range of issues, including the demonstration that animals which are less stressed give better quality meat, better use of animal skins, a pork product for the Singapore market and production of paper from barley straw.

**Beef cattle**

Improved management of the pastoral cattle industry was a focus. By 1990/91 a long-term program on the Ord River Research Station had shown that substantial gains in efficiency and profitability were possible through improved weaning practices. This approach began to be adopted.

A beef genetics and technology experiment at Wokalup opened the way for embryo-based selection which had the potential to double the rate of genetic progress in a breeding herd.

During the period there was a general thrust across Australia for development of a carcase classification system for the beef industry. In WA a carcase classification group was established to develop and promote the use of objective descriptions for the marketing of livestock carcases and meat.
In 1986/87 the national meat body, Aus-Meat, saw WA as having the most comprehensive and complete system for carcase classification and asked the department to hand over responsibility for monitoring the various schemes. Other research showed that silage was a better way to conserve high quality roughage than hay.

**Sheep industry**
The sheep industry was in good condition through the 1970s and 1980s, following the price recovery in 1972. Major research issues related to annual ryegrass toxicity, facial eczema, sheep lice and lupinosis. During the 1970s and 1980s the Division of Animal Health carried out research in a wide area of animal production and management. During 1986/87 farmers responded positively to legislation requiring them to contribute to a fund for lice eradication, and their representatives were involved in advisory services to the program. The collapse of the wool market and price support scheme in 1990 ushered in a very difficult time. Sheep numbers fell sharply.

The department worked with farmers to devise strategies to deal with the reduced income from sheep. The Wool Industry Strategic Extension Program was developed to extend the immediate and long-term implications of the wool industry changes to growers.

Experiments showed sheep subjected to very cold conditions immediately after shearing could not maintain body temperature for more than a few hours, leading to potential heavy losses.

In 1990/91 seven research programs were analysed and it was concluded that increased lambing percentage and decreased fibre diameter were likely to give the greatest industry benefit.

The Animal Breeding and Research Institute, established during the period near Katanning, carried out extensive work on artificial breeding of sheep against comparisons between different Merino strains.

New medic species were showing great promise as pastures on suitable soils. Other animal research covered poultry and pig nutrition. Potential cashmere, kangaroo and emu industries were investigated but failed to establish successfully.

**Rangeland management**
The development of rangeland management for the semi-arid pastoral country and the Kimberley was an important part of the department’s work over four decades from the 1960s. This was based on major surveys and the production of quality maps plus guides for future use. A monitoring system covering many of the land systems was introduced.

After successful revegetation of the denuded and eroded Ord River catchment a similar approach was considered for regenerating the degraded soils of the Fitzroy Valley. Following experimental work the WA Government committed to this regeneration and voted the necessary funds in 1982/83.

**Soil conservation**
Soil conservation legislation was amended in 1982 to strengthen its provisions and provide for the formation of landcare groups within soil conservation districts. This legislation was used extensively in the late 1980s and 1990s to drive natural resource management.

Soil management studies included the use of geophysical methods developed for the mining industry, for salinity identification. Remote sensing continued to be used in land use study both in the agricultural and pastoral areas. Land capability was assessed in areas of the South West. Landsat imaging and other evidence identified a waterlogging problem in some higher rainfall areas and the upper Great Southern was studied in some detail. The role of surface trash in countering wind erosion was examined.
Studies of structures to conserve water in the eastern agricultural areas continued. The impact of wheat and lucerne on reducing groundwater recharge was compared.

Eutrophication studies of coastal water bodies due to phosphate and nutrient leaching from adjacent agricultural land continued.

Experiments showed trickle irrigation gave better yields and quality on some vegetables than sprinkler irrigation.

The Esperance Research Station was redeveloped to demonstrate a sustainable farm system for this area. This included some deep drainage.

Deep drains installed by farmers in the wheatbelt were also studied. The grazing value of halophytic shrubs was further tested under a range of stocking rates.

Protection of the Denmark River from further salinisation commenced.

The treatment of sandplain seeps to manage salinity was demonstrated.

**Plant research**

After the major work on plant nutrition through the 1940s, 1950s and 1960s, the 1970s was one of consolidation and integration of the knowledge base and investigating the impact and opportunities of the new agriculture in cropping.

Issues of particular interest were the residual value of trace element applications, nitrogen in the new rotations, phosphate in soils after years of topdressing, leaching from sandy soils, and the development of diagnostic techniques. Considerable time was taken in testing the usefulness of some commercially advertised soil amendments and fertilisers against the extravagant claims made for them. The impact of acidity and the potential for various rates of lime to neutralise acidity were studied.

Soil testing was critically studied, including ways to increase its accuracy. A number of models to help farmer decision-making were developed. In 1988/89 the placement of phosphate fertiliser in narrow bands below the seed was shown to be more effective than the conventional banding of seed and fertiliser together. The use of peas in the rotation was shown to have a big effect on the following wheat crop. Work was undertaken with tagasaste on deep sands. The department also developed a furrowing technique for planting crops on water-repellent sands.

**The Ord River**

As a direct result of research after 1977 (when the cotton industry failed) a double cropping system was developed for the Ord River Irrigation Scheme. The components included soya or mung beans in the wet season and sorghum or sunflower in the dry season. High sugar yields continued on the pilot farm but markets remained difficult.

**Overseas activities**

There was strong overseas demand for the department’s expertise both in terms of Western Australian agriculture and its administrative approach. This resulted in four overseas projects being established during the period.

**1995 to 2008 – A change of focus**

Just as 1970 marked the end of the great period of expansion, largely in the medium and lower rainfall areas, the mid-1990s saw the completion of consolidation and development of new cropping methods within that framework. It also saw development of the viticultural industry in the South West and Great Southern and movement of horticultural activity out of the Perth Metropolitan Area to other areas to make way for urban expansion.

The department started to focus more on the specific needs of markets and opportunities. Increased productivity and emphasis on quality control were needed to ensure that industry could meet price competition,
particularly in the corrupted markets which continued to plague world trade in commodities.

1994 Review

A major review of the Agriculture Portfolio was submitted in October 1994 covering the Department of Agriculture, the Agriculture Protection Board and the Rural Adjustment and Finance Corporation. While its recommendations were progressively implemented over the following 18 months it is hard to see that they made any substantial difference to the overall thrust or the administrative structure which had been set in place and reported in 1992/93. The recommendations, implementation and outcomes of the review are discussed in Chapter 5.

As indicated, structural and management changes were initiated in early 1993 (before the review). Overall, these changes appear to have had long-term detrimental effects on the department’s cohesiveness, not anticipated at the time.

In November 1994 the then Director General of the department, resigned. The new Director General commented in his June 1995 report that: “… future priorities will reflect a strong market orientation to research and development, a commitment to the sustainable development of agricultural production and land use and a renewed commitment to protection of the agricultural resource. There will also be a stronger focus on the delivery of services from regional bases”.

A similar statement had been made by his predecessor in 1993 and would be made by his successor.

The review combined three organisations under the name of Agriculture Western Australia and resulted in the loss of almost 120 positions in response to a voluntary severance package offered in November 1996. The loss of these positions was a significant and unfortunate outcome. This clearly reduced the capacity of the department to provide services. To the extent that experienced staff was lost, it was a double loss of capacity. A further loss came from the impact on morale. This was obvious at the time and recovery was slow.

The amalgamation of RAFCOR with the department departed from the original intent of keeping the adjustment decision-making body separate from the research, advisory and inspectorial role of the department and from political interference. The amalgamation with the APB may have had some minor advantages but these would have been small following changes from the 1987 review. Subsequent reduction in the role of the APB has seen a surge in vermin problems in outlying areas.

In 1996/97 the operational functions of the department were carried out under three programs:

1. Industry and Market Development
2. Sustainable Rural Development

Industry and Market Development comprised eight delivery programs; Sustainable Rural Development was based on six regional groups stretching from the South Coast to the Kimberley; Resource Protection was managed by the Agriculture Protection Board aided by regional advisory committees in each of its 10 zones.

In addition, the Office of Policy and Planning was responsible for strategic planning, budget allocation and valuation, and policy development. It also managed Ministerial issues, legislation and government business.

At this time the department participated in six Cooperative Research Centres (CRCs) related to Legumes in Mediterranean Agriculture, Biocontrol of Vertebrate Pests, Premium Wool Quality, Quality of Wheat and Wheat Products, Weed Management Systems and Sustainable Development of Tropical Savannas.

Communication had been dramatically enhanced through investment in statewide communication and financial management information systems. This facilitated the
transfer of functions to regional and district offices.

As part of the decentralisation of the department 10 new community agricultural centres (CACs) were developed. They were the first part of a program to establish 40 such centres over a three-year period. In practice, not many more were established, probably due to staffing problems. These offices were a departure from the policy set 40 years previously to avoid small offices because of the generally improved performance of officers where there was support within an office in dealing with complex issues.

The Director General saw a distinct shift from bureaucracy to business, accompanied by new opportunities to establish collaborative projects with industry. In 1996/97 the department maintained formal contact with rural industry through some 66 committees, some statutory and some related to statutory functions. Others were liaison committees.

He also commented that the department had established industry and regional partnership groups in each program area comprising industry, business and community representatives to provide direction for the WA Government's investment in agriculture. It is doubtful if this change was as marked as stated if comparison is made with the structure and industry committees existing before the review.

In support of the view that increased productivity was an important marketing tool, the Director General pointed to a key component being higher cereal yields. This in turn had been driven by research and development which had led to a total change in crop production, including the release of higher yielding varieties with emphasis on identifying new quality-discriminating markets.

A particular advance in the development of the department’s biological research capacity was the opening of a new biotechnology laboratory at the State Agricultural Biotechnology Centre at Murdoch University. The laboratory was to undertake collaborative research on new and existing molecular techniques.

The review also resulted in the introduction of a new operational system based on the Funder, Purchaser, Provider model. This involved the Office of Policy and Planning as the Funder, the Industry Resource Protection, Sustainable Rural Development and Industry and Market Development Programs as Purchasers, and Program Services and Corporate Services as Providers.

This program had never previously been used in a complex research/extension/biosecurity body and proved to be an administratively clumsy and ‘blunt’ tool for identifying and funding key and potentially important work. It was abandoned following a change of government in 2003.

In 2006/07 sources of the department's funding were the State Government 48 per cent, Commonwealth Government 24 per cent, research grants 15 per cent, revenues 8 per cent, and other sources 5 per cent.

Utilisation of the department's budget by category showed the allocations were: employee expenses 37 per cent, grants 34 per cent, supply and services 14 per cent, capital use 4 per cent, depreciation 3 per cent and other expenses 8 per cent.

If the budget was divided on the basis of the area of service, agricultural and resource management received 44 per cent, food and fibre industry development 28 per cent, biosecurity 26 per cent and services provided to the Rural Business Development Corporation 2 per cent.

If the budget was divided on the basis of service to each industrial area, grain programs received 43 per cent, horticulture 20 per cent, wool 13 per cent, meat 8 per cent, trade and market development 10 per cent, new industries 3 per cent and dairy and apiculture 3 per cent.

The total staff at 30 June 2007 was 1660, of whom 703 (42 per cent) were professional, 431 (26 per cent) technical, 336 (20 per
cent) were administrative and clerical, 53 (3 per cent) were wages and 137 (8 per cent) were inspectorial.

The report stated that agriculture and the department were operating in an environment in which:

... consumer demand was becoming very sophisticated, global sourcing was increasing competition and there was an impact of greenhouse policies and dryland salinity. In addition there were strong pressures to control agriculture’s impact on environmental values, and internationally to scientifically justify bio-security barriers. Internationally there was the continuation of multi-functional agriculture which had resulted in countries supporting agricultural businesses for non-economic objectives, which continued to distort markets and continued the cost price squeeze. Risk management techniques were also needed to deal with the range of risks to which agriculture was exposed, including climate change, which had emerged as a major issue.

The department published information on the change in annual rainfall, comparing rainfall from 1976 to 1999 with 2000 to 2007. This showed that most of the State’s agricultural areas had experienced rainfall reduction of at least 5 per cent, with 25 per cent experiencing 5 to 10 per cent less.

In his 2007/08 overview, the Director General stated that the focus of the new strategic plan was on how the department was going to do its business rather than what it was going to do. He saw the impact of climate change and rapid advancements in food and fibre technology as ensuring exciting and challenging times.

A staff development project was initiated to ensure staff quality was maintained in a tight labour market. The targeted staff level for 2007/08 was 1598. The average level for the financial year was 1499. The decrease was due to fewer externally funded projects. In this total, 42 per cent of staff were professional, 25 per cent technical, 8 per cent inspectorial, with 22 per cent administrative and 3 per cent wages.

The department continued to deliver production-related research, diagnosis and information services to industry over the period from 1995 to 2008. Communication systems were revolutionised by use of the internet for technical and market information.

Special activities during 2007/08

The department developed and launched the WA Government’s new food marketing campaign. It also established the first commercial wheat breeding company, InterGrain Pty Ltd, a partnership with the Grains Research and Development Corporation.

During 2007 the Bio-Security and Agriculture Management Act (known as the BAM Act) was passed. This important piece of legislation improved the ability of the State to manage, prevent and contain biosecurity risks, including pest plants and animals as well as diseases. It was not proclaimed immediately as the regulations needed to be prepared and approved. The department also enhanced the biosecurity team of inspectors and detector dogs and launched the new look Quarantine WA (QWA)initiative.
Chapter 2

1894 to 1940: changing roles – adapting to need

Establishment of the Bureau and Department of Agriculture

The Bureau of Agriculture began as a small organisation servicing a small, slowly expanding industry. That changed with the discovery of the value of superphosphate and the availability of new innovative machinery.

Halted by World War I, rapid expansion resumed in the post-war years only to be stopped by the Great Depression, which began in late 1929 and was followed by slow recovery through the decade.

In response, the department grew slowly, responding to the needs of the expanding agriculture with the best advice available, and financial and physical assistance. After the war it began to move towards becoming a science-based research and extension organisation. By 1940 this had been largely achieved.

The Report of the Commission on Agriculture, 1887-91 clearly describes agriculture in Western Australia. The agricultural areas at that time were the Avon Valley, New Norcia, the Swan Valley, the Greenough area between Dongara and Geraldton, the south-west towns of Pinjarra, Harvey, Brunswick, Bunbury, the Vasse, Bridgetown, Preston, Dardanup, Williams, Marradong and Wandering. The Avon Valley was regarded as the ‘Eastern District’.

The Commission on Agriculture’s report referred to new machinery becoming available—particularly the two or three furrow ploughs and stump-jump ploughs. The stump-jump plough was seen as very important as it reduced the cost of clearing by eliminating the need to remove all stumps before ploughing. There was also discussion of the merits of the stripper and winnower combination as opposed to reaping, binding and thrashing for harvesting crops.

The commissioners concluded that there was opportunity for a greatly expanded agriculture. They noted the importance of concessional finance, and the need to establish ‘school farms’ where experiments could be carried out and where students could study. They also considered the farmer associations should provide information through meetings where papers could be read to members, and to provide information to new settlers.

While farmers were aware of the need for artificial fertiliser, guano, which was being mined in the Abrolhos Islands, was seen as very expensive, precluding its use for many. Much of the guano mined was exported and the commissioners were critical of this. Animal manure remained a major source of fertiliser.

In evidence to the Commission in 1888 a prominent farmer in the Northam district, Thomas Wilding, stated that his animals produced some ‘25 acres of manure’. Surprisingly there was no mention of superphosphate, which was manufactured in Victoria from 1876.

In April 1893 the first conference of pastoralists, agriculturists and fruit growers was held. Associations of farmers with common interests, and local agricultural societies, had never met previously to consider policy issues. They met under the auspices of the Swan District Vine and Fruitgrowers’ Association. These conferences were to become an annual
event and an important interface between the government and the farming community. A major request from the first conference was for the establishment of a Bureau of Agriculture, similar to organisations established in other colonies.

In response, Premier Sir John Forrest set up the Bureau of Agriculture. The bureau was formally proclaimed in the *Government Gazette* of 19 January 1894. Forrest established a board made up of prominent farmers to manage the new organisation. The chairman was well known citizen and farmer, Charles Harper. The other members were AR (Alexander Robert) Richardson, JGH Amhurst, G (George) Throssell, W (William) Paterson, and FH (Frederick Henry) Piesse. The Secretary was Mr Lancelot Lindley-Cowen, who was also the Executive Officer of the Bureau of Agriculture. Mr Piesse resigned in October 1894 and was replaced by Mr F Craig.

The bureau became the Department of Agriculture in 1898, when it was placed under the control of the Minister for Lands, Forests and Agriculture. Mr Lindley-Cowen became the first Secretary of the Department of Agriculture and held that position until his early death in 1902.

The objectives of the Bureau of Agriculture as set out in the 1894 *Government Gazette* were to:

- bring the pastoral, agricultural and viticultural associations under the bureau at the earliest date
- establish experiment stations throughout the Colony - and quickly disseminate the results of work done there to the community
- analyse typical soils of the Colony and disseminate meteorological information
- advise manures to certify their content
- advise farmers on the dairy industry (which they forecasted would become very important in the Colony)
- import new crop varieties, fruit trees and fodder plants
- prevent the introduction of noxious weeds and eradicate existing weed species
- prevent the adulteration of foodstuffs
- eradicate insect pests
- achieve the correct nomenclature of fruits; fruit was apparently being grown under different names throughout the Colony
- encourage the introduction of new mechanical appliances and carry out field trials to demonstrate their use
- improve market outlets and information for both sellers and buyers.

These objectives were clearly aimed at the needs of the early days of farming in a strange land, on unusual soils and in a climate quite different to that experienced previously.

The capacity of the new bureau to provide advice and guidance to the farmers and pastoralists of the day has to be measured against its resources of people and knowledge. Science was yet to make a significant contribution and most ‘good agricultural practice’ was based on experience. In the early days of the Colony most of that experience had been obtained in the United Kingdom and had to be modified to fit local conditions.

In the developing agriculture of the next 25 years the Bureau/Department of Agriculture was also required to take on a series of administrative roles. This need was doubtless a major reason leading to it becoming a government department in 1898. In his communication to the Minister recommending this change, Mr Lindley-Cowen remarked: “It is better to be accused of being far ahead of the times than behind them. The average agriculturist is slow to learn and I would suggest that it is better to instruct the people boldly in the possibilities of the future and let the present, which is prosperous, take care of itself”.

The Hon George Throssell commented: “The education of the people is our first duty, and must be regarded as one of the main factors leading to national wealth”.

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Chapter 2 – 1894 to 1940: changing roles
The role of the bureau changed very quickly. Its role was perhaps better described by the then Under Secretary, AJ Despeissis, in his annual report of 1907/08:

While the function of the Lands Department is to put people on the soil and open the country to settlers, those of the Agricultural Department are to see them settled and turning their land to account, and generally looking after their interests.

The population was small until the gold discoveries from 1890. The movement of population in response to gold was aided by the long drought of the 1890s in eastern Australia and a bank crash in Melbourne in 1893. In 1889 the WA population was only 44,000, but it grew to 138,000 by 1896 and 180,000 in 1900.

**Mechanisation**

This chapter covers one of the most dramatic periods in the history of agriculture, and the work of the bureau/department has to be seen against these changes. Until the mid-1800s a single furrow mouldboard-type plough was mostly used followed by light cultivators. Seed and fertiliser (where it was used) were spread by hand or through an early type drill.

In WA the fertiliser was animal manure, guano or bone dust. But the last 40 years of the 19th century and first 40 years of the 20th century saw a major revolution in mechanisation and the development of a new phosphate fertiliser vital to the development of agriculture. These inventions, which are briefly referred to below, progressively changed agriculture around Australia and the world.

The stump-jump plough

Richard Smith, a blacksmith/farmer in South Australia, invented the stump-jump plough in 1876 when he produced a three-furrow version. This was too heavy and after modifications it was shown in 1877. Clarence Smith set up a factory to make the plough in Ardrossan and started production in 1880, continuing until 1930.

Ploughing in 1925. Until the 1930s tractors had steel wheels with lugs for traction.

The disc plough

It is uncertain when disc ploughs were first made but photos exist of them in about 1910. They were made by T Robinson of Melbourne and Spotswood—maybe as early as 1903.

An early pioneer in the Doodlakine/Bruce Rock area claimed to have invented the plough which became the ‘sundercut’, which was used all around Australia. He claimed that he sold the patent to a South Australian machinery manufacturer who subsequently became bankrupt and the patent was on-sold to an American firm.

The Ridley stripper

In 1843 a competition was held to develop a machine which could cut a crop faster than by hand. John Wrathall Bull entered a machine which had a comb to grip the head and a beater to thresh the grain. While he did not win, it seems likely that flour miller John Ridley improved his design and produced the stripper which did harvest and thresh the wheat faster than workers, and claimed the prize. By the 1880s wheat stripping machines were in use throughout Australia and the world. It was an important method of harvesting wheat in WA up to 1910. Although the grain was thrashed out of the head it still had to be winnowed to separate it from the chaff.
The harvester
From the 1840s inventors were trying to combine the stripper and the winnower. In December 1883 a competition was held at Dookie College in Victoria which James Morrow won and collected a prize of seventy-five pounds. He harvested one acre and obtained six bags of a perfect sample. Morrow won against HV (Hugo Victor) McKay in 1885/86 when McKay exhibited his first harvester. However, McKay was the first to commercially manufacture and supply machines of reasonable quality.

The header
Around 1886 Hedley Taylor, a farmer at Henty in New South Wales, invented the header. It was a major advance for harvesting heavy crops and was widely used across international wheat growing areas.

Superphosphate
Superphosphate was first manufactured in Australia in 1876 by James Cumming. Little was used in WA before 1900.
In 1905, 2855 tons of fertiliser was imported, largely superphosphate. In 1906 the quantity imported was 18 566 tons. Usage increased rapidly and James Cumming opened the first manufacturing plant in WA in 1911.

Motor trucks, cars and better roads
Motor trucks gradually replaced wagons both on the farm and for grain carting. At the beginning of the 1930s much of the crop was still carted to the sidings on horse-drawn wagons. By the end of the 1930s most was carried by trucks.
Equally, cars revolutionised the social life of the country. In the early 1930s, life focused around small close-knit communities within a 10 to 15 mile radius. As roads improved and cars became more sophisticated the radius extended to 30 miles or more.

Tractors
The production of wheeled and track tractors in the post-World War I period progressively changed the method of farming and the size of farms. Their adoption was doubtless delayed by the Great Depression, but by the mid-to-late 1930s tractors began to dominate as the main power source on farms.

Pneumatic tyres
Until the early to mid-1930s wheeled tractors were fitted with steel wheels with lugs for traction. Manufacturers experimented with low pressure (15 pounds per square inch) aircraft tyres and developed tyres suitable for fitting to tractors. These were demonstrated in 1933 and by 1937 an estimated half of new wheeled tractors were fitted with rubber tyres.

Bulk handling
Bulk handling of grain was developed in the early 1930s. It had been discussed in 1913/14 but it was 1931/32 before legislation was passed and the Cooperative Bulk Handling company was formed. Bulk handling of wheat commenced at five receival points. By the 1937/38 harvest the facilities were universally installed across the wheatbelt.

The shearing handpiece
Shearing handpieces replaced hand shears and made shearing much more attractive. Originally they were mechanically-driven off a motor driven shaft. Electrically-driven handpieces were developed later.

The railways and land release
The work of the bureau/department should also be seen against the background of the experience and financial resources of the settlers. Many new settlers came from overseas, other colonies or non-farming occupations within the Colony.
Sheep and cattle could be run extensively on the scrub and grass of the semi-arid pastoral properties and on the limited native pastures on the unused cleared land of the settled areas. Horticulture and viticulture could be carried out in much the same way as in England.
Camel teams used to transport wool bales. *Transport was a costly problem before the advent of large trucks.*

On the other hand, crop production on the strange and largely infertile soils needed a great deal of innovation to be successful. Until the mid-1890s most ploughing used a single furrow mouldboard-type plough, followed by light cultivators. Seed and fertiliser (where it was used) were spread by hand or through an early type drill. The fertiliser was animal manure, guano or bone dust.

The stripper harvester does not appear to have been generally used in WA before 1900. In this early period (really through to the mid-1930s) much of the crop was cut for hay to feed livestock, particularly horses.

The development of railways also had a marked impact. The first substantial railway, from Albany to Beverley, was built by a private company in 1889. This was on the basis of the sale of land granted to the company on either side of the line. The line was bought by the government in 1896 and later connected to Perth through Spencer's Brook.

Separately, in response to the development of forestry and some agriculture in the South West a railway had been built from Bunbury south-east to Boyanup in 1891. Perth was connected to Bunbury in 1893. This line was extended to Collie and the Boyanup line was extended to Bridgetown in 1897.

The Midland Railway Company built a short line east from Midland Junction in 1891 and later from Midland Junction to Geraldton on a land grant basis. The gold rush focused the government mind on the need for rail transport both for goods and passengers. The line to Southern Cross was finished in 1894 and extended to Kalgoorlie in 1897.

Both the Bureau of Agriculture and the Agricultural Bank were established in 1894. The bank followed the enactment of the *Homestead Act* of 1893 which allowed any citizen who did not own 100 acres of freehold land to apply for a free Homestead Farm of 160 acres. In 1898 the *Land Act* provided that the settler could apply for Conditional Purchase land at 10 shillings per acre, with 20 years to pay.

Much land was released for settlement in the decade following 1889. Land was surveyed in 40 locations from Northampton to Albany and from Jandakot to Southern Cross. The Meckering area was released in 1889, Doodlakine and Baandee were opened in 1894 and 1895, and the Yilgarn area near Southern Cross in 1899.

While the rail network provided the framework for development, some farmers were as much as 100 miles from a railway line. The conference of farmer associations in 1903 resolved that no farmer should be more than 15 miles (24 km) from a railway and pressed the government to adopt this policy.

In 1905 the government decided that no farm should be more than 25 miles (40 km) from a railway. This resulted in a major expansion of the rail system over the next 13 years. However, much of the system was on light tracks with high maintenance cost and had to be progressively upgraded and consolidated by CY O'Connor who had been appointed Government Engineer in 1891.

As the easily-won gold was exhausted and the government opened land along the railway lines, many miners turned to farming. These new land allocations attracted settlers from the city. Most new farmers had little knowledge and few resources. This was the real challenge for the government and the bureau/department became its main agency for providing advice and help to the new farmers.
There were major increases in land sown to crop between 1906 and 1910, carrying through until World War I stopped expansion in 1916. Development did not start again until the early 1920s, with the alienation of land for soldier settlement after the war, coupled with satisfactory prices. The areas sown to various agricultural industries are shown in Table 1 between 1901 and 1918. Figures for some early years were not recorded.

**Staffing resources – 1894 to 1920**

A major activity of the bureau was to carry out inspections under the *Insect and Destructive Substances Act*. Much of this work was at the ports to prevent the entry of damaging insects and to monitor the introduction of dangerous substances. As a result inspectors made up the majority of staff during this period. Professional input was much greater after the 1910/11 reorganisation of the department.

The staff of the bureau in 1895 (no record was found for 1894) was the Secretary, a clerk, a caretaker and a messenger, plus five experts. These were a viticultural and horticultural expert, an entomologist, a biologist, a consulting veterinary surgeon and consulting dairy expert. There was also a Chief Inspector under the *Destructive Insects and Substances Act* and probably one inspector. All expert staff were gazetted as inspectors under that Act.

In 1896 an artist and two additional inspectors were added. The two inspectors were stationed at Albany and Geraldton. By 1898 the artist was gone but a botanist and an agricultural analyst had been employed, together with inspectors for Busselton, Bunbury, Esperance and Hamelin.

By 1901 the department had lost its entomologist and biologist but had been given control of cold stores, and had 18 pest inspectors. In 1902 the Chief Rabbit Inspector and six inspectors were added, together with the Chief Veterinarian and his assistant, and a number of stock inspectors.

From 1905 to 1911 the department had two senior positions of Under Secretary and Director. Before this the senior position was titled either Secretary (1898–1902) or Director (1902–1905).

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<th>Season</th>
<th>Cereals</th>
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<th>Vines</th>
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Chapter 2 – 1894 to 1940: changing roles

The position of Under Secretary was established in 1905. It was occupied by AF Crawford until 1906, by WB Hooper from 1906 to 1907 and by Adrian Despeissis from 1907 to 1909. CF Chaplin was Director from 1905 to 1906 and Adrian Despeissis in 1906 and 1907. Professor William Lowrie, a well credentialed agricultural scientist was listed from 1909 to 1910. He travelled widely through the agricultural areas and wrote an important analytical report on the department. However, he only remained for a short time, leaving to take a senior position in the South Australian Department of Agriculture in early 1910. This frequent change in senior positions doubtless provided little opportunity for leadership.

In 1909 there were only five professional officers listed, two of whom were veterinarians, with 29 general division officers (mainly fruit and stock inspectors) and 28 clerical officers. By 1910 staffing positions for 12 professional officers were listed. Five of these were in the stock section and four in the general area. There were 25 general and 33 clerical staff. In 1911 there were 14 professional officers listed. In that year Commissioners for the Wheatbelt, South West, Horticulture and Tropical Agriculture were listed. Six veterinarians were part of the 14 professionals. This structure was largely retained until Trethowen was appointed as Under Secretary in 1920.

Members of the staff of the Department of Agriculture in 1905. Photo supplied by Mrs RJ Pratley in 1981.
In 1920 there were 36 general division and 57 clerical officers. The number of clerical officers reflects a big accounting section in that year, which did not appear before or afterwards.

**The bureau starts to function**

The Bureau of Agriculture was gazetted in January 1894 and almost immediately began to publish a fortnightly journal “... in order to place it in direct and frequent contact with the agriculturists of the Colony”.

The first series of the *Journal of Agriculture* was published in April 1894 and continued to be published until 1909 when the Under Secretary of the day decided to cease its publication. During the period it changed from being published fortnightly to being published quarterly. It was resurrected in 1924 and continued to be published in various forms until it was overtaken by the new media outlets in 2000.

*The Journal of Agriculture was the key to communication with farmers in the early years and an important method in later years.*

In the first issue the bureau set out its immediate objectives, noting that it would take some time to become fully operational. The editorial stated that the chief objective was to act as a board of advice to agriculturists of the Colony on matters related to the welfare and management of their land, crops, trees and stock.

It said the bureau had information from all parts of the world and imparting this to the agriculturists in an acceptable form would be one of its chief roles. Farmers were encouraged to seek its help when an expert opinion was required. Certainly the fledgling bureau received a lot of early assistance from comparable organisations which had been established in other Australian colonies, particularly New South Wales.

In the first six months of the bureau’s existence more than 16 000 copies of the *Journal of Agriculture* were distributed. It was available free to members of associations. Non-members were charged an annual subscription of 2 shillings.

Money was received from advertising and this was used to increase the size from eight to 12 pages after six months. The 1894 issues totalled 284 pages - a remarkable achievement. The journal continued to be very popular and in 1895, 29 numbers were published. It was further enlarged so that the average size was 14 pages over the year. In all, more than 46 000 copies were issued during 1894/95.

*The Journal of Agriculture* continued to be a valuable communication tool and in 1896, 51 450 copies were distributed.

Much later, the Under Secretary reported in 1905/06 that there continued to be a big demand for the journal. While considerable savings had been made in printing, and revenue was received from advertising, the net cost to the department was around £14 per month.

In the September 1894 issue the bureau published its first ‘annual’ report covering the period from its establishment in January to 30 June. Further reports were issued in mid-1895, 1896 and 1897. These reports dealt with the major issues facing the bureau and action taken to deal with them.

The potential importance of the fruit and viticultural industries to the Colony was
recognised. In the first few months the bureau was able to employ a viticultural and horticultural expert, Mr Adrian Despeissis, from the NSW Department of Agriculture. By June 1895 Despeissis had visited many districts, giving advice on the full range of horticultural activities.

Despeissis was to become an important professional officer of the bureau and the department. Obviously a person of considerable knowledge and energy, he prepared a book of 350 pages on horticulture and viticulture, first issued in 1895. Assistance was received from the NSW Department of Agriculture. It was reprinted as a revised second edition in 1896 and enquiries for copies came from outside the Colony. Later it was decided to issue the *Settlers Guide and Farmer’s Handbook*. A copy of this comprehensive handbook is held in the Department of Agriculture and Food library.

At the time the bureau was formed, legislation titled the *Destructive Insects and Substances Act* required the disinfestation and disinfection of all fruit trees entering the Colony and was enforced by the new bureau despite objections from importers. This legislation did not provide power to prevent the spread of a disease or pests already in the Colony and, when requested by the bureau, the legislators passed a new *Insect Control Act* in the following year. The bureau took responsibility for its implementation.

The control of pests and diseases in orchards became a major activity. In 1896 the bureau commented on resistance from orchardists to the inspection and disinfestations required under the Act, and it was modified to make the restrictions more acceptable. The control of the introduction of vine cuttings was amended to allow cuttings from any part of the world provided they were held by the bureau in quarantine for one year. Strict control was maintained over pome fruit imports for fear of introducing codlin moth.

In 1896/97 a serious attempt was made to eradicate the Mediterranean fruit fly (Medfly). Apparently it had been first reported three years previously but was not initially seen as a serious threat to the stone fruit crop. The attempted eradication was unsuccessful; Medfly remains a significant pest today.

The bureau also sought amended legislation to better control the spread of noxious weeds. The existing legislation only provided for control of Spanish mustard and stinkwort. It took some time for appropriate legislation to be enacted but this was finally achieved.

The bureau imported seeds of a range of crops and fodder plants for possible use in the Colony. Little was known about what was suitable and what was not. In its first year experimental plots were established in various districts in cooperation with farmers. In 1895 an experimental planting of sandalwood was made at Pingelly as a possible future plantation crop.

Realising the potential value of having its own property for experimental work, in 1895 and 1896 the bureau requested funds to establish an experimental farm. In the 1896 submission it proposed that the farm have a comprehensive technical training role. Separately, the bureau wrote to agricultural societies and associations recommending that land be reserved in their areas for a possible future agricultural college or experimental farm. There were 43 such organisations at the time.

There was an early demand for legislation to empower the bureau to require the testing of all fertilisers and manures. While artificial fertilisers were not used, various manures including guano and bone dust were sold and farmers were aware of differences in the ‘quality’ of these materials. The bureau also asked that the proposed legislation provide for control over feedstuffs even though they only had the resources to deal with fertilisers.

In 1896, concerned at the continued adulteration of food, the bureau also sought amendment of legislation controlling adulteration of foodstuffs and liquors. A particular problem was the continued adulteration of milk with water, and the
addition of other animal fat to butter. The greatest problem was water added to milk where it was drawn from a well which might be close to drains or other sources of contamination.

In its first year the bureau approached the Education Department to persuade it to introduce a book on agriculture to State-run schools to give students some background in agriculture. Unfortunately this request failed.

The bureau was concerned that suitable arrangements should be made to conserve the Colony’s forests. It identified a suitable consultant from the east coast to provide an objective assessment of the nature and extent of the State forests. He needed surveying help to carry out this work so the funds provided for his employment were transferred to the Lands Department.

The bureau was in contact with machinery manufacturers, seeking the introduction of new machines on an agency or trial basis. It saw the need to encourage the importation of improved machinery and imported two spray pumps for testing.

In its first year it also examined the quality of Western Australian flour. There had been claims, particularly from the north of the State, that WA flour had inferior keeping quality to imported flour. The December 1899 Journal of Agriculture contained favourable objective reports on the quality of WA flour from Coolgardie, eastern states agricultural shows and an American analysis.

The bureau also set up sub-branches throughout the Colony and by 1896 there were 41. These were avenues for communication in both directions.

In 1896, the bureau moved to the fourth floor of the West Australian Chambers building. This enabled it to establish an area called the Museum and to give its expanding library more room. The library was already becoming very useful, with some 430 books on its shelves. The books were mainly annual reports and journals (66), botany (64), horticulture (36) and viticulture (33), but livestock, veterinary and dairy issues were also represented.

The Museum was the repository for ‘an expanding collection’ of insects and also housed samples of soil types, with attached analytical data. A herbarium had been started and included a large number of native plants, together with introduced species of economic value. It also housed a collection of native grasses seen to be likely to have some economic importance. The bureau was also cooperating with the Perth Museum to educate farmers on the value of insectivorous birds.

Other actions taken by the bureau in these early days were to:

- provide a soil analysis service for farmers, meeting half of the cost
- test the toxicity of various shrubs and other native plants on rats and mice
- ask to have the Dog Act made more effective in the interests of stock owners
- request legislative authority to inspect for possible diseased poultry being introduced into the State
- appoint another veterinarian as a consultant in order to maintain a generally healthy animal population and in particular to monitor tuberculosis in dairy cattle
- establish a labour branch, quite separate from its inspectorial and advice role, to
help men obtain employment in rural areas

- advocate to producers that they form cooperative arrangements as the means of marketing their products (amid concerns that small producers could not market their products successfully)
- seek funds to catalogue the poison plants in the Colony
- recommend a method of collecting agricultural statistics to the government.

A sample of articles in the 1894 *Journal of Agriculture* follows:

Cultivation; potato spacing; feeding pigs on wheat; picking, packing and marketing of fruit; vermin control; preventing rust on tools; adulteration of milk and cleanliness in the dairy; the choice and use of artificial fertiliser (this continued through a number of issues); spraying insects using insecticides such as an emulsion of kerosene, soap and water, or resin, caustic soda, fish oil and water at various strengths; rickets in cattle (zamia palm poisoning); lemon growing; concern that imported apples may be retailing in Perth; the food taken from the soil by an acre of fruit; treatment of wine in the cellar; protein food for cattle; use of arsenicals for fruit spraying; advice on setting a hen; analysis of night soil manure; hints on stable building and fitting; ring-barking; experimental crops; cottony cushion scale; control and identification of codlin moth; spraying for fungus on fruit; pruning and budding of fruit trees and vines; analysis of bone dust; wheat growing in the world; ploughs and ploughing, recommending a short-breasted digging plough rather than a long shear mouldboard plough; cost of wheat growing; saving farmyard manure; hives and frames; a grub which was destroying tomatoes; how to clean harness; how to poison wild dogs; home-made soap; how to cure bacon; butter making; visits by the horticultural expert; lice and ringworm in calves; the cultivation of peanuts and cowpeas; the claimed poor keeping quality of WA flour in the northern areas.

The fifth conference of societies, associations and sub-bureaux was held in April 1897. Some items discussed are listed below as an indication of the issues seen as important by farmers of the day:

- Water boring (farmers were interested in underground water being found in the agricultural areas);
- establishment of an agreed basis for measuring 1 ton of chaff;
- the need for a zone system of railways;
- the making of timber reserves for settlers;
- the suppression of noxious weeds;
- prevention of the introduction of phylloxera;
- the cost and management of pastoral rents;
- the destruction and eradication of vermin;
- problems with the adulteration of food;
- concern at the continued export of guano;
- the need for shed accommodation at railway sidings;
- the question of cooperation among viticulturists and horticulturists;
- the use and control of poisons;
- the preservation of wild duck and kangaroos;
- supervision of dogs;
- drainage;
- concern about the immigration of Chinese;
- a proposal to introduce the two-bushel bag; plus a range of other issues.

**The beginning of the Department of Agriculture**

In 1898 the Bureau of Agriculture was seamlessly converted to a State Government department responsible to the Commissioner for Colonial Lands. Mr Lindley-Cowen, in recommending the change, made the following remark: “It is better to be accused of being far ahead of the times than behind them. The average agriculturist is slow to learn and I would suggest that it is better to instruct the people boldly in the possibilities of the future and let the present, which is prosperous, take care of itself”.

The Hon George Throssell commented: “The education of the people is our first duty, and must be regarded as one of the main factors leading to national wealth”.

Mr Lindley-Cowen became the first Secretary of the Department of Agriculture but was not successful in having the department report directly to a minister. It
became part of an enlarged Lands Department. This arrangement was in place until 1903 when it was separated from the Lands Department and became responsible to a Minister. While no published annual reports can be found for the department during its period as part of the Lands Department, it reported to the Parliament and its reports are among the parliamentary papers of the time. The board of the bureau became an advisory committee.

The first field station was established at Hamel in 1898. The Chapman State Farm and the Narrogin Experiment Farm were established in 1903. Early in 1906/07 a portion of land in the Brunswick area was vested in the department “for the purpose of creating a Dairy Farm”. It was intended that the farm be stocked with pure bred dairy cows and pigs. The cows would be milk-tested so that the potential value of any surplus stock would be known at the time of sale.

In 1907 the Nangeenan (Merredin) State Farm was transferred from the Lands Department to the Department of Agriculture. In 1913 the Commissioner for the South West was instructed by the government to establish a Model Dairy Farm at Denmark.

In 1902, after much discussion and some delay, a decision was taken to build a rabbit-proof fence following reports that rabbits had reached Eucla. There was not universal support for the idea but eventually three fences were built. The No. 1 fence started at Twilight Cove, some 125 miles west of Esperance, and stretched for 1145 miles to a point south-west of Broome and about 20 miles north of Condon on the north-west coast. The No. 2 fence stretched from Point Ann on the south coast for 730 miles to join the No. 1 fence at Gum Creek in the Murchison.

The No. 3 fence started from the No. 2 fence about 20 miles north of Yalgoo and ran due west to the Indian Ocean. It was built east-west to protect the northern areas from rabbits invading from the south. In 1912/13 a new wing was built, extending into the interior from a point 840 miles north of Burracoppin. This was aimed at stopping the rabbits from reaching the northern regions. In addition during that year 158 miles of fence were made ‘dingo and fox proof’.

Because by the time building of the fence started rabbits had been seen near Coolgardie the fence was started at Burracoppin.

The initial erection was started by the Department of Agriculture, but following a dispute over a contract the task was transferred to the Public Works Department. The maintenance of the fences became a major undertaking for the department.

Because of the importance placed on the development of a dairy industry, the department employed a man who had extensive experience in Canada, New Zealand and South Africa to advise farmers.

The Cold Storage Facility had been managed by the Public Works Department until it was transferred to Agriculture in 1902. The 1906/07 report by the manager of the Refrigerating Works was his tenth, indicating the Cold Stores had been established around 1896. He also had responsibility for the markets and abattoirs.

At the beginning of the 1909/10 financial year the department took on the responsibility for providing water supplies and road clearing in advance of settlement and as an aid to settlement in the new
‘outlying’ areas. In the first year some 60 earth tanks and wells were constructed. The tanks ranged in size from 1000 to 2000 cubic yards. Also 300 miles of roads were constructed. As the new areas expanded there was a continued call for this service. Land was also set aside for catchments for possible future railway or town supplies. The 1912 report stated that management of the road clearing and water supply activities continued apace. Because of the expansion of the settled areas “there has been a big demand for this service, which has been difficult to meet”, the report said.

The department was also involved for a short time (about 1910) in providing initial capital to civil servants who were allocated blocks in the Tammin area. This area had been reserved for retrenched civil servants and blocks were allocated to them. In earlier years the department had made loans to settlers for stock purchase but there was little demand from the new farmers who were focused on cereal production. During 1910 the Donnybrook fruit growers sought a loan to help develop a small factory to process excess fruit. The Minister granted this loan, then a small additional loan in 1911.

In 1911 the department took on a new function to help settlers. A branch was established with eight traction engines to pull trees. The comment was made that using the ‘powerful’ engines greatly sped up the clearing process through forest country. The 1912 report shows that the majority of the work was done in the South West, where 4122 acres were pulled. A technique had also been developed to use the engines for scrub rolling. This service was charged for and extended terms were offered where first mortgage was available, but it appears other arrangements were made where it was not available.

A very dry year was experienced in 1911. Many of the settlers who had taken up land only a few years before, lost all their crops including their seed. The WA Government decided to supply seed from the State farms and a Grain and Foodstuff Act was passed to allow seed wheat to be purchased by farmers. The sales were under the direction of the Seed Wheat Board which consisted of the Under Secretary for Agriculture, AJ Monger and A Gorrie.

In more ‘normal’ activities, the period from 1904 to 1909 was one in which the department was largely involved in inspectorial work in the plant and stock industries, limiting entry of insects and diseases and monitoring the state of pests and diseases in fruit and animal industries. It was doubtless promoting the use of modern equipment and, after 1903/04, the use of superphosphate. As the State farms developed after 1907 there were annual reports on progress, some experimental work, and some wheat breeding. Young potential farmers also received some training and experience at the Chapman and Narrogin State Farms. These were part of the everyday activities of the Department of Agriculture.

Other activities were periodically added to its responsibilities. It was, for example, required to manage a horse breeding project at Jigalong Station, a farming and meat production enterprise at Yandanooka, and after 1902 a growing enterprise of abattoirs, cool stores, butter factories and a bacon factory. Towards the end of this period it took
over the role of maintaining the central stables for the horses required by government departments. This proved to be very time consuming.

The development of the wheat industry was very important to the State. In 1905/06, for example, the cost of wheat imports was £2587 but flour imports cost £86 313 and the import of bran and pollard, chaff and hay, and malt and oats cost a further £200 000. The same applied to the dairy, pig and poultry industries.

In 1905/06 bacon and ham imports cost £116 000. The failure of the pig industry to develop was blamed on the failure of the dairy industry. In 1904/05 imports of cheese cost £27 500 and imports of butter £340 000.

The poultry industry was also slow to develop and in 1911 egg imports cost £80 050, leading to a comment that farmers were more interested in showing birds than in their egg-laying ability. In 1906/07 the department was planning to import young ewes from the east coast to improve and increase the sheep flock. It was planned that these would be on-sold to farmers at concessional rates. The increase in sheep numbers had been slow.

Professor William Lowrie, a highly respected agricultural scientist, took up a temporary appointment as Director of Agriculture in January 1909. He carried out a major review of agricultural development and travelled extensively in the wheatbelt in the months before writing his 1910 report. He concluded that the department should focus on trying to raise the general level of farming practice rather than on development of scientific knowledge based on experimentation and analysis. However, he did not see these as alternatives but as two arms that needed to go on together with the main effort initially devoted to developing better farm practice.

After analysis of the potential of the Chapman, Narrogin and Merredin State Farms, he recommended they all be closed. The reasons were interesting. He felt Chapman was too isolated, Merredin was a hay-producing property and therefore not really suitable as an experimental farm, and Narrogin was unsuitable due to soil variability and drainage difficulties.

Lowrie also considered it was a waste of money to provide training for potential farmers, which he claimed would be better done on private farms. He favoured the continuation of Brunswick as it would provide both the potential farmers and the department with sound information about the development costs of such a farm. He was doubtless influential in getting new appointments of professional officers.

Professor Lowrie resigned in January 1910 to take up an appointment in South Australia. Immediately he left it seems that the new Under Secretary, TS (Thomas Sydney) McNulty, took the opportunity to reorganise the department.

McNulty had been appointed Under Secretary in mid-1909 to replace Adrian Despeissis, who had occupied the position from 1907. Despeissis was moved to the new position of Commissioner for the Tropics. He was given the task of assessing the potential of the vast North West area and undertook the work with characteristic vigour. After a second visit he reported favourably and the Under Secretary saw an opportunity for a very much expanded tropical agriculture. Despeissis’ report on tropical agriculture was so voluminous that a special group was appointed to study it.

At that time the department became responsible to the Minister for Agriculture and Industry, and its name changed to the Department of Agriculture and Industry. Doubtless in consultation with the Minister, McNulty immediately set about revitalising the organisation.

The 1910 Public Service List shows positions for a horticulturist, a botanist and horticulturalist, an irrigation expert, and an officer-in-charge of a new information section. This preceded major changes at the beginning of 1911.

In 1910 the Minister decided that the vast areas of the State, the diversity of
agriculture, and the multitude of problems facing the new settlers made it appropriate to split up the work in the expert field and secure senior specialists in three distinct spheres. Three Commissioner positions were created for the southern part of the State and the position of Director was abolished. The Commissioner for the Tropics had already been appointed in 1909. The four Commissioner positions were:

- Commissioner for the Wheat Belt
- Commissioner for the South West
- Commissioner for the Fruit Industries
- Commissioner for the Tropics.

The three southern positions were filled by applicants from the eastern states. The appointments were:

- Mr GL Sutton as Commissioner for the Wheat Belt
- Mr JMB Connor as Commissioner for the South West
- Mr JF Moody as Commissioner for the Fruit Industries.

Sutton had had an outstanding career in NSW. He was initially appointed as experimentalist at Hawkesbury Agricultural College. He was then placed in charge of a station at Cowra where he worked on wheat breeding in association with William Farrer. He then took charge of the whole of the wheat breeding in NSW after Farrer’s death in 1906.

Moody had managed a very large orchard in Victoria and had extensive horticultural experience.

Connor had been Agricultural Superintendent for the Victorian Department, a gold medallist at Dookie College, and farming recently in his own right.

At the same time the expert staff was further strengthened by the appointment of a botanist and pathologist from Birmingham, two new veterinarians and a sheep and wool instructor. Additional clerical support was needed to deal with added work associated with potato import restrictions and a reported outbreak of codlin moth. The potato restrictions were due to an outbreak of ‘Irish blight’ in potatoes in the eastern states.

The three new commissioners took up their appointments on 1 July 1911. All three spent their first year travelling extensively in their areas of responsibility, and prepared comprehensive reports.

Sutton reported that in his first year he travelled 17,488 miles by train and 1,773 by road or water. The main points in Sutton's report were:

- The land was not uniformly good but good results had been achieved on better class sandplain.
- Most areas were in a pioneer stage of development.
- Most settlers had had no farming experience but were anxious to learn.
- A vigorous information service was needed.
- Wheat seed used was poor quality of mixed and unknown varieties.
- On the Minister’s instructions quality seed wheat was to be distributed.
- It was preferable to export flour as the valuable bran and pollard is retained along with the majority of the minerals in the wheat.
- The State farms should be retained for demonstration and experimental work, to produce supplies of reliable seed wheat, to develop new wheat varieties, to test imported varieties and to test alternative crops.
- It was unlikely that a variety of wheat would suit the whole wheatbelt.
- Narrogin should focus on providing education at secondary level teaching both skills and practice to potential farmers.
- Specific conditions should be placed on money made available to farmers in the Salmon Gums area.
Connor’s first report made the major points that:

- There were great opportunities for intensive agriculture; particularly dairying and intensive activities such as vegetable and fruit production. Dairy products and vegetables cost the State £600 000 ($1 200 000) to import in 1911.
- Insufficient land preparation prevented production of valuable fodder crops, and this reduced the capacity of the land for dairy production.
- Little of large properties had been cleared and smaller properties more intensively worked would be more productive.
- Areas on both sides of the Perth to Busselton railway line needed drainage and liming, which was also needed on the large areas of clayey flats near Brunswick.
- Lime deposits were available between Pinjarra and Bunbury.
- The State should favour the South West as the settlement area rather than the wheatbelt.
- The absence of a pig industry was a reflection of the absence of a dairy industry.
- More care should be taken to select and breed quality dairy cows.
- Much of the South West was suitable for dairying and vegetable crops, particularly potatoes. He forecast the potato crop for 1912 would be 15 000 tons compared to 5500 tons in 1911.

Moody agreed with Connor and was enthusiastic about the future of the South West, particularly as a fruit growing area. Moody recognised that:

- Export was necessary in view of the periodic gluts on the domestic market and the large mark-up at retail level.
- A standardised packing case and packing order was required. The Fruit Growers Association was apparently working on this.
- Mt Barker and Bridgetown were important future fruit growing areas.
- A small demonstration orchard was needed and being established at the Brunswick State Farm.

The reports of Sutton, Connor and Moody and their subsequent work, coupled with the increased professional capacity they provided, resulted in a major shift in the department’s work. The arrangement of three commissioners appeared to work well, particularly for the wheatbelt where Sutton was proving to be both innovative and decisive and the problems and solutions were much clearer.

The position in the South West and the horticultural industry proved more complex and in due course Connor and Moody resigned during 1916/17. This resulted in the Commissioner for the Wheat Belt taking responsibility for the South West. He was assisted in this work by the transfer of an officer from the Lands Department who acted as ‘Agricultural Expert Generally Assisting’. He appears to have been given responsibility for the South West and reported to Sutton.

By the middle of 1916 the department had a mixed role. It was concerned with experimental work, advice on insect or disease control and on the general technical aspects of farming, as was addressed by the three commissioners’ reports. In this area concern was expressed about issues such as the impact of septoria on early sown crops, or the extensive growth of wild mustard. On the positive side it was noted that the practice of running sheep on wheat farms was growing and should be encouraged. It was noted that there was interference of the war with experimental work, particularly wheat breeding, due to the absence of staff.

Separately the department continued to be involved in a range of industry development and administration roles. The main ones were:
• Its role in maintaining the rabbit-proof fences continued but this work was severely hampered during World War I by staff leaving to join the army.
• The Rabbit Branch also maintained the horse breeding station at Jigalong.
• The department continued to run the cold stores, abattoirs and markets for the State. Abattoirs were operating at Wyndham, Kalgoorlie, Midland Junction, South Fremantle and North Fremantle. Cold stores were operated at Albany, Perth, West Perth and North Fremantle. Markets were operated at West Perth and Perth City. In addition the department was involved with the Denmark Bacon Factory and the Albany Butter Factory.
• The Yandanooka Estate was operated by the Stock Branch. This very large property supplied meat to the meat stalls which operated in the Metropolitan Markets.
• The Stock Branch was also involved with arrangements for the movement of cattle from the North West to Perth for slaughter because of the shortage of shipping.
• The department was still carrying out tree pulling, scrub rolling and ploughing, using steam engines.

In addition, Sutton was involved in a number of related issues:
• an advisory board looking at extension of the railway north from Toodyay to Piawanning and beyond
• developing a cooperative marketing arrangement for eggs, which was put in place during the previous year
• appointment to a board to examine the problems of areas known as Wodjil lands
• member of a joint committee on agricultural education which resulted in the development of a proposal for an education spectrum stretching from primary school to university
• member of a board established in 1913/14 to report on the possibility of bulk handling of wheat. The board had recommended that bulk handling be introduced gradually. In 1916 it was noted that while it had not proceeded, it could be used later if shipping was in short supply to export grain
• required to visit Melbourne to make arrangements for the marketing of the 1916/17 wheat crop and basic arrangements for the 1917/18 harvest.

By 1918/19 a number of substantive staff items had fallen vacant and one had been transferred out of the department. The positions of Commissioner for the South West, Commissioner for Fruit Industries and the Botanist had fallen vacant and the Plant Pathology Branch had been transferred to the Agricultural Chemist and Government Analyst Section.

These changes, coupled with the resignation of Under Secretary for Agriculture (TS McNulty), provided an opportunity for the new Under Secretary, HC Trethowan, to implement a further major reorganisation of the department.

As part of this change the Minister arranged to periodically chair a meeting of senior departmental staff.

The objectives for the new organisation were the promotion of the agricultural industries, including the prevention and suppression of pests and diseases, the successful operation, on commercial lines, of business undertakings and trading concerns controlled by the department; and the observance throughout of strict economy.

Eleven salaried positions were not filled, saving £2061 ($4122). In addition the work of the three officers dispensed with was more efficiently carried out at a lower cost, saving an added £1176 ($2352).

Two new professional positions of OIC of Fruit Industries and Economic Entomologist were created.

The inspection responsibilities in the South West were catered for by the creation of a position of Chief Inspector of Agriculture for the South West.

A Dairy and Pig Expert was employed.
A new position of Sheep and Wool Inspector was created to cover the whole of Western Australia.

A new branch was established styled the Meat and Produce Trading Concerns Branch. The Metropolitan Abattoirs and Saleyards, Kalgoorlie Abattoirs, Perth Markets, Perth Refrigeration Works, Albany Cold Stores, Busselton Butter Factory and the Wyndham Abattoirs were placed under this branch. It was headed by a general manager and assistant general manager.

The Wyndham Meat Works became the responsibility of the department.

The position of Controller of Abattoirs was abolished.

The independent experts were responsible directly to the administration and not through another officer.

A committee was formed to advise on the establishment of a State College of Agriculture. The members were the Director of Education, the Commissioner for the Wheat Belt, Mr AJ Monger, and the Agricultural Chemist and Government Analyst. Professor Paterson was initially a member but resigned.

In 1918 Sutton suggested that consideration be given to settlement east of Merredin, which was then regarded as the eastern margin of the wheatbelt. He went further and said that if such settlement was undertaken the department would need a cadre of graduate agricultural scientists to advise the potential settlers. He favoured this new staff being Western Australians as they would be more likely to remain in the State. He considered that these men should start training immediately as it would take time to complete their training. He favoured students being recruited in a cadetship scheme in which the department paid for their training.

In 1918, the department was for the first time asked to inspect grain for export. This was done at the request of the South African Government. The work was carried out by an assistant field officer under direction of the Commissioner for the Wheat Belt.

It was against this overall progressive development of Western Australia’s agriculture that the department’s work was undertaken.

**The Department of Agriculture, 1920 to 1930**

World War I finished in late 1918 and the return of the soldiers and their demobilisation occurred largely in 1919.
The settlement of the ex-servicemen onto farms was one of the major post-war reconstruction initiatives of governments around Australia. In WA some were settled in new districts while others were settled on farms created by the government buying up existing large estates and subdividing them. Virtually all these properties had not been cleared. Their development, coupled with the further expansion of existing properties, saw the State’s agricultural industry launched on another period of rapid expansion which continued until the Great Depression in 1929.

The renewed expansion and large number of new settlers, many of whom again had little or no farm experience and limited resources, was almost a repeat of the experiences of the previous decade. However, there were better roads and general access than in the previous decade, and there was a body of more experienced farmers from whom new settlers could obtain advice or merely observe. Communication was aided by the progressive increase in motor transport and telephones.

In addition, tractors were beginning to appear and farm machinery was being further developed.

By 1925 it was reported that there was “a rapid increase in the use of tractors on farms even though their use has not been shown to be more economical than the use of horses”. It was however acknowledged that this new device could cover a greater area in the same time, “which would allow more fallow to be prepared” and therefore a greater cropped area. The increased use of trucks was commented on favourably as allowing faster movement over longer distances, and the possibility of “establishing farms further from a railway line”.

However, later in the decade some questions were being raised about the reliability of tractors. Where breakdowns occurred at critical times, farmers who were solely dependent on them could incur big losses. It would be the mid to late 1930s before tractors became the dominant form of power on the farm.

There was a renewed interest in the development of ‘light land’ areas. To this end a conference was organised in early 1921 to discuss light land development. Some of the better light land would be developed in this decade but most would be left until the big expansions which followed World War II.

Table 2 shows the increase in cereal and other crop production during the decade.

A major development in the dairy industry began in 1922 with the establishment of the Group Settlement Scheme in the high rainfall timbered areas. This was seen by the Minister for Agriculture as the equivalent to

<table>
<thead>
<tr>
<th>Year ended February</th>
<th>Wheat, oats, barley</th>
<th>Other grain crops</th>
<th>Hay</th>
<th>Other crops</th>
<th>Vines</th>
<th>Orchards</th>
<th>Total</th>
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<tbody>
<tr>
<td>1920</td>
<td>1 242 925</td>
<td>763</td>
<td>327 498</td>
<td>34 176</td>
<td>2 975</td>
<td>19 817</td>
<td>1 628 163</td>
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<tr>
<td>1921</td>
<td>1 479 847</td>
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<td>266 824</td>
<td>34 604</td>
<td>3 209</td>
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<td>1 804 986</td>
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<td>1 506 988</td>
<td>1 099</td>
<td>335 561</td>
<td>35 069</td>
<td>3 951</td>
<td>19 012</td>
<td>1 901 680</td>
</tr>
<tr>
<td>1923</td>
<td>1 776 380</td>
<td>1 653</td>
<td>431 633</td>
<td>41 069</td>
<td>4 858</td>
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<td>329 534</td>
<td>60 527</td>
<td>5 235</td>
<td>18 782</td>
<td>2 323 070</td>
</tr>
<tr>
<td>1925</td>
<td>2 198 202</td>
<td>2 736</td>
<td>397 591</td>
<td>88 471</td>
<td>5 331</td>
<td>18 525</td>
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</tr>
<tr>
<td>1926</td>
<td>2 403 682</td>
<td>4 082</td>
<td>391 142</td>
<td>133 204</td>
<td>5 270</td>
<td>18 358</td>
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<td>358 488</td>
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<td>18 512</td>
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<td>414 866</td>
<td>158 116</td>
<td>4 943</td>
<td>18 735</td>
<td>4 259 269</td>
</tr>
</tbody>
</table>
the development of the wheatbelt in the previous decade.

In his report in June 1921 the acting Under Secretary outlined a new policy for the department. He repeated that its functions were primarily advisory, educative and protective to the agricultural industries. He noted that to assist in carrying out these activities the government had decided to appoint an agricultural expert as permanent head and to employ a limited number of highly qualified technical officers “whose duties will keep them entirely in the field advising farmers”.

It was also decided to appoint a number of university cadets who would be attached to the various branches for the times they were not studying at university. These officers would receive a thorough technical and scientific training at a university level. They would then take their place in the department, required to serve a minimum of three years after completing their training.

He advised that the Narrogin School of Agriculture had been transferred to the Department of Education in accordance with the government policy that all education activities should be with that department.

Despite the expectations of the 1920 report that the business functions of the department would be transferred to another department set up to manage such activities, the Department of Agriculture retained a number of business undertakings. These were the Metropolitan Abattoirs and Saleyards, Kalgoorlie Abattoir, the City Markets, Cold Stores and Butter Factories. Wyndham Meat Works had been transferred to the Department of the North West.

The heads of branches and other responsible officers at this time were:


In accordance with the earlier proposals to appoint a technical rather than an administrative person as the head of the department, GL Sutton was appointed Director of Agriculture in July 1921. Sutton had joined the department in May 1911 as Commissioner for the Wheat Belt.

In 1918 Sutton had recommended that university graduates be appointed to the department and to ensure that such people were available he also proposed that the department set up a cadetship scheme to increase the supply of graduates.

In his first report as director in 1922 he advised that two agricultural advisers with the necessary training had been appointed. These were GK Baron Hay and CD Sharp. Sharp was attached to the dairy industry to become familiar with the manufacturing side of the industry. Baron Hay was appointed to the southern areas to cooperate with the Agricultural Bank inspectors and to advise farmers in order to reduce defects and improve farming methods. While a position was available in the north, Sutton had been unable to obtain a suitable graduate. (GK Baron Hay was to take over as head of the department in 1941.)

Sutton also reported that six cadets had been appointed to undertake university training over the next four years. Two more cadets were appointed in 1923 and four in 1924. He stated that two of the four in 1924 were to be veterinary cadets, but this does not seem to have occurred, possibly due to difficulty in arranging training.

The decision to employ graduates to staff the ‘expert’ positions and introduction of the cadetship scheme was one of Sutton’s greatest contributions to Western Australian agriculture.

In 1922 he negotiated the return of the Botanist and Pathologist and his assistant to the department from another department. Just as this was achieved the Botanist and
Pathologist left for an overseas position. This vacant position was filled a year later by WM Carne, who became important in WA, first with the department and then with CSIR after it was established in the late 1920s. Another appointment was to replace the manager of Chapman State Farm. The appointee was Mr ‘Ike’ Thomas, who would later become an important senior officer of the department.

The policy of having the field advisers cooperating with the bank inspectors is interesting. It had been discussed with the bank and was the subject of a conference in early 1922, and was based on the view that the bank was likely to be dealing with people of limited resources and/or new to farming.

In this initial report, the structure of the department, which was largely to last to the mid-1970s, started to take shape. To limit his own involvement in detailed administrative matters Sutton appointed a senior clerical officer, LStJ Jones, as Secretary to the Director. He then divided the department into a number of branches:

- The Stock Branch, which was headed by Alistair McKenzie Clarke and consisted of two veterinarians and two stock inspectors, the Poultry Inspector and the brands registry. Its duties were disease control, advice to farmers and prevention of disease entering the State. In addition to controlling brands they were required to register stallions as a way of improving the quality of horses in the State. They were responsible for the administration of eight Acts of Parliament.

- The Fruit Branch, headed by George Wickens as Officer-in-Charge of Fruit Industries, contained 12 orchard, market and fruit inspectors operating at the ports, markets and orchards. They administered seven Acts of Parliament.

- The Dairy Branch was headed by PG Hampshire, the Dairy and Pig Expert. It included two agricultural advisers, two herd testers, the Busselton Butter Factory staff and the Denmark Stud Farm manager and staff. It was responsible for encouraging expansion of the dairy industry through advice on a wide range of issues. The branch was also responsible for herd recording and the administration of the Dairy Industry Act which regulated manufacture and grading of dairy products. It administered the Dairy Cattle Improvement Act through the registration of bulls used in the industry.

- The Irrigation and Drainage Branch was headed by ARC Clifton, the Irrigation Expert, who had one assistant. They were responsible for advice to farmers on irrigation and drainage and the pumping of water from streams. They also surveyed potential irrigation paddocks for farmers and organised grading at cost. These officers also had responsibility for determining the possibilities of growing tobacco in the South West.

- The Wheat Branch was under the control of the Superintendent of Wheat Farms, Mr Thomas, and included a newly appointed wheat experimentalist and an agricultural adviser plus the staff of the experimental and seed farms. It was responsible for disseminating information to farmers, organising experiments and demonstrations, export grain inspection and management of the experimental farms. Thomas is also listed as the manager of Chapman Experiment Farm. The experiment farms had particular responsibility for producing pedigreed seed for sale to farmers, and for cereal breeding and testing.

- The Sheep and Wool Branch was under the control of Hugh McCallam, the Sheep and Wool Inspector. He was responsible for giving lectures on sheep management and demonstrations on preparation of wool clips and making visits to settlers’ holdings to give advice on selection and culling to improve flocks.

- The Potato Branch was headed by the Senior Potato Inspector, GN Lewis, assisted by two potato inspectors. It was responsible for advising farmers on all
aspects of potato growing, including pest and disease control. It was also responsible for the administration of the *Plant Diseases Act* within its industry and the production of certified disease-free seed for farmers.

- The Botanical and Pathological Branch was headed by the Botanist and Pathologist, WM Carne, who had one assistant. The branch was responsible for advising farmers on plants of economic importance; particularly poison plants. He was also responsible for advising on methods of weed control, and the identification of plant diseases and the best methods of controlling them. The branch also provided seed testing services to industry and farmers.

- The Entomological Branch was headed by entomologist Mr LJ Newman, who had one assistant. The branch duties included forest entomology. It was responsible for the identification of beneficial and destructive insects and, where appropriate, methods of control. It was also responsible for developing biological control methods.

- The Vermin Branch was headed by the Acting Chief Inspector of Rabbits, and included an assistant, three rabbit inspectors, 31 boundary riders and gangers. The branch was responsible for maintenance of the rabbit-proof fences and control of major breeding areas. Their work was assisted by district vermin boards.

- The Agricultural Chemist Branch appears to have worked in the Government Analytical Laboratory, outside the department. The main work in the department was the analysis of flour yield and bread-making quality of new varieties and promising selections.

- The Abattoirs and Refrigeration Branch was headed by the Controller of Abattoirs, Mr EH Golding, who controlled the staff at the abattoirs, refrigeration facilities and the city markets.

Government policy was that all slaughtering for the Metropolitan Area was carried out at the government abattoirs at Midland and South Fremantle. The Perth Markets and the Refrigeration Works were also controlled by this branch.

- The Experiment Farms contained the State Farms at Merredin and Chapman. Each had a manager and five other staff.

- Tropical Agriculture included Tropical Adviser Mr FJ Wise. His duties were to obtain information about land suitable for development in the north of the State and to advise settlers on the best methods of cultivating their land.

- The Publicity Branch was headed by Mr J Buzza, whose duties were to publish the *Journal of Agriculture* and to inform the press about the activities of the department.

In addition to this overall organisation, the department operated a cadetship scheme and worked in close contact with the Education Department and the University of WA’s Faculty of Agriculture.

Sutton also considered there was a need for an in-house agricultural chemist, but at that stage that had not been approved and it was never accepted.

The outstanding feature of this structure was the very small number of people in each area.

In 1923 another two graduates and a diploma holder were recruited. One was LJH Teakle, who was to become the first Commissioner of Soil Conservation in WA, and later Professor of Agriculture and Vice Chancellor of the University of Queensland. At the same time an agricultural adviser had been appointed to the Geraldton district for five months to stimulate interest in dairying. This proved so successful that it was decided to place three graduates and the diplomate in the country. One was located in Wagin, one in Bridgetown, one in Bunbury and one in Geraldton. This was the beginning of the regional extension services.
Teakle only worked with the department for five months before taking leave without pay in 1924 to take up an Exhibition at the University of California, Berkeley. While the exhibition was for only one year, he completed his PhD before returning to duty. At the same time Sutton recruited WM Carne from New South Wales as Botanist and Pathologist, and in 1924 CA Gardner was employed as Carne’s assistant. Although not a university graduate, Gardner would become a giant in botanical research in WA and served his entire career with the department. He became an expert on WA flora but unfortunately did not record all this knowledge before his death.

It was also decided to appoint an Apiculturist (Mr Cailes) and Viticulturist (Mr Johns). Unfortunately FJS Wise resigned for ‘private reasons’ during 1925. He appeared again as a temporary officer in 1930.

On the veterinary side McKenzie Clarke had joined the department in 1916. He would become the Acting Director in the 1950s. In 1924/25 he was joined by JF Filmer and HW Bennetts, both of whom would be important veterinarians.

In 1924, when the position of Superintendent of Wheat Farms was established, this position was intended to focus on the work of the experiment farms at Chapman and Merredin and the developing Light Land Farm at Wongan Hills, but its role expanded over time. Mr I Thomas, who had been manager of Chapman, was appointed to the superintendent position. In 1926, five cadets were attached to the position. This presumably was to give them some on-farm experience.

In 1925 the position of Superintendent of Dairying was created and PG Hampshire, who had joined the department in 1919 as the Dairy Expert, was appointed. Four of the young advisers who had been previously recruited or had finished cadetships were made responsible to this position. This was a challenging time for the dairy specialists and their support staff due to the development of the Group Settlement Scheme.

In his 1925 report Hampshire states: “… the Dairy Branch has been unsparing in its efforts in assisting in their (the farmers) sound establishment, especially in the laying down of 23 000 acres of virgin country to permanent pasture, the application of fertilisers, sowing of fodder crops and the erection of dairy buildings and the supply of plant”.

The Veterinary Pathologist, Bill Bennetts, established a research capacity in that field. Bennetts had an outstanding career.

JF Filmer was also important in the resolution of the cause of nutritional problems of cattle in the Denmark area. The 1926 report recorded that the cadets appointed in 1922 joined the department as professional officers. The names TC Dunne, N Davenport and AS Wild appear for the first time. Veterinarians AF Flood and CR Toop also appear for the first time. HJ Hughes, who was appointed as Principal of Muresk in November 1925, was also listed. He took over the development of the school immediately. Toop was later Chief Veterinary Surgeon for many years. Both Bennetts and Toop were inducted into the Royal Agricultural Society’s Hall of Fame.

In 1927 a decision was taken to appoint a stock inspector at Broome and a veterinary surgeon at Wyndham. G Gauntlett and GL Throssell joined the staff, having completed their cadetships in that year. Another graduate joined and was sent to Muresk as an experimentalist.

By 1928 the structure of the department was largely settled. However, it was decided to split the Botanical and Pathology Branch into two—the Botany Branch and the Pathology Branch. The opportunity was taken to negotiate the transfer of the small herbarium held by the Forests Department to the Botany Branch and CA Gardner was placed in charge of that, which became the State Herbarium.

LJH Teakle, who had completed his PhD in California, rejoined the staff as Plant Nutrition Officer. He worked at the university because of lack of laboratory facilities.
Also in 1928 three further cadets finished their courses and joined the staff. They were B O’Connor, HR Powell and EJ Underwood. Another veterinary surgeon, EF Twaddle, was appointed. In 1929 WM Carne resigned to take up employment in CSIR but remained in WA.

Employment of cadets as they finished their courses continued. In 1929 H Andrewarther and P Roberts were appointed and HA Pitman replaced WM Carne.

In 1930 the staff was further strengthened by the addition of cadets GH Burvill and KT Lutz, who had finished their courses. In this year GK Baron Hay was appointed Superintendent of Dairying.

In a statement for the Minister, Sutton summarised the actions the government had taken to strengthen the department from 1923/24 to 1928/29:

- The budget had been increased from £60 050 to £92 580.
- Muresk College had been established.
- Staff had been increased by the appointment of a veterinary pathologist, four veterinarians, three stock inspectors, a viticulturist, eight agricultural advisers, a plant nutrition officer, an apiculturist and several cadets.
- Three experiment stations had been established at Salmon Gums, Ghooli and Dampawah.
- The area under wheat had increased from 1.6 to 3.0 million acres.
- Ten Acts of Parliament had been enacted, including an amendment to the Plant Diseases Act aimed at improving control of Mediterranean fruit fly.
- Cooperation with the Commonwealth had been initiated to undertake study of the buffalo fly in an endeavour to devise a control measure.
- Overall, the decade to 1930 had been a good one in terms of building resources. It had also seen a shift to a professional,
- scientifically-trained cadre who would drive the organisation in the years ahead. The downside was the start of the Great Depression as the decade closed.

**Educational (extension) work**

Sutton described the disseminating of information through visits, lectures and experimental work on farmers’ properties as ‘extension’. In 1921/22 there were 14 trials of wheat or oat varieties, nine fertiliser trials, four depth of ploughing and four drainage trials on farmers' properties.

In that year 13 Bulletins were issued, and it was decided to again publish the Journal of Agriculture, after a break of 15 years. The first of the new series was seen in April 1924. Articles in the journal were reprinted as Bulletins, which were available on request to farmers or members of the public. The Bulletins covered subjects such as vermin, poison plants, control of the ‘stickfast’ flea, and cultivation of minor crops, fertiliser use etc.

A new medium became available in 1924 when Westralian Farmers Cooperative Limited established a radio broadcasting station (6WF) in Perth. They invited the department to arrange for officers to give talks every second Monday to the radio audience. Specialists within the department took this offer up very readily. This arrangement continued for many years.

In 1924 the government also decided to establish an agricultural college in a farm setting. The department purchased a 2220 acre property at Muresk and began the development of the Muresk Agricultural College as part of the Department of Agriculture. (The history of Muresk is dealt with later.) This was a surprising change in policy, in contrast to the transfer of Narrogin farm school to the Education Department. The files show that this was a government decision as Sutton wanted the college to be closely associated with the University of WA.
A developing agriculture

While the pastoral, horticultural and grain cropping industries were relatively established at this time, there was interest in alternative crops and fodder crops. In 1920/21 there was a Sudan grass competition. At the same time there was some experimentation with sugar beet. The sugar beet grew quite well and was considered as a fodder plant. This was in a period before the true value of subterranean clover was realised. Today, fodder crops are of less interest in south-west agriculture, where subterranean clover is the dominant pasture legume.

The 1920s saw the continued extensive development of the wheatbelt and continued development of the horticultural industries. Up to 1920/21 the dairy industry had been slow to develop and large imports of dairy products continued. An agreement was signed with the British Government in 1919 to develop dairy farms in the heavily timbered high rainfall districts of the South West.

It is doubtful if the British Government understood the nature of the undertaking. They had a big unemployment problem and saw the migration of potential farmers as part of the solution. The plan was for farmers to be gathered in groups of around 20 who would jointly develop part of 20 separate, 160 acre blocks per group. When sufficient area had been cleared and pastured on each block, the settlers would move to their blocks and dairy cattle would be supplied for them to start farming. This arrangement caused the scheme to be known as the Group Settlement Scheme. The scheme continued from initiation in 1921 into the 1930s.

A sheep and wool inspector employed in 1920 as a temporary officer was appointed to the permanent staff in 1921 and reported annually on the state of the industry. In his 1925 report he referred to having travelled some 7500 miles during the year and had contact with over 1400 people. This was a remarkable performance for the time. In addition he gave demonstrations and lectures at the Narrogin School of Agriculture and ran a ‘winter course’ for farmers at the school.

In his 1926 report Sutton refers to agriculture as being buoyant, with favourable rains and good market outlooks for most products. That year proved to be outstandingly favourable climatically, with production records in the sheep, wool, wheat, apple, dried fruit, wine, dairy, poultry and potato industries.

Sutton pointed to the success of crops sown on ‘well prepared fallow’. His motto was ‘fallow early and thoroughly’. For comparative purposes the wheat harvest was around 926 000 tonnes.

The centenary year of 1929 brought a record wheat crop from a record acreage. Again, early promise had been affected by dry weather early in the year but the crop had been saved by late spring rainfall. Medals and certificates were awarded to farmers who achieved outstanding results. In all, 280 awards were made across eight industries. The wheat, wool and dairying industries dominated with 259 awards across the three industries.

Surprisingly, there was little mention in the 1930 report to the depressed price outlook for the coming harvest. The only reference was the comment that due to the fall in wool prices there was increased interest in the production of fat lambs. To assist this switch, experiments had been set up at Avondale to investigate the best rams to use across Merino ewes.

The experiment farms (previously State farms)

After Sutton’s promotion to Director, the experimental and plant breeding programs at the experiment farms were continued under the direction of the experimentalist. Sutton outlined the main functions of the wheatbelt experiment farms as:

- The growing of pure pedigree seed of the main varieties of wheat for sale to
farmers, to ensure farmers had a supply of seed which was true to name and free of impurities. It not only ensured farmers had access to seed of the varieties they wanted to use, but it focused farmers' attention on the recommended varieties and away from varieties which had little merit.

- Crossbreeding and selection of new varieties of cereals and fodder crops suitable for the wheatbelt.
- Experimentation aimed at improving the yield of wheat and/or reducing the cost of production. Such experiments dealt with cultivation methods, fertiliser rates, seeding rates, and comparison of varieties.
- The farms were to be conducted solely for educational and experimental, not commercial purposes.

This reflects the progress after 1910 away from the original purpose of these farms, which was to demonstrate that wheat growing was possible in the districts where they were established.

In 1925 the Wongan Hills Light Land Farm was officially opened. Very little experimental work was done initially, with most of the cleared area planted to wheat and oats to determine how the crops grew. The seed was sold as pedigreed seed to farmers.

Dairying

Despite low prices in the first three years after World War I, dairy output continued to rise. At that time there were butter and bacon factories at Bunbury, Narrogin, Northam and Gnowangerup. New factories opened during the year at Geraldton and Harvey. The department also had factories at Busselton and Denmark (on the stud farm).

The 1922 report states that “matters are well in hand for the establishment of a butter and bacon factory at Ravensthorpe”. This reflects the enthusiasm for dairy farming at the time, but the factory did not get beyond erection of the building because of a shortage of cows.

The Group Settlement Scheme dominated and effectively developed the dairy industry in the 1920s and early 1930s. The first group was formed at Manjimup in 1921. This was followed by Pemberton, Denmark, Northcliffe, Walpole, Nornalup, Bridgetown and Margaret River. By 1924, 120 groups had been formed. With 15 to 20 members to each group this amounted to 1800 to 2400 farms. Even with only 10 cows per farm there were a further 18 000 to 24 000 dairy cows required. In his 1924 report the Dairy Expert refers to 2500 farms in the course of preparation.

Early field day at Salmon Gums Research Station, one of the first wheatbelt experiment farms.
Once established, this made a very big impact on dairy supplies in Western Australia. However, history shows that by 1924, 42 per cent of the original settlers and their families had left the settlements. Nevertheless, over time a dairy industry was developed which serviced the State for the next 40 to 50 years. In due course it developed an export capacity to supply the United Kingdom. The areas cleared for dairying at that time are today the basic infrastructure for the wine grape and associated tourist industries of the South West.

The Group Settlement Scheme placed a great deal of pressure on the limited departmental staff. Planning, advice and supervision were all required. Subsequently the department was involved in quality control in the factories and on farms, in herd recording, general advice and exercising control under the Dairy Improvement Legislation. Advice to settlers was a major task comparable with the work earlier in the century in the wheatbelt.

‘Other’ crops
In the early 1920s there was interest in growing cotton. It was decided that Broome presented the best opportunity for dryland cotton but unfortunately the pink bollworm was already established. It was decided to proceed with the experiments but no industry was established.

In 1925 tobacco was grown successfully by a group settler. As a result the government decided to fund a commercial planting of five acres in the Manjimup district.

The fruit industry
Over-supply during World War I resulted in falling prices for fruit as the industry matured, even with some exports and off-season storage. This resulted in marginal orchards becoming unprofitable and a fall in the area under orchards from around 1916. This decline was probably exacerbated by labour and shipping shortages during the war. By 1921 the decline appears to have peaked and plantings were keeping pace with any loss of area.

A dried fruit industry developed in the Swan Valley due to the immigration of Southern European settlers who had experience of this form of production. Exports of currants and lexias increased through the period. Grapes were exported both as fresh and dried fruit.

Vermin
By 1921 rabbits were widespread and foxes had been sighted throughout the agricultural areas. The Chief Inspector of Rabbits was clearly frustrated by the lack of interest in rabbit control by settlers. By 1925 the fight to keep rabbits out of WA had been lost. Good rains through the 1924/25 summer and autumn resulted in “vastly increased numbers” through the autumn and winter.

Livestock
The Stock Branch was concerned mainly with the inspection of imported animals either from overseas or interstate. There was particular control of cattle imports to prevent pleuro-pneumonia being brought in from South Australia. Kimberley Horse Disease remained an unsolved problem.

Also, there was the routine monitoring of endemic diseases and problems such as pleuro-pneumonia and cattle tick in the north, and tuberculosis of dairy cattle, lice and tick on sheep and problems of internal parasites, particularly of sheep.

Outbreak of rinderpest in dairy cattle in 1923 was a serious crisis, but successfully dealt with using firm action.

An extensive outbreak of swine plague was diagnosed along the Great Southern railway and branch lines in late 1927. A very large area was quarantined. The disease had been largely eradicated by the following April.

Research became a significant role of the branch with the appointment of Bennetts in 1924/25 and Underwood’s return from PhD
studies. In the latter part of the decade a considerable amount of research was carried out. In 1925 the department agreed to jointly fund a study of the life cycle of the buffalo fly with the Commonwealth. Reports of wasting and deaths of calves in Denmark from an unknown cause were of concern. After his appointment Bennetts started to study the cause of some obscure stock diseases. Initially he focused on the ‘braxy-like’ disease, which was causing serious trouble for stock owners in the Great Southern and Avon Valley. The investigation was difficult, partly because the animals decayed quickly after death, making it difficult to determine the cause. The solution came early in the 1930s when the causal organism was identified and a vaccine to control the problem developed (see Chapter 6).

Bennetts also worked on the toxicity of native plants. He carried out tests of some 17 native plant species, 11 of which belonged to the _Oxylobium_ or _Gastrolobium_ genera. He was able to show that the toxin was water soluble.

One of the branch’s more mundane activities was to maintain and manage horse resources for other government departments. In one instance a change in policy by the Main Roads Department resulted in 400 horses being returned to the government stables, causing considerable problems.

The provision of dairy cattle for the expanding industry associated with the Group Settlement Scheme was also a big issue for the Stock Branch. In 1924 Avondale State Farm was transferred to the Department of Agriculture from the Lands Department. Its intended role was to produce seed of selected pedigree varieties of wheat and oats. In 1925 it was also used as a depot for assembling dairy animals for despatch to the Group Settlement Schemes.

**Biological services**

A great deal of work was done by the entomologists to find parasites of introduced insects for biological control. Some successes were achieved. The Plant Pathology Branch was transferred back from the Government Chemists Laboratory in 1922. It also took over management of the library and seed testing. The branch was responsible for finding solutions to plant pathological problems encountered in all industries in Western Australia, the recording of important pathogens and the development of a collection of ‘type examples’ of these pathogens. Its botany section was responsible for the collection, identification and curation of the native vegetation of WA.

**Cold storage and abattoirs**

In 1922 the department controlled the Metropolitan Abattoirs and Saleyards, the Kalgoorlie Abattoirs, the Perth Refrigeration Works and the Perth City Markets; it also arranged shipments of livestock and fodder to Singapore. During 1924/25 the North Fremantle abattoir was closed, followed by two private abattoirs, the Union and the Anchorage abattoirs at South Fremantle, in September 1925. In 1927 the Perth Refrigeration Works were closed and demolished, having outlived their usefulness. The Midland Abattoir was enlarged to cater for the increasing kill. The Perth City Market was closed in 1929 or 1930.

**The Great Depression and following years**

Effects of the Great Depression varied across industries. In WA the big industries of wheat and wool were the worst hit. For both, the Depression did not really end until after World War II. The dairy, pig and fruit industries did not suffer the same severe price depression as the two major industries and survived the decade in reasonable shape.

Many wool producers turned to production of fat lambs for the UK and European markets, with wool becoming a sideline. In fact, the fat lamb export industry in WA owed its
development to the onset of the Depression. There was no market for mutton, which had been a by-product of the wool industry, and an alternative had to be found. The change was largely led by the Department of Agriculture.

The Kimberley beef industry struggled until after World War II. The British Government had agreed to take virtually all the export beef available at the beginning of the war. However, once Japan entered the conflict, the Kimberley became isolated due to transport difficulties.

In many ways the onset of the Depression was an unexpected disaster for the wheat and wool industries. Many returned servicemen from World War I had taken up new land in 1921 or 1922. They had really just begun to reach their potential when they were faced with prices below the cost of production. Their potential was reflected in the production in 1930. In his 1931 annual report Sutton states: "... in the past year there has been a general advance in agricultural productivity and development. Records have been established in the Sheep, Wool, Wheat, Dairying, Pig, Poultry, and Dried Fruits Industries. Unfortunately this magnificent achievement of productivity resulting from the enterprise of agriculturists and pastoralists has not received its proper pecuniary reward".

The figures speak for themselves. Sheep increased by over 300 000 to 9.875 million. Dairy cattle increased by 11 000 and pig numbers by 36 000 to reach over 100 000. The area in crop was 390 000 acres greater and the wheat crop was 53.5 million bushels - an increase of nearly 1.5 million bushels. This was the largest wheat crop until the late 1940s, planted on 3.996 million acres.

By 1935/36 plantings had dropped to 2.5 million acres. Encouraged by higher prices, acreages again started to increase and reached 3.4 million in 1938/39 but fell again in 1939/40.

The wool clip was 711 million pounds, an increase of 4.4 million pounds. The apple crop increased by 300 000 bushels to 749 450 bushels and the grape harvest by 21 000 pounds to 297 000 pounds. Butter production increased by nearly half a million pounds. There were also increases in egg production.

The price of wheat in mid-1931 was about $14.51 per tonne and top quality wool was selling at 42.2 cents per kilogram. Sutton felt these prices were so low that an increase could be expected. History shows they went lower.

In 1933 wheat remained low but wool prices improved. In 1934 wheat had a period of good prices but wool fell to only about 1 shilling per pound (22 cents per kilogram). In 1935 and 1936 both wheat and wool prices were reasonable and at times good. In 1937 and 1938 the prices for both were very poor. By the end of June 1938 the price of wheat at the siding was 2 pounds 15 shillings a ton ($5.50 per tonne). In the 1938/39 sales wool averaged about 1 shilling per pound (22 cents per kilogram).

On the other hand, prices for export apples were satisfactory and the dried fruits sold quite well on the UK market. The dairy industry was largely focused on the local market.

In 1932 Sutton wrote that the attitude of wheat farmers had improved. They had moved from a feeling of despair to hope for better times. He saw this as the outcome of close cooperation between the government, financial institutions, merchants and the farmer. While this was also partly due to a slight improvement in the prices for wheat and wool and a Federal Government bounty for wheat, he put the main thrust as the dogged determination of the farmer to win through despite the current difficulties. He pointed out that one measure of the nature of the 1930/31 collapse was that if the record crop and wool clip of that year had been sold at the prices of the previous year, a further £7 million would have been spread over the agricultural areas.

The results through the decade were also affected by seasonal conditions. Although these did not directly affect the department,
they affected the environment in which it operated. The prices received on world markets had a similar impact.

A major climatic event was the prolonged drought in the Murchison and Gascoyne. It began in 1933 and continued to at least the middle of 1938, perhaps to 1941. This resulted in heavy stock losses. One figure was that two million sheep were lost of the five million in the areas at the beginning of the drought. Overstocking resulted in long-term damage to the perennial native vegetation and the stocking rates before 1933 were never repeated.

The seasons were variable for wheat. While 1930 was a good year with record production, 1931, 1932 and 1933 were generally average; 1934 was good in the south and south-east but dry in the east and north-east; 1935 was a repeat of 1934 with the east and north-east having their worst year since 1914; 1936 and 1937 were again poor in the east and north-east but average in the south and south-east.

Some late rains in 1937 resulted in higher yields than in the previous two years. Then 1938 was a mixed year with the central and southern portions of the State having good to excellent yields. However, the northern districts were only fair and the eastern and north-eastern were poor with some crops being a total failure and hay yields below requirements.

At Yilgarn (Ghooli), Dampawar, Avondale and Wongan Hills Research Stations, the rainfall in the 1938 growing season was the lowest recorded. At Chapman the growing season rainfall was the lowest since 1914. These years in the east and north-east appear very much like the 1970s, 40 years later. The 1939 season began well with heavy cyclonic rain in January and February. After a dry March and April, rains in late May and June started the cropping year well; 1939 finished well and the yield per acre of 13.8 bushels was a record. While the area sown was down, the high yield resulted in the largest total crop since 1933.

One important feature of the decade was the move to sown pasture. This was made possible through the identification of subterranean clover as a suitable pioneer legume with a range of naturally occurring cultivars which extended its range into the medium rainfall districts.

The number of sheep in agricultural areas was increasing, with the western part of the Great Southern focused largely on sheep. The area sown to pasture increased from 60,000 acres in 1925 to an estimated 450,000 acres in 1934, 635,806 by mid-1937 and an estimated 870,000 in mid-1939.

This change was due to increased sheep numbers and growing awareness of the potential feed value and soil improvement that a legume-based pasture could bring. Much of this awareness had come from the pasture demonstrations established by the Department of Agriculture, either independently or in association with the fertiliser companies. The sown pasture was largely topdressed with superphosphate to achieve the best results.

**Organisation of the department**

**Staff numbers 1930 to 1940**

The major changes in professional capacity which had started in the 1920s continued through to 1940. In 1930 there were 46 professional officers, of whom seven were veterinarians in a total staff of 108. They were supported by 38 general and 24 clerical officers. By 1935 there were 55 professionals employed out of a total staff of 117. They were supported by 38 general and 24 clerical officers.

In 1940 the total staff recorded in the Public Service List was 146, of whom 60 were professionals, 52 were general (largely inspectors) and 34 clerical officers.
**Staff organisation and policy**

Sutton, in his 1935/36 report, written about 12 months before his retirement as Director, reviewed the development of the department in his 15-year term. His general comment was that “it is apparent that there has been a complete change in the organisation through the establishment of a scientifically trained advisory staff and a strong team of specially trained research officers”.

One can only agree with his conclusion. The development was slow in the early period because the professional advisers were not available, were gaining experience, or still being trained. However, from about 1929, the impact of the cadetship scheme and the training of some officers to PhD level became obvious. This is reflected through the performance of the department through that period.

Sutton also outlined some of his philosophy in developing the department and summarised his view of where it was as 1937 approached when he wrote:

> The practical value of the work of the department is largely determined by the effectiveness of the extension services in disseminating information and advice in the farming areas … an endeavour has been made to keep farmers informed with respect to the most effective methods of managing their holdings … and also to keep them in touch with the latest advances in agricultural techniques. The general work is in the hands of a group of field officers located at key positions throughout the agricultural areas, and this is supplemented by specialist advice from head office. The country personnel includes 14 agricultural advisers, three veterinary officers and 32 officers engaged in herd recording, orchard inspection, stock inspection and other work affording an opportunity for the dissemination of advice by means of personal contact.

In order to make technical advice and assistance available to the district bank managers and inspectors of the Agricultural Bank, the headquarters of agricultural advisers are located as far as possible in the wheat and sheep districts near the bank's offices. This is supplemented by field days, attendance at agricultural shows and by field demonstrations. The heavy demand for their service is testimony to the high value placed on them by the farming community.

Sutton's 1935/36 report also refers to officers in the dairy areas helping bank officers to plan development for farmers who sought relief from some of the bank's charges.

At the time agricultural advisers or instructors were stationed at Geraldton, Carnarvon, Northam, Katanning, Bunbury, Harvey, Roelands, Manjimup, Albany, Narrogin, Bridgetown, Denmark, Gosnells, Mundaring, Northcliffe and Vasse, while veterinarians were at Beverley, Bunbury and Derby.

In 1935 the department was asked to help the university with lectures pending the arrival of the new Professor of Agriculture. When the professor arrived he reorganised the courses and asked the department to provide 150 lecture periods and 100 laboratory periods and to set and mark the exams in the courses given in Agricultural Chemistry II, Plant Pathology, Agricultural Botany, Dairying and Horticulture.

Sutton was concerned at suggestions that a university agricultural research institute should be established. He felt that this possibly arose from a misconception that departmental researchers were distracted by administrative requirements or that the department could not undertake long-term projects. He rejected both of these contentions.

His concern arose from the possibility that scarce funds would be directed away from the department. This proved to be the case almost 20 years later and there was a further major change 70 years after Sutton expressed his concern.
He said the department was in a unique position (to carry out relevant research) in that it was committed to research to aid the agricultural industry and had professionally trained field officers in contact with farmers, who were able to assess the nature and importance of an issue. They were then in a position to supply a directive force to the research process. He went further and stated that “there is no doubt that the Department of Agriculture is a research organisation. It is probable that no institute or similar organisation anywhere is doing more (research) per unit of expenditure”.

The overall organisation was quite stable from 1930 to 1940. This would be expected, as Sutton remained Director of Agriculture until his retirement in 1937. He was followed by LSTJ Jones as Under Secretary until 1941. Jones had been Sutton’s senior administrator for virtually the whole of his period as Director. In 1941, GK Baron Hay took over as Under Secretary.

The combination of trained staff, Sutton’s personal attitudes, and the downturn in agricultural development in the post-Depression years, saw the department become more involved with problem solving and increased productivity at farm level. There was a reduced need for servicing the needs of farmers developing new properties from a virgin state.

As the Depression started to bite, government expenditure had to be reduced and this was reflected in areas such as the experiment farms which had to operate on reduced and in some cases skeleton staffs. There were also long delays in maintaining existing or providing additional infrastructure on these farms. However, over the decade to 1940, there was an easing of the financial environment. It was possible to increase field staff and experimental farm staff and to start the maintenance of the essential infrastructure.

The problems brought on by the Depression created a greater demand than ever for departmental services. In 1931 Sutton bemoaned the fact that, even making every effort at reorganisation, it had not been possible to meet this increased demand. As the years passed, the reports display the increasing emphasis on experimental and advisory work. The department’s capacity was increased by not only a steady increase in professional staff, coming from the cadet scheme and direct employment, but the postgraduate training of some officers. Three graduates who had gone overseas for postgraduate training returned with PhDs in 1928, 1930 and 1931. They were LJH Teakle, TC Dunne, who would follow Baron Hay as Director (Under Secretary), and EJ Underwood, who would become the outstanding Professor of the Faculty of Agriculture at the University of WA for the 20th century.

As part of the changing focus Sutton obtained Ministerial permission in 1936 to change the names of the ‘experiment farms’ to ‘research stations’.

Expansion was stopped by the low prices for wheat and other grains and many farmers looked for other ways of surviving financially. Some who were particularly exposed, or perhaps did not have the protection of being soldier settlers, had to leave the land. It was common to hear that someone had ‘walked off’ their property. This meant they had not taken anything except their personal belongings, and had left everything to satisfy their debts, normally to the Agricultural Bank, which became a major landowner. This situation continued to the end of World War II. Many ‘abandoned’ properties were leased by neighbours while others were left to become refuges for vermin and breeding grounds for locust plagues.

On the brighter side, the experimental work and plant breeding continued at the experimental farms. There was some reduction in experiments on farmers’ properties because of the need for economy, and a drop in interest by farmers due to the economic situation.

Two wheat varieties were released at the 1930 Merredin field day. One was called Sutton, a late maturing variety. The other
was Bencubbin and described as a mid-season variety. Both had resistance to flag smut. Bencubbin became one of the most extensively planted varieties in Australia and was used in all states.

In 1932 the plant breeders were able to release another new wheat variety with flag smut resistance. Named Totadgin after a railway siding near Merredin, it was early maturing and should have been successful in the lower rainfall areas. It did not become popular with farmers, which is surprising because it should have been better than Bencubbin for the eastern and north-eastern wheatbelt.

There were no more releases of new wheats until 1938, when a selection from Bencubbin called Bungulla was released. It became quite popular. Experiment farms established at Yilgarn and Dampawah Springs appear to have been closed at the end of the decade. The 1940 drought probably convinced the administration that they were too far east.

In 1931/32 a major innovation was the bulk handling of wheat at five receival points. Legislation was passed and the Cooperative Bulk Handling company was formed under the auspices of the Westralian Farmers Cooperative. By the 1937/38 harvest the facilities were installed across the wheatbelt.

There had been a steady reduction of area sown to wheat from 1931 through to 1933. The 1931 crop produced 53.5 million bushels; the 1933 crop was 37.3 million bushels.

As mentioned earlier there had been a major increase in the planting of pasture and its topdressing with superphosphate. While this had occurred initially in the high rainfall areas there was a growing interest in a legume-based pasture in the medium rainfall areas. The work of TC Dunne at Muresk had provided the foundation for the publication by Dunne and Shier of the paper on *An Alternative Rotation for the Wheatbelt* in 1934. This became the basic text for development of ley farming, which was to be the crop rotation from the 1950s to the early 1980s.

In the mid-1930s a cereal research laboratory was set up in the department to examine the bread-making characteristics of flour from WA wheat varieties.

The poor prices for wheat and wool resulted in a decision to foster a move to fat lamb production using a crossbred ewe (Merino x Border Leicester) and British breed ram. A small number of lambs had been sent to the London market in 1929 and production developed from that. In this way, the drop in the price of wool led to the development of the fat lamb industry.

By 1934 there was growing concern for the cattle industry in the Kimberley. International beef prices were low. The southern market was well supplied by beef, mutton and lamb from southern areas. While the east Kimberley had access to Wyndham meat works there was a problem in getting the cattle to the works in condition for slaughter. This situation continued until after World War II, with the opening of the American beef market.

**Animal disease research**

By 1931 the research on the 'braxy-like' disease had been successfully completed and a vaccine prepared for commercial use. More detail of these investigations is in Chapter 6.

In 1933 the investigation of 'Denmark wasting disease', started earlier, was continuing. Dr EJ Underwood and veterinarian JF Filmer were in charge. There had been some indication that iron in the form of limonite may be involved. Analysis of the limonite showed the solution lay in a group of elements described as the zinc group. Further testing showed the problem was caused by a deficiency of cobalt in the animal's diet.

In 1933 an investigation of the problem of enzootic ataxia at Gingin was continuing under the direction of Dr Bill Bennetts. By mid-1937 it had been shown that the addition of copper to the diet overcame the problem.
There was concern about the high incidence of botulism or toxic paralysis among sheep in the inner wheatbelt. It was shown to be due to the sheep developing a depraved appetite and eating carrion in the form of rabbit carcases. The final solution came through a vaccine prepared by CSIR which was shown to protect sheep from the toxin under field conditions. While protein deficiency had been identified as the cause, supplementary levels of hand feeding which would control the problem were not economic. The achievement of higher protein summer feeds by the introduction of a legume into the pasture, and the control of rabbits, were management options which became progressively available to the farmer. Nevertheless, occasional occurrences of botulism occurred throughout the wheatbelt.

Tuberculosis in the dairy herd caused concern. The problem was that the disease was transmissible to humans, particularly children, through unpasteurised milk. Testing had been continuous for at least 20 years but reactors continued to be found. In 1933/34, 169 reactors were detected and slaughtered, which was about 2 per cent of the animals tested; this appeared to be the 'normal' level in the herd.

In 1936/37 the problem of 'falling disease' of cattle was identified in the Margaret River area. High producing cattle would just fall down and die from no apparent cause. Investigation showed that there was a tendency for the cattle to be anaemic and it was decided to treat a herd with copper. Anaemia had been a characteristic of sheep affected by copper deficiency at Gingin. No further cases were experienced with cattle treated with copper but the incidence of the disease did not permit definitive work to be carried out until some time later.

'Coast disease' was the name given to the very poor performance of cattle grazing pastures on the south and west coastal soils. Following reports from South Australia that an identical problem could be controlled by providing stock with both copper and cobalt, experiments were started in susceptible areas to test the same treatment here. The results were the same.

In 1938/39 a test for contagious abortion was made available by the department's veterinary pathologists. Using this test it was thought it would be possible to free a herd of the problem.

**Dairying**

There was a lot of emphasis on the dairy industry through the decade. The industry was described as having taken phenomenal strides during the late 1920s and early 1930s. The increase in production was 12 per cent in the 12 months ending in 1930. This was almost exactly equal to the increase in cow numbers from 74,200 in 1929 to 89,700 in 1930. But it was after this that major increases in productivity were achieved.

To improve the genetic base of the industry the government had enacted the *Dairy Cattle Improvement Act* in the mid-1920s. This established bull zones in the South West. The government paid a subsidy of 15 guineas ($31.50) per head for the purchase of pure bred bulls provided it was of the correct breed for the zone where the farmer was located. It was argued that the accepted theory among dairymen was that the best rate of herd improvement came from mating successive generations to the same breed. The Zonal Scheme aimed to make it easier to keep to the same breed without in-breeding, which was seen as undesirable.

In 1934/35 an Australian price of around one shilling per pound of butterfat to farmers was set by the Federal Government.

During 1934/35 the first Dairy Products Marketing Board was set up. Consumers, manufacturers, producers and licensed dealers were represented. The Superintendent of Dairying was an ex-officio member and Sutton was Chairman. Its role was to:

- regulate and organise the sale, distribution and storage of dairy products
and related plant and equipment; and plant inspections.

- enforce quotas
- issue and cancel licences
- fix the maximum rate for the road transport of milk and cream to factories
- regulate the duties of inspectors
- deal with any other incidental matters.

The department then implemented an intensive program of inspection aimed at improving the quality of butter. It was also decided to enforce certain health regulations covering the requirements for dairy premises on farms. These were:

- concrete floor to the dairy and milking shed
- facilities for supply of boiling water to the dairy
- adequate drainage from the milking shed
- provision of a suitable dairy for storing cream.

Soil surveys

There had been concern about poor crops in the Salmon Gums area from early settlement. The Royal Commission into the Esperance Mallee Lands was set up to look at this problem and reported in 1917. In evidence to the Commission the recently appointed Professor of Agriculture, Dr Paterson, stated that after visiting the area and collecting soil samples he concluded that excess salt in some soils was the underlying problem.

Other evidence was given that the problem was due to laziness and poor farming methods among the settlers. The Commission broadly accepted that view and ignored Paterson’s advice.

In the years which followed there appears to have been no definition of the problem. The government instead proceeded with an ambitious plan to develop 3500 farms between Salmon Gums and Lake King and included land west of Lake King around Lake Camm and Lake Carmody. By 1929 the area had been largely surveyed and there had been some development of farms west of the rabbit-proof fence.

The funding for this project was to come largely from the British Government. In 1922 the Empire Settlement Act was passed by the Westminster Parliament, providing authority to fund, in association with Dominion Governments, the settlement overseas of British citizens on land identified by Dominion Governments. In Australia such proposals had to be approved by a commission set up for the purpose. This commission was aware of the problems at Salmon Gums and asked for further advice.

When Teakle returned from his PhD studies in 1929 he was asked to look at the soils within a triangle with its apices at Salmon Gums, Newdegate and Southern Cross. After a general survey and collecting samples from 650 sites, Teakle advised that as much as 37 per cent of the better class soils of the area were unsuitable for wheat growing. He advised that a more thorough survey was needed before a definitive answer could be given.

Soil surveys were undertaken in the Lake King district and areas around Lake Carmody and Lake Camm. The areas west of Lake King around Lake Camm and Lake Carmody had just been settled. The surveys were concentrated on the forest and mallee country, as it was known that there was no accumulation of salt in the sandplain. They showed that almost 40 per cent of the soils carrying forest and mallee were affected by high salt, which made them unsuitable for cropping.

By late 1933 the department was heavily involved in a redesigned scheme for the settled area. The need for some farmers to leave under the redesign arrangements made Teakle unpopular. There were some side effects, with some railways, such as that from Newdegate to Lake King, not being built. An area around Lake Brown, north-west of Southern Cross was also surveyed. The soil surveys of all these areas covered an area in total of 615 000 acres. It is
assumed that these results meant the Commission could not accept the project for funding.

With the onset of the Depression the proposal was abandoned. When the light land was considered later, the affected area was probably only 10 per cent of the total. But that technology was not available in 1930.

The Salmon Gums soil survey, on the eastern edge of the 3500 farms scheme, began in 1932. By mid-1935 it had covered 565 100 acres, with the final total area surveyed being 583 018 acres. Some 70 000 samples were tested in the field laboratory. These gave similar results to those obtained further west.

Based on these results and in collaboration with the Agricultural Bank, a redesigned scheme to rehabilitate the district was drawn up. It was calculated that 150 farms could be developed in the area on the following premises:

- that the district be developed for mixed farming
- a farming unit should have at least 800 acres suitable for wheat growing
- fencing, water supply and plant must be adequate for the task
- evaluation of the value of the asset should be based upon the producing capacity of the cleared land which would be indicated by the soil survey
- £400 should be provided for each farm for fencing, water supply, new machinery etc.

Other soils issues

In 1936, in conformity with other states in the Commonwealth, a Soil Conservation Committee was formed within the department. No real action was taken until after World War II.

With the growing interest in pastures in this post-Depression period, extensive experiments had been established looking at different species in the South West, the irrigation areas, the Great Southern and wheatbelt.

With the soil survey work largely completed, the Plant Nutrition Branch turned its attention to use of trace elements. In an early experiment carried out in cooperation with the Conservator of Forests, pines were injected with a number of nutrients. In 1937 a response to zinc in pines was seen.

In 1938/39, experiments were established on ‘swamp’ lands in the Albany district. While many were flooded due to heavy rain, this showed responses to copper on some acid swamp soils, some sandy soils and the Grasmere and Lake Sadie soils. Response to copper was also obtained at Wagin on a gravelly low fertility soil. This work is dealt with in more detail in Chapter 7.
Biological services

The primary blowfly, *Lucilia cuprina*, which was first recorded in Australia in 1913, was found in WA for the first time in 1934. However, its range extended into the Murchison, suggesting it had been in WA for some time. Biological control was tried but failed.

The importance of insect pests ‘comes and goes’ depending on seasonal conditions. In 1937 concern was expressed about the predations of the bryobia mite. An arsenate-based spray was tried against it, unsuccessfully. There was also concern about a suite of scale insects. Negotiations were in place to obtain a parasite of wax scale from the NSW Department of Agriculture. The apple weevil had reappeared and was causing concern.

In cropping areas webworm continued to cause damage where crops were sown on land which had been in pasture and was ploughed and sown after the first rains. Redlegged earth mite was a major pest of pastures for the whole decade. In 1936 and 1937 under dry conditions early in the year it caused considerable crop damage. A grant for a study was made by CSIR and a committee of CSIR, the department and the University of WA was formed to oversee the study. The lucerne flea also caused problems where the bdellid mite was not established. The branch was also distributing other potential parasites.

The little plague grasshopper (*Austrostictes cruciata*) occurred in plague proportions in 1937/38 for the fourth year in succession. A baiting program was tried and the Agricultural Bank carried out a fallowing program on abandoned farms. This was repeated in 1938/39 with some reduction in severity of the outbreak.

The Plant Pathology Branch responded to an increasing demand for *Rhizobium* cultures for a wide range of legumes which farmers were testing. This work was so popular that demand had grown substantially; in 1938/39 some 3000 cultures were sent to farmers. Separately, the Dairy Laboratory had prepared 52 cheese starter cultures. Cultures were introduced from overseas in order to maintain the vigour of the culture held in WA. The laboratory also examined a large number of milk samples for bacteriological content and for cream content and solids-not-fat.

During the year experimental work seeking the best way of eliminating mastitis began. The research concentrated on mastitis because of evidence that it was the causative organism for an objectionable odour in some milk.

The Botany Branch established a seed certification program in 1934. The branch certified the purity and germination of a sample of seed of a particular cultivar of a species. The seed was also certified to be of the specified cultivar. This program was applied to subterranean clover in particular and 63 tons of the Dwalganup variety were certified during the summer of 1934/35.

The fruit industry

The fruit industry began the decade with good domestic and export markets and maintained this position. In 1938 there was concern that quotas would be introduced in the London market. In the event there were no restrictions, which was fortunate as a record crop was produced and 1.3 million cases of apples were exported.

An outbreak of 'black spot or apple scab' in 1930 was declared eradicated by 1934, with great savings to the industry. This disease reappeared in early 1936 at Mt Barker and Manjimup. By late summer of 1937 only traces could be found at Mt Barker and none at Manjimup. In late June 1937 the disease was found in a small nursery in Albany and all the apple trees involved were destroyed and burnt. This outbreak caused closer inspection of nursery imports from the eastern states which were found to be heavily infested.

An outbreak of codlin moth occurred in Collie in 1935. In 1937 it was found again at Mumballup and effectively eradicated by
1938/39. In 1938 apple scald was found in one orchard and was considered to be eradicated by 1939.

The department investigated a problem of ‘die back’ or ‘wither tip’ of apple trees, particularly in the Bridgetown district. Sprays and injections of a range of elements were tested and a response was obtained to copper sprays. It was concluded that copper deficiency was the cause of ‘wither tip’.

Tropical fruit production at Carnarvon began in the early 1930s. The department conducted fertiliser and variety trials there and in 1938/39 plans were being developed to establish a research station.

Other issues

The production of eggs exceeded domestic needs early in the decade, resulting in exports to England. The eggs were of high quality and well received. Approval was obtained in 1933 to mark them as a product of WA, as opposed to only being able to mark them as from Australia.

The Manjimup district became the focus for the developing tobacco industry and the department provided strong technical and other support. The issues were selection of the right soil type and plant variety, and avoiding disease in the seedbed. Keeping downy mildew (blue mould) out of the seedbeds was a particular issue. Growers also needed help to design and build drying and curing sheds.

All the leaf sold quite well on the national market. By 1936/37 the crop had increased to slightly over 1000 acres. In view of what happened in later years (when buyers stopped attending sales in WA) it is interesting that in the late 1930s the buyers found the WA leaf of good quality with good burn characteristics and competitive with other Australian-grown leaf.

In the early 1930s the irrigation areas were beginning to take shape and the Irrigation Commission was reconstituted during 1934/35. Harvey No. 1 and No. 2 areas had started and the Public Works Department was building the main channel from the Wellington Dam. The first water was released in 1933/34, when about 500 acres of new land were irrigated. By 1938/39 the area had increased to 11 032 acres. This rapid development of a new industry for farmers with little or no previous experience placed considerable pressure on the irrigation experts of the department.

The first reference to vermin in annual reports for the decade was in 1933/34, where concern was expressed about the increase. Dogs were a serious problem and bounty was paid on 12 720 scalps. Foxes and eagles were also a concern, with bounties paid on 24 120 scalps and 5614 eagle beaks. Rabbits were causing serious damage in many places west of the No. 2 rabbit-proof fence. With some seasonal variation vermin were a continuing problem during the decade.
Chapter 3

1940 to 1970: war and the major post-war expansion

World War II, its effects and demands, and the post-war recovery dominated the first decade of this period. Advising on and managing the shortages of labour, fertilisers, machinery, materials and staff in order to produce the food needed for the armed forces and the community was the challenge of the war years. A new wave of development using trace elements to develop millions of hectares of previously uncleared light land dominated the second decade. Dealing with the demands related to the rapid expansion based on the use of trace elements, new machinery and high prices, was then the challenge of the 1950s and 1960s. Major increases in departmental professional staff and capacity, the development of the South Perth headquarters, expansion of the research and extension capacity and improvement in country office space were the main features of the later years. The Ord River development had started and the dam was virtually completed by late 1970.

The war years

War was declared between Germany and Britain on 3 September 1939. It continued until April 1945—more than 5½ years later. Australia joined England and declared war on Germany. On 7 December 1941 Japan attacked Pearl Harbour and brought the United States into the war on the Allied side and Australia was automatically at war with Japan until August 1945.

By September 1941 Germany had control of all of continental Europe and Scandinavia except for Sweden, Spain and European Russia. The loss of Western Europe meant that supplies of primary products to the United Kingdom were totally severed. Australia’s major agricultural industries depended on exporting much of their production, so the whole export segment was threatened by the loss of shipping space because of enemy activity and the need to transport munitions.

The Australian Government moved rapidly to market the main exports of primary products. By June 1940 it had introduced legislation to establish boards with extensive powers to acquire and dispose of products such as meat, wheat, barley, apples, pears, and eggs and/or made arrangements for the disposal of the export products.

The British Government:

- Contracted to take 240 000 tons of meat at 1938 prices, which were above those immediately before the war. The government was confident the remainder would find a ready market.
- Contracted to buy the whole of the wool clip for the period of the war at a price of 13.4 pence (11.2c) per pound. In addition, the Australian Government would receive 50 per cent of any profits from sale of wool outside the UK.
- Agreed to buy 200 000 tons of the previous season’s wheat held in store in WA. The government established the Australian Wheat Board to acquire all wheat delivered to sidings for the remainder of the war. At 30 June 1940 the Wheat Board paid $15.75 per tonne and more payments were expected.
- Contracted to buy almost 95 000 tons of butter annually, starting with 75 000 between September 1939 and 30 June 1940. They agreed to pay 90 per cent on shipment and 10 per cent within 28 days of arrival at an English port.
• Contracted for 13,000 tons of cheese on the same payment basis.

In addition, the Australian Government:

• Appointed a Barley Board with the same powers as the Wheat Board to acquire the barley crop.

• Acquired the apple and pear harvest at a price of 2 shillings per bushel for apples and 3 shillings per bushel for pears. A further shilling per bushel was to be paid on delivery of a specified quality.

The entry of Japan into the war in December 1941, and its capture of Indochina, Singapore, Indonesia and Burma resulted in Australia becoming a major base for the eventual fight-back across the Pacific. As a result, a large number of American troops were based in Australia. Australian troops, who had traditionally fought overseas, were called home.

By June 1940 the shipping shortage was impinging on WA’s export industries, particularly those which needed refrigerated space. The Australian Government’s purchase of all unshipped wheat and fruit allowed those industries to stay in business. The UK contracts were renewed for 1940/41 at much the same price. The Australian Government also bought some grades of lamb, which allowed the market to continue to function.

By early 1942 Japan occupied much of South-East Asia and by mid-1942 the whole outlook for Australia's primary industries changed again.

Australia became a military base, with a great deal of food required by the armed forces. Conscription was imposed in 1942 and farm labour became very short. The position was so acute that 150 prisoners of war were used in April 1942 to dig the potato crop. A survey showed that between 25 and 50 per cent of permanent labour remained in the major industries but casual labour was virtually unavailable. The Commonwealth Government recognised this and manpowered all remaining permanent farm workers.

The casual labour situation was partly resolved by forming a women’s land army and using Italian prisoners of war who were willing to work on farms. Women had a particular role in labour-intensive areas such as fruit picking and packing, vegetable production and tobacco picking. Examples of women virtually running broadacre farms on their own are also well documented.

A major concern was the availability of fertilisers. The Germans attacked Nauru in December 1940 and sank British Phosphate Commission ships. In 1942 the Japanese occupied the Nauru, Ocean and Christmas Islands. In 1940/41 the only phosphate rock available had come from Christmas Island. This met only 70 per cent of the State’s needs. As a result the area sown to cereals in WA was reduced by 33 per cent. Farmers were advised in mid-1942 that phosphate supplies for 1942/43 would be only half of those available in 1939/40.

The Department of Agriculture was required to administer this rationing and the two fertiliser manufacturers were fully cooperative. Petroleum and rubber supplies were also interrupted with the occupation of South-East Asia by Japan.

In 1942 only about 25 per cent of the normal sulphate of ammonia was available and that was reserved for commercial market gardeners. Wyndham abattoir had ceased operation after the winter of 1941 so the amount of blood and bone was reduced to about half of normal requirements. Again these supplies were only available to commercial market gardeners. The supply of meat meal was also reduced.

By 1942 the war was affecting the capacity of the Department of Agriculture to operate efficiently. Nine professional officers had joined the forces during 1941/42. In the farming areas there was a shortage of manpower, farm equipment, chemicals for pest control, stock foods and fertiliser. While a policy was introduced to declare agriculture a protected industry and to ‘manpower’ participants, shortages already existed. Wheat production had been
curtailed through acreage restriction, labour and fertiliser shortages. Only 1.5 million acres were sown for grain in 1942/43 compared with 3.4 million in 1938/39.

The area cut for hay had been reduced along with other forms of fodder conservation. The area under orchards was also falling. Beef supplies from the north had been interrupted largely due to Japanese activity. Sheep numbers and wool production had increased. Pig production suffered in 1942 through an outbreak of swine fever in metropolitan piggeries, necessitating the slaughter of some 12 000 pigs.

A major change in policy was to declare certain agricultural products on the same footing as munitions for access to scarce materials. The shortage of manpower created increased demand for farm machinery but manufacturers had been largely redirected to the war effort. The distribution of the limited supply was controlled.

The war in Europe ended in April 1945 and there was now an urgent need to plan for the future. The Under Secretary for Agriculture was concerned that the UK, which was Western Australia's biggest export market, and the USA, which was a potential export competitor, had both developed high technology agriculture during the war. If Australia was to compete it needed to go down the same path. The capacity of the UK to buy would also be affected by its changed financial situation.

The sale of a range of agricultural commodities was covered by agreements with the UK until 1948. While wheat surpluses had been depleted by drought he felt that wool could be a problem. This view was obviously widely held as the Commonwealth Government provided a £325 000 research and marketing incentive for the wool industry to help dispose of the accumulated stocks. Egg production and market gardening had expanded rapidly in response to the increased population driven by a major influx of troops, and adjustment was expected to be necessary.

When the war with Japan ended in August 1945, the wholesale unwinding of wartime arrangements had to begin. In the short-term there was a demand from Europe for some products but it was recognised that markets would progressively become more competitive.

By the end of 1948 Australia was adjusting to peacetime. The damage to European agriculture which helped the demand for agricultural products was continuing and prices were high.

**Some post-war issues**

During 1946/47 the UK extended the price guarantees for agricultural products including wheat. On this basis it was considered that a policy of land development and increased production could be followed in WA.

A Royal Commission was appointed to recommend on the best method of marketing wheat in the event of the Australian Wheat Board collapsing. The commission recommended a State-controlled compulsory pool system. In the case of pears, apples and tobacco the government agreed to continue the acquisition schemes to the end of 1947. In WA it was decided to empower a State board to control the acreage planted to potatoes and to acquire and market the crop. It was expected that there would be a need to downsize the industry but the development of the Singapore market overcame this problem.

Two years after the war ended the supply of machinery had not improved. There was a particular problem with large tractors; few were produced in Australia and supplies had to come from the UK or the USA.

**Seasonal conditions**

The year 1940 was very dry throughout the agricultural areas. Early April rains in 1941 helped feed supplies and it was a good year. In the pastoral areas the long drought in the Gascoyne finally broke; 1942 was again a favourable year except for part of the Murchison. In cereal growing areas the
season was reasonably favourable early but a dry September and October affected late-sown crops. The 1943 season opened well but spring turned dry, which affected crop yields and pasture growth in the dairy districts. Some crops were affected by an outbreak of stem rust. Autumn rains in 1944 were light and feed was short but sufficient rain was received for grain yields to be reasonable and hay yields near normal level.

The 1945 season started slowly but very heavy June rains interrupted cropping and caused damage to sown areas. The spring cut short despite the heavy winter rains, reducing grain yields and the quantity of hay conserved in the high rainfall districts.

Autumn rains in 1946 were satisfactory and widespread. They were followed by heavy and widespread rains in June, giving an excellent outlook for both crops and pasture. In the agricultural areas the very wet winter of 1946 was followed by a dry spring and a dry summer. In 1947 autumn rains were adequate for cropping in the cereal areas and it was generally a favourable year. These satisfactory climate conditions continued through 1948.

The 1949 season completed a run of five very good years, with eastern districts being a little dry, but crops were helped by October rain. However, farm water supplies were difficult due to the light winter rains.

**The department at war**

**Staff numbers during 1940 to 1950**

In 1940 the total staff recorded in the Public Service List was 146, of whom 60 were professionals including 11 veterinarians, 52 were general division officers (largely inspectors) and 34 were from the clerical division. By 1945 there were 76 professional officers, of whom 15 were veterinarians, in a total staff of 205. They were supported by 61 general and 68 clerical officers. In 1950 there were 97 professional staff of whom 16 were veterinarians in a total of 235. They were supported by 91 general division and 45 clerical division officers.

**Staff policy and administration**

The department had to adapt to the war. Initially there were a number of staff losses due to enlistment. In his report of 1939/40 the Under Secretary had commented on the work of the officers in the following terms: “The technical officers of the department continually contact the rural community by personal visits, correspondence, lectures, demonstrations and by articles in the Press and the Journal”. Capacity for this was greatly reduced during wartime.

By mid-1941 the continued enlistment of young officers created difficulties in providing a full suite of services to industry. In addition officers worked in areas seen as being of greatest importance which resulted in the cessation of some activities. The department had always been short of laboratory space and either could not carry out some work or had to use space made available by the University of WA.

In his June 1942 report the Under Secretary wrote: “The greater control of production during wartime has required the department to carry out many functions—particularly on behalf of the Commonwealth Government—other than the normal duties … officers have adapted themselves to their new and varied duties … a tribute is paid not only to the technical staff but to the administrative and clerical staff for the manner in which the increased work has been carried out under difficult circumstances”.

By June 1942 Australia was firmly established as the major platform for the fight-back against Japan. Agriculture was recognised as an important 'munition' of war. This focus increased the demands on the department at a time when it was undermanned. Advice was sought on varied war-related issues including the suitability of soils for airfields, control of pests in army camps, and the dehydration and canning of fruit and vegetables. The department was also asked to undertake the inspection and supervision of all food manufacturers (other than meat and fish) providing food to the defence forces.
An officer chaired the State Nutrition Committee which monitored civilian nutrition problems occasioned by the war. Another officer was responsible for the organisation of District War Agricultural Committees and field officers acted as the chairmen of these committees. The approval to purchase certain equipment and materials including fertilisers was controlled by the department. The department was also represented on the Shipping Priorities Committee and provided advice to the Commonwealth and State Governments on a wide range of industry policy and technical issues.

To achieve an informed approach to the control and distribution of scarce equipment and materials the District War Agricultural Committees throughout Australia dealt at the local level. Their broad remit was to assist in the maintenance of agricultural production. They were all chaired by departmental officers and included the local manpower officer, a paid executive and four others, at least two of whom were farmers.

Thirteen of these committees were formed throughout WA. Each committee covered selected statistical districts, which made information collection easier. They were required to focus on the areas of production needed for the war effort, which could mean restricting some industries and stimulating others. Their task was not to list the difficulties but to plan and solve the problems at a local level. Labour intensive operations such as fodder conservation, shearing, potato digging and fruit picking were special areas needing attention. Where machines were not installed milking was a challenge in dairying areas.

Labour needs were eventually met by a range of actions. In some cases the army agreed to release soldiers for short periods for specific purposes; in others Italian prisoners of war were willing to work on farms, and the Women’s Land Army made a big contribution. As a result the casual labour needs were largely managed successfully.

Fuel was a special problem. Apart from war needs, oil and rubber supplies, which were largely cut off by the Japanese advance, were not available. In some cases fuel shortages were overcome by the use of charcoal gas producers. These devices produced carbon monoxide by burning charcoal in an oxygen-deficient environment. They were made to fit onto tractors, trucks or cars. The carbon monoxide could be used in petrol or kerosene motors and made a major contribution to overcoming the fuel shortage.

The loss of rubber supplies was more difficult because of the lack of a cheap alternative. Later in the war artificial rubber became available in limited quantities. One of the committees’ tasks was to identify the most strategically important use of the very limited numbers of motor tyres. The allocation of special fuel supplies was another important role.

The change in attitude to agricultural production clearly spelt out its importance while the war lasted and for a number of years after. The Under Secretary made the point that while there was an immediate short-term need, the longer term must also be kept in focus. This statement carried with it a need for the department to increase capacity in its traditional roles of applied research and extension to deal with both current issues and long-term opportunities and needs. Looking forward, the WA Government appointed a Post War Works Committee early in 1942; the Under Secretary was a member.

The department formed an agricultural sub-committee to review suggestions from its various industry committees before they were fed into the major policy committee. This committee comprised the Under Secretary, Plant Nutrition officer, Chief Veterinarian and the Superintendents of Dairying and Horticulture. Departmental officers also gave extensive evidence to the Post War Reconstruction Commission when it visited WA in April 1943. In their evidence they pointed to areas which were available for development.

There was little change over the following year. It was a case of dealing with the
routine issues associated with the war. By June 1944 the focus was clearly on the post-war period and the challenges that would bring. Materials and equipment continued to be in short supply and had to be managed. Grain and other surpluses had been cleared, partly due to drought.

Additional fertiliser supplies were expected and plans were being made for significantly increased plantings of crop in 1945. The District War Agricultural Committees dealt with their important responsibilities in an efficient and professional manner. They were required to determine allocations of farm labour, allocate scarce materials such as motor tyres and galvanised iron among farmers, and allocate special fuel supplies. Advice was also important in allocation of machinery. The committees also promoted and organised the use of machinery pools where appropriate.

While the second half of 1944 had been very busy for the District War Agricultural Committees the end of the European war saw a slowing of their activities from early 1945. Nevertheless the shortage of materials continued and the local committees continued to carry out their responsibilities efficiently. Machinery allocation, which was managed by the committees, could be released for purchase or lease, or for groups (on a pool basis) or contractors depending on the committees’ assessment. Pools were established, and operated on smaller properties; 43 such pools were established between September 1944 and June 1945, largely in the South West. The Department of Agriculture also acted as an agent in any transactions where the Commonwealth retained ownership.

Concluding his 1944/45 report, the Under Secretary commented that while the demand for educational and advisory work continued at a high level, the department’s capacity to provide it was limited by trained staff and the pressure of wartime commitments, particularly among staff who were involved with the War Agricultural Committees. The committees were disbanded in March 1946. It was considered that with some informal advice the situation could be managed by normal administrative means. After they were disbanded the central executive was retained for a time in head office. In the northern agricultural areas two executives were maintained to assist in the distribution of tractors, which were still in very short supply.

There was an increasing demand for extension services but manpower limited the extent to which these could be offered. Some services were offered through the production of educational films, which began with the end of the war, and the continued use of radio broadcasts and the Journal of Agriculture.

During 1946/47 the Under Secretary, GK Baron Hay, was seconded to the War Service Land Settlement Department as Chairman of the Land Settlement Board, and Alistair McKenzie Clarke became Acting Under Secretary. In the annual report McKenzie Clarke commented on the loss of senior staff due to lack of opportunity for advancement and the difficulty he anticipated in recruiting young staff due to the salary differences in later years between the Commonwealth and the State.

Other problems included difficulty in obtaining motor vehicles, and country housing. He commented that the department was less than holding its own in providing extension services desperately needed by new settlers and the agricultural industry, which was starting to develop again after almost two decades of stagnation.

In 1947 there were four country offices and three professional advisory officers stationed there. Gerry Throssell, who had returned in 1944 after serving with the AIF, was at Geraldton; Jim Marshall who would later lecture at Muresk and Fremantle Technical College, was at Beverley; and Eric Watson, who would later join CSIRO and manage Glen Lossie Research Station at Kojonup, managed offices at both Kellerberrin and Merredin.
During 1948/49 the title of the head of the Department of Agriculture was formally changed to Director of Agriculture. In his annual report the Director commented again on the problem of a lack of experienced technical staff to meet the needs for advisory and research work. He was taking an interest in the enrolments in Agriculture at the University of WA, but commented that these young graduates would take time to become experienced. He was also critical of the accommodation arrangements for the department.

In 1949/50 there was still a shortage of technical staff, and accommodation remained an issue at head office. Two new research stations were established, one at Bramley near Margaret River, and the other at Wokalup, south of Harvey.

The department proposed formation of a branch to provide research and advisory services to the pastoral industry. It was recognised that officers with experience in the pastoral areas were not available in Australia and young graduates would have to be trained.

While there was evidence of development starting to pick up, there was still a shortage of superphosphate, requiring rationing in 1949/50. Supplies of sulphur from the USA were uncertain. Iron pyrites from the Goldfields would be used to overcome this problem in due course but in the interim, experimental work to investigate alternatives to normal superphosphate was needed.

**Rural industry highlights, 1940 to 1950**

**The dairy industry**

The big expansion of the dairy industry was over and production was up and down, depending more on feed supplies than on any other issue. Seasonal conditions and the availability of fertiliser were important. The department was faced with additional work to meet the quality requirements of the UK contract and of the US armed forces later.

The focus was on improved quality through the decade.

The Commonwealth Dairy Products Marketing Board, which was established in 1939 to administer the arrangements with the UK, required the department to test all butter produced after October 1939 and potentially available for export. After that date, twice the amount of butter was tested as was tested under the State testing arrangements. It also involved testing butter produced in the summer; this had not been tested previously. The tests revealed problems with the quality of butter produced in the warmer months.

The first licence for margarine manufacture was issued during 1939/40.

In order to increase the amount available for export, butter rationing was introduced by the Federal Government in early June 1942. Previously, to increase butter production, the government had put an embargo on the sale of table cream, which absorbed an estimated 100 000 pounds of butterfat.

In order to improve returns to farmers the Federal Government decided to provide a subsidy to producers and allocated some $4 million for the purpose in 1942. In April 1943 this was increased to $11 million.

In 1943 there was a fall in the quality of butter. This reflected a drop in the quality requirements of the UK Government and reduced intensity of inspection and associated advisory work due to staff shortages. In 1943 the US army requested permission to be associated with the inspection of the whole-milk processing depots. Following these inspections they suggested changes in cleaning procedures, which improved the quality of the milk. In 1944 the US asked for cows in the Harvey area producing milk for their forces to be tested for TB.

In 1945/46 the quality of WA butter had fallen further. Despite staff problems 2500 visits were made to dairy farms in that year. The department began a bacteriological and chemical survey of all butter coming forward.
This was welcomed by manufacturers as it gave them guidance on how to clean and manage their factories. The increase in inspection and the laboratory input was rewarded and in 1946/47 the quality of the butter produced improved, with 20.2 per cent graded ‘choice’ compared to 5.3 per cent in the previous year.

The 1948/49 dairy production was marginally down on the record production of 1947/48 but 40 per cent more butter was graded choice than in the previous year.

During 1947/48 the Commonwealth Government announced that it would make £250 000 available for dairy industry improvement over five years. The allocation to WA was £16 125. Funds were used for initiatives in extension and research.

With more manpower available, inspections were increased and in 1949/50 field officers made 2252 inspections of farm premises. In 517 cases the premises were considered unsatisfactory, either structurally or through poor hygiene.

By the end of the decade the drift out of dairying had begun. By 1947/48 the number of dairy cows had fallen by 6400 since 1944, due to a move to beef or fat lambs in areas such as Kendenup and Mt Barker.

**The poultry industry**

Egg production fell initially but with the government seeking increased production after 1943, there was considerable expansion, notably in the wheatbelt. Surpluses were pulped after the Commonwealth installed an egg drying facility in WA. This facility was operated by the Department of Agriculture. In the year following the war the production of eggs was so much above home consumption that the government decided to introduce legislation to control marketing. A board with power to acquire all eggs and sell to available markets was created. In 1947/48 the industry bounced back, exporting to the UK. Significant amounts of poultry meat were also sent.

With assistance from the department, poultry farmers tested a new infra-red system of brooding for rearing chickens. During 1946/47 the department obtained land near Herdsman Lake for development of the Poultry Research Station. A Poultry Industry Trust Fund was also established.

**Livestock**

At Avondale Research Station the experimental feeding of grain supplements to ewes in the last four to six weeks of pregnancy continued to show improved survival of ewe and lamb.

The veterinarians were now involved in widespread testing in association with plant scientists to estimate the extent of mineral deficiencies. Surveys of copper status of farm animals showed that mild deficiency was widespread and that ‘stringy wool’ was a reliable indicator of copper deficiency in sheep. Samples from properties suspected of cobalt deficiency were also collected. Copper and cobalt deficient areas were mapped as they were identified.

An investigation began into dystokia among lambing ewes. Subsequent work showed that the subterranean clover strain in pastures contained an oestrogen precursor. By the end of the decade the infertility
problem in sheep appeared to have been managed in the field by increased cropping and a focus on balanced pastures.

A problem of malnutrition and sterility in cows at Manjimup was investigated, together with a serious infertility problem in cattle in the Margaret River area. This work showed a serious phosphorus deficiency late in the summer, leaving little time to recover before the demands of milk production commenced. It was found that milking cows need direct phosphorus supplementation to raise their blood phosphorus to ‘normal’ levels. The research station at Bramley was purchased as the focal point for future investigations of this problem.

It was shown that only ‘greenish’ coloured cereal hay had sufficient carotene to be a source of vitamin A. Based on the knowledge that animals at birth have no vitamin A in their livers there was an interest in the vitamin A content of the colostrum of ewes following a dry summer. It was found that the level was only one-quarter of the ‘normal’ level produced on green feed. The effect on lamb health was studied as it was known that in calves low levels can increase the degree of infections, but no effects of treatment were seen.

Despite improved methods of treatment, mastitis continued to cause serious losses to the dairy industry. Mastitis caused by Streptococcal bacteria had been successfully treated with penicillin but results with Staphylococcal-caused mastitis were not promising.

The testing of dairy cattle under the Cattle Compensation Act for tuberculosis identified 191 reactors. This was similar to previous years. In 1941/42 farmers were given help to free their herds from both TB and contagious abortion.

In 1946 the amended Milk Act replaced the Dairy Cattle Compensation Act and provided for the compulsory tuberculin testing for all cows owned by licensed dairymen. In 1947/48 tuberculin testing of all cattle providing whole milk began.

In 1947/48 a serious outbreak of laryngotracheitis occurred in poultry. As eradication was not possible, vaccination was adopted for affected areas.

**The wool industry**

The price of wool was very low at the beginning of the war and fixed at a low rate for the acquisition scheme which applied until June 1946. In 1946/47 wool was auctioned against a reserve price scheme and acquired by the Australian Wool Acquisition Committee if it did not reach the reserve price.

From June 1947 it was auctioned on the open market and realised prices well beyond those ruling in the first part of the decade. In 1946/47 the prices were double the prices received previously. In 1947/48 the price averaged about 10 shillings a pound (220c per kilogram) and in 1948/49 about 4 shillings and 6 pence a pound (99c per kilogram). It was again firm in 1949/50.

In the pastoral areas there were serious problems with blowflies in favourable years, causing considerable losses. Sheep were still being run extensively in the Kimberley.

In 1943/44 the number of fat lambs slaughtered was up on the previous two years, at 314 000. The figure for 1939 was 330 000. In 1948, 228 000 lambs were processed and in 1949,142 000. These figures show the variability driven by season and wool price.

**The cropping industries**

The wheat industry through the decade was a product of the effects of seasonal variability and of the restrictions created by the war and post-war shortages.

The 1939 season proved to be favourable for the wheat industry, with good rains throughout. By contrast, 1940 was poor. It was only saved from almost total disaster by belated finishing rains that raised the average yield.
The area sown to wheat in 1942/43 was restricted to two-thirds of the four base years ending in 1940/41. In 1945, yields were reduced in the south by the wet winter.

As controls were lifted and supplies improved the area of wheat sown in 1946 was 30 per cent greater than in the previous year. A wheat price stabilisation scheme operated across the industry during the decade, based on Commonwealth and State legislation.

There was a small increase in the area sown to wheat and oats in 1948/49. The total harvest and the average yield in 1949/50 saw out the decade much the same as 1948/49.

Through the decade the plant breeding, field trials, pedigreed seed production and species testing activities of the research stations continued. Maintenance of strength in export flour was an issue as the quantity of wheat delivered was only enough to provide for orders, with little opportunity to blend wheat of varying quality.

The annual cropping competitions continued, most of them judged by departmental officers. Numerous trials were conducted on farmers' properties.

There was an interest in growing flax. Britain had obtained its flax from Belgium before the war, but this supply was no longer available. The price had risen from about 75 pounds to 400 pounds a ton ($150 to $800 per tonne) as a result. This resulted in the establishment of a flax industry in the Boyup Brook district later in the decade.

During 1944/45 the Commonwealth Seeds Committee decided it would be desirable to have enough vegetable seed in reserve for a full year. This work was handled by the department and involved making contracts, inspecting growing crops, arranging cleaning and purity and germination tests on the final seed to be obtained.

**Soils and plant nutrition**

During the war soil surveys were carried out on potential runways of seven airfields for the US Air Force. Assistance was also given to the Commonwealth Works Department on a proposal to use soil cement for runway construction on airfields.

Long-term experiments at Merredin were used as the basis for recommending farmers use only 40 pounds per acre of super for their cereal crops in the period of phosphate shortage, which extended through most of the decade.

Experiments were carried out to determine the most efficient use of scarce fertiliser resources on vegetables. They demonstrated that chemical fertilisers were as efficient as blood and bone. This work showed split applications were more efficient for maintaining the nitrogen and potassium fractions, particularly on sandy soils. The level of these nutrients was shown to have a big effect on both yield and quality. The value of bulky organic matter dressings on sandy soil was not questioned.

In the dry season of 1943 a soil survey was carried out on the potential for irrigation of the Ord River basin. It showed that there were extensive soil types suitable.

Soil surveys were carried out at Margaret River, Many Peaks (30 000 acres) and Rocky Gully (40 000 acres) by CSIR.

Trace element experiments carried out for most of the period demonstrated widespread responses, especially to copper and zinc across a large number of soils, particularly the sandy and gravelly soils of the extensive sandplain. This information laid the foundations for the major land development of the post-war period. This is dealt with in Chapter 7.

At Carnarvon there was concern about the deterioration of structure on some of the research station soils. The effect of sulphur and gypsum on the problem was investigated.

A soil reconnaissance east of Pingrup, extending to Lake Magenta, showed the heavy soils had quite high salt content and it was concluded that more detailed examination was needed before settlement.
could be recommended. The department was now concentrating on ‘land capability surveys’ instead of detailed soil surveys. These were based on general land classification, including limited soil sampling, and judgment on the basis of past experience. This survey covered 1200 square miles (303 000 hectares). Following these surveys some reconstruction of farm size was necessary; 150 farms covering 250 000 acres (100 000 hectares) were involved.

Concern was increasing among farmers about salinity in agricultural areas. Examination of seepage water in lighter rainfall areas showed the salt content to be between 3000 (42 900 ppm) and 4000 grains per gallon (57 200 ppm). Salinity investigations were continuing, with testing of salt-tolerant plants at Avondale and studies of the effect of shallow versus deep cultivation at Hines Hill. These experiments with different implements and depths of ploughing on a private property and at Merredin Research Station showed no advantage of deep ripping on either ordinary or saline soils.

The Soil Conservation Act was passed through Parliament and LJH Teakle was appointed the first Commissioner of Soil Conservation. In its early stage the service addressed gully erosion with banks and structures, wind erosion with plantings of cereal rye, and control of clearing. Clearing control was implemented in the eastern and north-eastern wheatbelt shires in October 1950, through the gazettal of two soil conservation districts covering these shires.

**Horticultural industries**

The Under Secretary stated that due to the war and related arrangements there was a considerable increase in the demand for advice, inspection and investigation for the vegetable industry. In particular, experimental work to determine fertiliser requirements was needed. There was also a major requirement for assessment of fruit crops under the Commonwealth acquisition arrangements.

In 1941/42 The Commonwealth Government requested increased vegetable production for troops. This was a major challenge to the industry during labour and fertiliser shortages. Shortages of seed and nitrogenous fertiliser were particular issues. In 1939/40 summer fruit production was substantially reduced by the severe conditions. Only a million bushels of apples were produced of an expected crop of 1.5 million bushels. Despite the difficulty with shipping it was possible to export some 601 000 bushels to the UK, the Near East and Europe. In addition 23 000 cases of pears and 52 000 cases of grapes were exported. It was 1945 before exports of apples to the UK were resumed.

The Commonwealth Government introduced an acquisition scheme to keep the apple and pear industry operating during the war. The Fruit Branch was required to inspect orchards to estimate the quantity that the grower could have delivered in a normal market situation and it was necessary to employ extra staff for this task.

In 1940/41 only 10 to 15 per cent of the apples available for export could be shipped. None went to the UK. Export of grapes was not affected until late in the year and 45 000 cases were shipped to the Near East, which was generally comparable with previous years.

The government acquisition scheme was extended to mid-1948. While the home market increased with the build-up of armed forces and limited amounts were exported, much went to waste.

After the war the neglect of apple and pear orchards caused concern. This was partly due to marketing problems, partly labour and partly shortage of chemicals and fertilisers. The citrus industry was much smaller and less affected.

Even when the war finished in 1945, recovery was slow, partly through an initial shortage of planting stock. By 1948/49 the
Commonwealth Acquisition Scheme had concluded but an Act was passed to continue the arrangement under State control.

During the decade fruit fly was a periodic problem. This was clearly due to seasonal conditions and failure of householders and orchardists to exercise proven control measures. Where these measures were implemented control was achieved. In 1944/45 a Fruit Fly Eradication Fund was established. In 1946/47 the Plant Diseases Act was amended to allow compulsory eradication schemes, with departmental inspectors heavily involved. Despite such schemes the general situation was not satisfactory.

The department’s studies of apple and pear storage had shown the importance of time of picking in both species, the importance of wrapping for long-term storage of apples and the need to get pears to storage as soon as possible after picking.

The Potato Industry Licensing Act (1941) provided for growers to be licensed. It was also expected to be ‘valuable in connection with industry control’.

When hostilities ceased in 1945 there was concern that there could be a problem with over-production of vegetables. This did not eventuate, due partly to the export of 14 500 crates to Singapore. An export trade in vegetables emerged, with Singapore an important destination.

During the decade canning of vegetables and dehydration of potatoes were carried out for the first time in WA. The department had been responsible for inspection of the product and provision of technical advice to the processors. Officers of the US Army provided valuable advice in this development stage. Three plants were engaged in apple canning and four in dehydration. The supervision of fruit and vegetable drying, and canning for the armed forces continued until hostilities ceased. Manufacturers then moved to packs more suited to the civilian population. New techniques were necessary, and these produced their own problems.

In 1946/47 trials were started to test the best locations and the management needed for the production and canning of peas. The longer growing and processing period made Albany a suitable location for a future industry.

Throughout the decade, inspection of packing sheds, orchards and points of entry continued under the Plant Diseases Act. Despite shortages of staff, inspection of imported fruit trees and nursery material. In 1945/46 and subsequent years inspection work resumed at about normal levels and some 62 000 fruit trees and seedlings and 134 000 bulbs and roots were inspected at the point of import.

Viticultural production continued to be high and wine production increased. Some poorer quality wine was directed to distillers, as was some dried fruit. No wine or fresh grapes were exported during the war.

**Entomology**

In the five dry years before 1939 the small plague grasshopper caused serious problems and periodic problems continued through the following decade, depending on the season and the effectiveness of preventative measures. The combination of abandoned farms and the limitations on cropping meant potentially large areas of uncultivated egg beds. To address this problem the government subsidised ploughing-up of the egg beds and the provision of baiting materials to the Roads Boards. Plagues were experienced in 1940, the dry year of 1944 and in 1948. With the move to more wheat in marginal areas the problem largely disappeared.

In dry years the redlegged earth mite and lucerne flea continued to damage pastures, crops and gardens. Shortage of insecticide contributed to the problem.

The pea weevil continued to be a problem. An attempt at biological control was not successful in 1939/40 and it was repeated in 1941/42.
Work started early in the war to address the problem of grain insects which were expected to cause serious damage if substantial grain storage was required. Successful control of the insects in departmental experiments by dusting with diatomaceous earth led to CBH acquiring large deposits of this substance. Dry seasons and the control of cropping removed the stored grain and the problem.

The Argentine ant was first discovered at Albany but soon spread to the Perth Metropolitan Area. By 1941/42 affected areas in the Metropolitan Area had been mapped and a baiting program started.

In 1942/43 both codlin moth and apple scab appeared to have been eradicated. However, infestation of codlin moth was reported from Collie in 1946/47. Further work was continuing on this outbreak in 1948/49.

A serious pest, the apple jassid, had been identified in the Bridgetown area.

Blowfly strike was a particular problem in the pastoral areas during 1942 and it is estimated that up to 300,000 sheep could have been lost.

The cabbage white butterfly, which was first reported in Bassendean in early 1943, spread rapidly through Western Australia.

In the post-war period experiments were conducted with DDT to determine its effect on a range of insects. These continued to the end of the decade. Unfortunately the predators of bryobia mite and lucerne flea were both affected by DDT and pest numbers exploded.

Demand continued at a high level for certified seed of potatoes but there was some difficulty finding areas isolated enough to ensure that there was no disease transfer.

Flax rust was identified in a heavily infected crop of linseed at Northam; it was present on all linseed crops in the area and was identified in some flax crops in the South West. It had not been reported previously in WA.

In 1949/50 five new diseases of flax were reported, together with eight new diseases of vegetables. The resulting problems were overcome through finding resistant material or, in the case of seed-borne viruses, developing virus-free seed.

**Botany and weed control**

The Government Botanist, CA Gardner, made major advances in classification of species and preparation of the Flora of WA during the decade. In 1941/42 a list of plants with medicinal qualities, or the possible capacity to produce rubber, was prepared. A list of possible fibre plants was also prepared. In 1943/44 investigations of the drug potential of a range of plants were carried out. The collection of plants containing drugs or essential oils continued in 1946/47. One plant *Eucalyptus oleosa* var. *robusta* was shown to be outstanding for oil content. Two of the four identified varieties were shown to have very high levels of oil. Pituri was found to contain more nicotine than the then-current commercial sources of the drug.

Weed control efforts were limited by lack of staff but work on endemic weeds continued through the decade. The main focus appears to have been on St John’s wort, rapistrum weed, Bathurst burr and cape tulip. In 1947/48 a Chrysomelid beetle was introduced as a parasite of St John’s wort. Attempts to eradicate Bathurst burr and star thistle continued in Kalgoorlie.

Certification of clovers on the basis of strain and separately on a purity basis was carried out through the decade. More than 100 tons...
of subterranean clover seed was tested in 1940/41. This increased to 733 tons in 1948/49.

*Tropical agriculture*

The decade was one of mixed fortunes for Carnarvon growers. The long drought from the mid-1930s finally broke in 1941. The years that followed featured variable climatic conditions, difficulties with transport during the war and some serious effects from disease and insect pests. The department had started to develop a research station in the area late in the previous decade, but, after getting it to operational level had to put it on ‘care and maintenance’ until after the war.

While bananas continued as the main crop in Carnarvon, the production of suitable vegetables was expanding. Vegetables provided a cash crop which could quickly provide income during or after drought or a cyclonic event.

In 1944/45 Carnarvon citrus proved successful but vegetable crops suffered damage from disease. In 1945/46 water supplies were satisfactory and production reached normal levels. Produce was largely transported to Perth by road. In 1946/47 the Gascoyne flooded three times, ensuring adequate water for the plantations. Some 310 acres of bananas were planted, of which 120 were full bearing. There was also a major planting of runner beans.

Research planning on the Gascoyne Research Station had been resumed and a new program was developed. However, it was 1948/49 before the station was fully functional with experimental work yet to get seriously underway.

The Abydos and Woodstock pastoral properties were taken over for experimental purposes. They had been abandoned and much of the fencing had been burnt and none of the mills worked. It was hoped to demonstrate how to make the country productive again.

In 1941/42 the Department of Agriculture and the Public Works Department established an experimental site at Carlton Reach on the Ord River. An engine and irrigation equipment was installed and an officer appointed. Mitchell, buffel, birdwood grass, paspalum, *Phalaris tuberosa* and lucerne were planted. By 1942/43 the experimental areas were successfully established and providing useful information. In 1945/46 the Western Australian and Commonwealth Governments agreed to examine the possibilities of developing an irrigation system based on the Ord River. In 1948/49, 450 acres of the Kimberley Research Station had been cleared and some graded ready for planting. It was planned that a wide range of crops would be tested. In 1949/50 there was serious erosion on the research station during heavy summer rains, causing concern about the erodability of the black soils of the plain.

During the decade the three main irrigation districts were consolidated. Outcomes depended largely on the amount of water stored and available for use during the irrigation season. The area irrigated varied between 12 000 and 14 000 acres. Most was in pastures and fodder, with potatoes, orchards and vegetables on the rest.
Vermin continued to be a problem. Rabbit numbers rose and fell with the seasons and the extent of poisoning and other control measures exercised by farmers and vermin boards. In the eastern districts dry conditions periodically caused heavy reductions of all vermin, particularly rabbits, from shortage of water and feed and interruption of the breeding season.

Rabbits continued to be a danger whenever sufficient rain fell. Wild dogs and foxes continued to be important predators. Legislation was being prepared to establish the Agriculture Protection Board to deal with vermin in general, but rabbits in particular.

Making the future infrastructure: 1951 to 1970

The war had been over for five years. Machinery shortages had largely disappeared, together with most of the special wartime marketing arrangements for agricultural products. Possibly the only exception was the supply of superphosphate, which had to be rationed during the early part of 1951 as supplies did not meet demand. Subsequently, special transport arrangements were made so that the struggling transport system could get supplies to the country.

Large areas of scrubland and forested country were being cleared. New equipment such as bulldozers had been introduced in the post-war period and some innovative farmers had converted army tanks for this purpose. Land was cleared by ‘chaining’, a method of pulling down vegetation by dragging a very heavy chain, pulled between two large tractors or bulldozers, through the light forest or scrub. In forest areas, where larger trees were being cleared, the chain was weighed down in the middle with a large steel ball. The area ‘pulled down’ was left to dry and then burned. In forest country the remaining logs were pushed together with a bulldozer and burnt. In scrub country a heavy chain alone was often enough to pull down the scrub, which could then be ploughed ‘on the burn’ with a heavy disc plough.

The availability of larger reliable rubber-tyred wheel tractors, sometimes fitted with lights, started to revolutionise cropping in the wheatbelt. In the higher rainfall dairying and fruit growing areas the Ferguson tractor with its range of attachable and detachable implements took a lot of the hard work out of farming. However, the major change was the development of the light land areas which had been classified as third class and regarded as largely unusable up to the mid-1940s. Now with the demonstration that when fertilised with superphosphate and the trace elements copper and zinc, they could be farmed profitably, a large area of formerly useless land could be farmed. These light soils were suitable for subterranean clover in the medium rainfall areas and after a period of legume pasture could be cropped very profitably.

The Department of Agriculture was heavily involved in research, development and extension to support this 'light land revolution'.

The availability of the physical technology, large areas of uncleared land, good prices for agricultural products and the accumulated knowledge were the driving forces for the biggest land development in Western Australia’s history.
At its peak, land was being cleared at a rate of a million acres a year. This provided both the infrastructure for the development of today’s agriculture and opportunity to restructure pre-war agriculture. In the areas developed before the war the nature of the technology, particularly the lack of tractor power, had resulted in farms being quite small and cropped areas also relatively small. Many of these smaller farms were sold to neighbours, allowing their previous owners to move to the new areas to develop much bigger and more viable properties, and their neighbours also to expand. In effect the cleared area doubled without any material increase in farmer numbers so that the average farm size increased substantially.

The main wave of development occurred from 1950 to 1968. The new technology which created today’s modern farming has been overlain on this framework since 1968. The major development phase halted with the collapse of wool prices in 1968/69, the introduction of restrictions (quotas) on wheat production in 1968 and the drought of 1969. By 1951 the gross value of agricultural production had reached record levels on the expansion which began soon after the war. Between 1946/47 and 1950/51 sheep numbers increased 17 per cent, and the area sown to wheat by 14 per cent over the previous five years. In the 1950/51 wool selling season, the price of wool reached 3 pounds a pound ($6.40/kg) because of the demand for woollen uniforms in the Korean war; the average was a little over 2 pounds a pound ($4.40/kg). While these prices dropped sharply the next year, reasonably profitable prices continued until 1968/69.

The impact of the high wool prices on the profitability of sheep was that they gave the farmers both the incentive and the capacity to develop clover-based pastures where suitable cultivars were available. A downside was that it caused some reduction in the interest in cropping and dairying. In the USA and Europe it stimulated the development of synthetic fibres which would later undermine the wool market. Fuelled by high prices, the area cleared in 1950/51 and 1951/52 exceeded 500 000 acres.

By mid-1953 there was increasing evidence that, with more competition on world markets and increasing costs, market conditions were returning to those which prevailed before World War II. Nevertheless, the gross returns for the major industries of wheat and wool in 1951/52 were double those of the growing manufacturing industry.

In 1955 the Director of Agriculture commented on the general reduction in prices received by farmers during the year. This trend pointed to tighter conditions compared with most of the post-war period until that time.

Development had continued and in 1955 the cleared area in the agricultural areas was 22 million acres as opposed to 14.7 million in 1945. However the area sown to wheat was only 2.9 million acres as opposed to the five-year average of 3.0 million acres. By 1956 the move to longer rotations, the use of subterranean clover and medic pastures and the practice of ley farming were well established. In 1958 the area sown to crop was virtually unchanged, as were all the other measures of agricultural production.

During the 1960s the push for development gained full pace. Most of the forest clearing had been completed and the focus was on the sandy-surfaced scrub lands of the medium and lower rainfall areas. Some clearing was done by the War Service Land Settlement Board in the early years but most was driven by private farmers. Land was cleared at a very high rate and pastures were established at much the same rate. Some pasture establishment was on recently cleared land and the rest on land which had been cleared for many years. In 1960/61, 750 000 acres of land was cleared and some 500 000 acres were sown to pasture. In 1961/62, 893 000 acres were cleared.

The imposition of quotas on the amount of wheat for which the Australian Government would pay a guaranteed price, coupled with a fall in wool prices at the 1968/69 sales, stopped this development at the end of 1968.
The area sown to wheat in 1961 was 4.0 million acres (1.6 million hectares) which was the highest cropped area since 3.9 million acres had been sown in 1930/31. The total area cropped to cereals was 5.8 million acres. Production on all sectors continued to expand during the decade.

All of this was the beginning of the expansion of agriculture to progressively become the modern high-tech industry it is today.

While quotas were introduced based on previous production history to give individual farmers access to the wheat covered by the guaranteed price, there was no limit of production of non-quota wheat. While the allocation of wheat quotas was reviewed in 1969 they eventually had little effect on production, as the world wheat price rose in the early 1970s. Wool prices, which had dropped dramatically in 1969, did not recover until 1972/73. This situation in WA was exacerbated by a major drought in the medium and lower rainfall districts in 1969.

In view of the general financial problems of the sector, particularly the wheat and sheep industries, the State and Federal Governments decided in late 1970 to introduce a Rural Reconstruction Scheme.

The dairy industry, which was not involved in the major expansion of the late 1950s and 1960s, started to adjust to poor market conditions in the mid-1960s. It was faced with higher costs, a reduction in the subsidy on butterfat and the need to continue to contribute to equalisation of export and domestic returns, despite WA not being an exporting State. During the 1960s this industry was subject to substantial reconstruction.

**Seasonal conditions**

The period from 1950 to 1968 was one of the most favourable for agriculture in the history of Western Australia. The year 1954 was dry and 1969 was the worst drought since 1914, but the remaining years were within the normal variation experienced in the agricultural areas. In the pastoral areas the Kimberley experienced record drought in 1951/52. In the Gascoyne and Goldfields a serious drought began in 1968 and continued to 1972. Otherwise, seasonal conditions were within the normal parameters for these areas.

**Department of Agriculture staff**

In 1950 the Department of Agriculture had a total staff of 235, of whom 97 were professional staff, including 16 veterinarians. They were supported by 91 general division and 45 clerical division officers. The departmental report shows that in 1951 the professional staff had increased to 108, of whom 17 were veterinarians. They were supported by some 106 general division and 51 clerical division officers. The intake of 11 agricultural graduates in one year was exceptional. By 1952 there had been further small increases. There were now 114 graduates, 130 general personnel and 53 clerical officers. In 1953 there was a net increase of seven further graduates, increasing the number of professional officers to 121, supported by 130 general division staff and 54 clerical staff. While further graduates joined the department in 1954, some staff losses resulted in the overall staff position remaining stable.

In his 1953/54 report the Director of Agriculture commented on the failure to recruit additional graduate staff due to resignations virtually equalling recruitment. This had meant that the department had been unable to use the full amount of the Commonwealth Extension Services Grant (CESG) made available to stimulate extension services to farmers. A similar grant for the dairy industry was proving very valuable. Proposals for the use of the CESG had been revamped and these funds were spent later.

A decision had been made to move away from having offices staffed by one officer in each centre. It was decided that country officers should where possible be located together in a smaller number of larger
offices. A senior officer would be placed in charge and a library and other facilities would be provided.

In his 1954 report the Director pointed to the disadvantages for country agricultural officers in that they could expect to spend most of their professional life in the country. Unlike for teachers or police, there was no major area of employment in the city. Also the longer the officer stayed in the country the more valuable he became, but the government system did not necessarily reward him for his increased professional capacity. For all of these reasons the Director argued that good housing at low rentals should be available to district staff. In 1954/55 the professional staff increased by nine and the general division staff by 29, significantly increasing the capacity of the department.

The 1958 report records that there were 115 officers engaged full-time in extension activities and a further 98 engaged partly in extension and partly in administration. In the wheat and sheep areas there were now seven district offices—Geraldton, Northam, Narrogin, Katanning, Moora, Mt Barker and Esperance—with another planned for Merredin in 1959. In the higher rainfall areas offices were at Harvey, Bunbury, Busselton, Bridgetown, Manjimup, Denmark and Albany.

**Departmental organisation**

The only notable change to the department in 1950/51 was the creation of the North West Branch and the recruitment of three new graduates to it. During the year a cattle adviser and three graduates were appointed to the new branch. The three advisers were stationed at Port Hedland, Broome and Kimberley Research Station. The Tropical Adviser and the Gascoyne Research Station came under the branch on 1 July 1951. With the addition of Kimberley, Esperance, Wokalup, Bramley, and the vegetable and poultry research stations at Herdsman Lake, the department now had 12 research stations.

In early 1952 the department entered into an agreement with the then Farmers’ Union for the extension staff to cooperate closely with their branches in order to increase the efficiency of the extension effort. In 1951/52 the Agriculture Protection Board (APB) was established under legislation agreed in the WA Parliament and it went through a period of establishment. This resulted in the control of vermin and noxious weeds becoming its role which was at arm’s length from the remainder of the department.

In July 1952 the Tobacco Research Station was shifted again, this time to the Tobacco Training Centre and 4.5 acres of experiments were planted.

In 1955 the Director of Agriculture stated that the department had made some progress in improving its extension services, with seven district offices. These were at Northam, Moora, Narrogin, Geraldton, Bunbury, Bridgetown and Manjimup. There was difficulty in getting staff to live at the Kimberley Research Station and in Wiluna and Carnarvon, which were not at full strength. The Swan Viticultural Research Station had been established, together with the Stoneville Horticultural Research Station and the Wembley Vegetable Research Station. Experimental work continued on the recently established research stations at Kimberley and at Abydos Woodstock as well as the Gascoyne station.

A major advance in accommodation for the department was made with the laying of the foundation stone for the first buildings for the new headquarters at South Perth by the Minister for Agriculture, Mr EK Hoare in April 1956.

The development of regional centres was proceeding and with added staff the extension effort was increasing. With this came an opportunity to expand experimentation on farms through cooperative effort of the new cadre of research officers and the extension staff. There had also been an increase in pasture groups and farmer field days. It was estimated that 3000 to 4000 farmers attended such days during 1956. In addition, officers broadcast 250 radio talks.
Chapter 3 – 1940 to 1970: war and post-war expansion

The format and presentation of the *Journal of Agriculture* had been extensively modified in 1951. This led to increased circulation, which had doubled in the previous six years and continued to rise during 1957. Advertising revenue had also risen by a factor of 10 in the period.

The new offices at South Perth were being completed progressively and most of the head office staff had transferred by the end of 1959. A new research station had been selected and was being developed at Badgingarra.

**Extension activities**

In 1959 it was claimed that there were 138 full-time extension staff across the whole department and 99 who combined advisory work with other duties. In a more focused way the 1966 report refers to 18 advisers at nine district offices in the wheat and sheep areas. The Horticulture Division refers to 11 officers in country areas and the Dairy Division refers to nine advisers at eight centres in the higher rainfall zones.

In the fruit industry there was a continued demand for advice on the use of new hormone sprays, pest control, disease, and packing and storage. The subject matter varied from year to year depending on seasonal conditions, size of the crop and disease and pest incidence. The development of a new piece of technology, a new disease or pest or new control or management information increased the demands on officers. This was complex and demanding extension work dealing with the growing, harvesting and marketing of a large number of crops on different soil types in a range of climates and varied seasonal conditions.

In the vegetable industry, while there was always a short-term focus on the inspection of areas for suitability and on certification for potato seed production, advice was needed on issues dealing with the range of crops and climates where the crops were grown. Processors needed help with selecting areas for growing crops for processing, plus advice on transport and marketing of the produce. In the early 1950s identifying areas suitable for producing peas for snap freezing was an issue. The department also held schools on a range of horticultural issues.

While advice had been given on all aspects of tobacco production and preparation of the leaf for market in the 1940s and 1950s, this ceased when the sales and the industry collapsed in 1961. This followed a buyer boycott on WA leaf, which the buyers claimed had too high a chlorine content, causing a slow burn time.

The cropping and livestock industries of the medium and lower rainfall areas were serviced by offices at Geraldton, Moora, Northam, Merredin, Narrogin, Katanning, Albany and Esperance. An office was opened at Lake Grace in 1965. The area covered included 12,000 holdings and 22 million cleared acres. Officers were advising farmers on all aspects of crop production and pasture and stock management. They were involved in conducting 329 field trials and judging 43 crop pasture and fodder conservation competitions in 1961/62. Visits to the offices and farmers’ properties, ABC radio talks, film evenings, field days, field walks on farmers’ properties, telephone discussions in and out of hours were all part of the contact with farmers. Officers were also involved in stock inspection, animal health and vermin and noxious weed control. This was the pattern for the decade.
This was the period of great expansion of the agricultural areas, particularly in the medium and lower rainfall areas. The Esperance plain, the western sandplain, the areas east and west of Mt Barker and Albany, including Jerramungup and the area south and east of Hyden were all part of this major development, together with a multitude of smaller on-farm expansions. Many farmers new to WA, or from other districts, who were not familiar with the sandy soils, created a huge demand on the department’s extension staff.

The work of the general advisers in the high rainfall areas broadly mirrored the wheatbelt in relation to all aspects of pasture production and stock management. They also dealt with issues involved in the dairy industry. Special issues included advice on solids-not-fat, antibiotic residues in milk, management of milk or cream production and storage and collection from farms. During the decade a new type of field day was organised combining the farm and factory with a focus on milking machine performance, sanitation, antibiotics, marker dyes, factory quality tests, calf rearing etc. The pig industry was in part associated with the dairy industry, in part with the cereal production and in developing intensive housing. Numbers fluctuated, being particularly affected by the price of grains. When wheat prices were high pig numbers in the wheatbelt were low and vice versa. During 1960/61 the numbers increased dramatically by 45,000. Visits to farms and attendance at field days and sales were all part of the pig industry specialist’s work.

Veterinarians were located at the larger offices and attended to animal health problems on farmers’ properties. There was more demand about health issues from the larger animal industries but the vets also advised sheep owners on general issues and attended to any unusual deaths.

Soil conservation specialists were at most larger offices. Their role was almost entirely involved in advising on, demonstrating and implementing soil conservation works and management. They also gave advice and carried out demonstrations on saltland management. In the early 1960s they were required to begin the special, long-term role of stabilising a major eroded and degraded part of the Ord River catchment.

Officers of the North West Branch serviced the pastoral community. Specialists provided advice to horticulturalists in the Gascoyne irrigation area.

Separate from the field staff, most head office staff had a partial advisory role. Specialists also had a large demand on their services from farmers and householders who came direct to head office. Plant pathologists gave advice on all aspects of disease control, management and avoidance. Entomologists gave advice on issues related to a wide range of insects. The Weeds and Seeds Branch gave advice on weed control, seed production and identification. They also arranged the certification of species or strains of commercially valuable plants and the use of new and improved chemicals.

The State Herbarium provided a plant identification service, particularly poison plants. They also gave advice on tree planting and to apiarists on location of potential sources of honey. Officers of the Plant Research and Soils Divisions spent significant time in the field, inspecting experiments and investigating special problems on farmers’ properties. All specialists attended and participated in farmer and research station field days.

Part of the funding of the extension services came from the Commonwealth Extension Services Grant and the Dairy Industry Efficiency Grant. These made a valuable contribution to the development and equipping of the district offices.

Services

The department also provided a large range of services. Many of these began before and continued through the decade and beyond. Officers providing these services were also partly involved with extension work. Some
statistics from 1960/61 and 1961/62 are
given below to indicate the nature and
uptake of these services.

Artificial breeding for the dairy
industry: 10 766 first inseminations were
carried out from eight centres with 619
farmer members of the scheme in 1960/61.
In 1961/62 virtually the same number cows
were involved. There was a progressive
increase in the use of this service over the
decade. In early 1967 it was transferred to a
board independent of the department.

The Dairy Laboratory: 24 020 samples were
tested or analysed involving 48 800
estimations in 1960/61. This service was
used substantially by the Milk Board for
monitoring whole milk supplies. The service
had probably started in the 1930s and
continued until it was taken over by the Dairy
Industry Authority.

Milking machine testing: This service was
only introduced late in the 1950s and was
clearly very valuable; 561 machines were
tested up to 1961/62 with a high percentage
found to need adjustment. While many of
these adjustments could be done by farmers
some needed expert advice. Involvement of
country officers in this testing resulted in 218
machines being tested in 1961/62.

Herd recording: During the year 13 900 cows
in grade herds and 906 cows in 40 studs
were tested. The average length of lactation
was 7.8 months. There was an increase in
grade herd participation in 1961/62, with
14 866 cows involved; 951 pure bred cows
participated in the scheme in 1961/62. The
service continued until it was replaced by
farmer sampling with analytical work done by
the Dairy Industry Authority.

Land grading and irrigation: This service was
provided on a continuing basis to irrigation
farmers. In the sample year 1763 acres were
graded under the supervision of officers and
29 miles of drains excavated.

Contour surveys: This service was provided
by Soils Division country staff. In 1960/61
surveys were carried out on 29 275 acres for
farmers. In 1961/62 a similar amount of
26 845 acres were surveyed for 169 farmers.

Botany: additions to the Herbarium through
collections made by staff brought the number
of specimens held to 64 000; 5500
identifications were made for the public and
government officers.

Grain and flour inspections: In 1960/61
shipments under certificate were
368 647 tons. These shipments went to
China, North Korea, Spain, Albania and
Syria. In 1961/62 almost 820 000 tons of
wheat and 20 000 tons of oats were
exported virtually to the same markets. Flour
was also exported under certificate.

Stock, produce and seed inspections: Import
inspection was an ongoing task. It was an
important part of the protection of Western
Australia from plant disease, pest and
weeds. Inspections were made at Kalgoorlie
and Fremantle. This service started after the
creation of the Bureau of Agriculture, when
the 'trans' railway line was completed in
1917. It has continued since. Special
problems were encountered with rugs from
India, chocolate coated Noogoora burr in
chocolate peanuts and burrs in tractor seats.
Birdseed, cattle and sheep seed from the
eastern states all had some individuals or
bags contaminated with weed seeds. In one
year inspection of 45 000 fruit trees, 10 000
seedlings and 32 500 bulbs which were
introduced was required. Inspections were
carried out for the Commonwealth on
exported produce, and for packing and
grading under the Agricultural Products Act.
In 1958 there was tightening of overseas
quarantine requirements and special
attention had to be given to San Jose scale
in fruit preparation.

Orchard inspections continued across all
industries to control pests and diseases and
to prevent the establishment of new pests
diseases in orchards. There was
particular interest in insects such as San
Jose scale, white wax scale, codlin moth and
argentine ants. A major outbreak of codlin
moth was found at Mullalyup in 1954 and a
smaller outbreak at Nannup. Both outbreaks
were controlled over the next two years.
Oriental peach moth had also been identified
and a major effort was being made to eradicate it; by 1953/54 it appeared to have been eradicated. Compulsory fruit fly baiting coupled with the employment of six additional fruit fly inspectors had allowed better control of that pest.

Detailed inspections under the Commonwealth Quarantine Act were also significant. These included examination of the baggage of immigrants at Northam holding camp. Also in 1952 there was a large import of prefabricated houses which had to be treated for sirex wasp. New regulations were introduced under the Quarantine Act to help prevent the introduction of diseases and insect pests.

Seed testing: 4600 seed tests were carried out during the year. This service continued in 1961/62 and beyond.

Seed certification: 800 properties were inspected and registered for certified seed production; 1464 tons of seed were produced from these areas. In 1961/62, 800 properties were inspected and 2220 tons of seed certified. Small parcels of rust resistant Westralia beans and Sorghum almum were also certified.

Pedigreed grain production: 3705 bags of wheat (eight varieties) 3889 bags of oats (five varieties), and 229 bags of barley (one variety) were distributed to farmers. This service began in 1911 and continued through to the 1980s.

Potatoes: 45 acres were certified for the production of seed potatoes at Albany. At maturity six acres were rejected and 306 tons were produced off the remaining 39 acres. In 1961/62, 17 growers submitted 52.5 acres for certification for a seed production of 514 tons.

Veterinary: Tuberculosis testing of herds producing milk for the Metropolitan Area showed an incidence of 4.5 per cent among 19 000 cows tested. In other herds sampling indicated an incidence of 1.5 per cent. In 1960/61, 31 674 cattle were vaccinated for brucellosis with Strain 19. In 1961/62, 37 600 were inoculated. This vaccination program substantially controlled the disease in Western Australia.

A number of other diseases were dealt with and programs carried out. These included:

- Vibriosis and leptospirosis causing infertility in cattle. These were a problem in 1961/62 and beyond, proving to be major causes of infertility in the State.
- Footrot eradication in sheep was reported to be progressing, with 20 properties cleared and 16 left in quarantine. The program was still continuing in 2008.
- Pig diseases, including swine erysipelas, sarcoptic mange and pig lice. In 1961/62 the focus had shifted to viral pneumonia and a scheme for eradication was being prepared. In that year pig imports from NSW were banned due to swine fever.
- Poultry: More than 2100 birds were post-mortem. Poultry continued to be included in the diagnostic service.
- Parasitology: Parasites of cattle and sheep were investigated and drenching trials, including testing of new anthelmintics were carried out. Later, worms resistant to anthelmintics became a management issue.
- Lupinosis and white muscle disease research – Investigations were carried out without success. In 1961/62 some 17 200 specimens were examined.
- Poultry: Two new diseases were discovered. One was avian encephalomyelitis and the other was vibronic hepatitis.
- Pig diseases accounted for 6 per cent of the specimens received. Sheep problems were also a major issue because of testing related to evidence of white muscle disease.
- Examination of samples of mastitis from dairy cows showed a high resistance to penicillin had developed. Mastitis continued to be a significant disease affecting milk and also contributing to shortened production lives of cows.
Research stations

Wheatbelt stations
This was a period of great activity at the wheatbelt research stations and on farmers’ properties. Research began on cropping systems and fertiliser need, particularly the use of nitrogen in early and later crops in a multi-crop system. Cereal variety trials were carried out with wheat, oats and barley and were repeated annually during the period. Work was also conducted on pasture species and on sheep management issues such as time of lambing, feeding of weaners, rate of stocking, ‘flushing’ trials and testing stocking rates, set stocking and the response of pasture to stocking.

An oat crop on Esperance sandplain planted after six years of subterranean clover fertilised with superphosphate, copper and zinc.

During these two decades major work was done at Esperance Downs Research Station. The results of this work provided the basis for the development of Esperance Plain.

Plant breeding and introduction continued to be a major function of these stations, as well as pure line rows for the development of pedigree seed supplies. Wheat breeding was carried out at Avondale and Wongan Hills (for clover ley areas) and at Merredin, which was the principal wheat breeding centre.

Rust resistance, yield and flag smut resistance were the main areas of focus. Oat breeding was at Merredin (early maturity) and Wongan Hills (later maturity); 2-row barley was at Wongan Hills and Avondale, with the aim to replace the variety Prior. The 6-row work was at Merredin with some small yield trials at Esperance and Kojonup. Introductions were made from USA and Victoria.

Linseed breeding was aiming to get rust resistance and higher yield. Flax breeding was continuing at Boyup Brook and aimed at rust resistance. Both these programs had been terminated by the end of the period because the industry had collapsed.

North West and Kimberley stations
At Carnarvon experiments were in progress with passionfruit, bananas, pawpaw, beans, tropical apples, custard apples, dates, onions, strawberries, grapes, avocados and mangoes. This work was continued in 1961/62 as part of an ongoing program.

At Abydos research showed the importance of a totally changed management in regenerating the degraded native pastures. Industry practice was to burn the spinifex in winter and graze the young grass shoots as soon as they appeared after summer rain. Early summer burning and deferred grazing until the grasses were established after summer rain allowed the swales to revert to a grass dominant condition. It was shown that it was essential that lambing be timed with the rainy season from January to March.

Studies of fertility of rams and ewes and feeding of lambs were continuing but showed that locally bred rams maintained their libido better than imported animals.

Development of the Ground Water Research Station at Wiluna was progressing well.

A water problem was overcome and experimental work initiated. Later this work was terminated and the station was taken over by a private operator, but access to markets proved a problem. It was finally taken over by the Department of Native Affairs.
Kimberley Research Station continued its work for the developing irrigation industry on the Ord River. By the end of the period a demonstration of stock management on regenerated pastures on the Fitzroy River frontage had started.

**South West stations**

Denmark Research Station's role as a source of stud stock and a demonstration farm continued. An experiment on viral pneumonia eradication from the pig herd was also started. This program continued in 1961/62. Pasture work was also in progress.

Cattle yards at Wokalup, an important high rainfall research station. These yards were used in a major cattle crossbreeding experiment.

At Wokalup Research Station artificial breeding was being used to develop two herds (one Jersey and one Friesian). The breeds were compared on the basis of milk production and composition, influence of time of calving and weight at birth on weight at sale of sale stock. Plant introduction was being continued. These programs continued through most of the 1960s. At the end of the period a major breed by stocking rate trial was being planned.

At Bramley Research Station the phosphate feeding trial with dairy cattle was the major work. The residual availability of copper was also being investigated. Cobalt availability was also being studied and a stocking rate trial was in progress. These experiments continued for some years.

**Horticultural stations**

At Stoneville, development was continuing with preparation for trials of rootstocks and pruning techniques. Small scale trials on hormones and herbicides and jarrah sawdust as a mulching agent and hilling material were carried out. During the period the infrastructure was consolidated and experimental work started.

At Swan Viticultural Research Station 11.5 acres were planted to experiments dealing with rootstocks, long-term fertiliser use, and replanting.

Development continued in the early 1960s at the new Vegetable Research Station but the facility was also used by other divisions to work on diseases and other issues.

At the Manjimup Tobacco Research Station an area was planted to hops following the collapse of the tobacco industry. Fertiliser, irrigation, variety, red spider control and nematode control trials were carried out. The latter trial was done in cooperation with a private farmer. In 1961/62 a tomato trial was planted to determine varieties suitable for processing. This station was largely unused for the early part of the 1960s and it was then closed and a new area more suited to work on fruit, vines and other crops was purchased.

**Research**

**Soils**

Soil structure issues were being studied at Merredin Research Station and other sites. Soil amendments were compared, along with continuous subclover pasture. Soil moisture penetration and moisture utilisation under different vegetation types were studied, with some of the trials carried out on farmers' properties. At the same time examination of a soil for irrigation potential was being studied.
Saltland vegetation studies were being carried out and yield and grazing trials conducted with bluebush and saltbush. Seed viability was investigated. Bluebush and Wimmera ryegrass seeds were found to be able to survive for an extended period under water with a 3 per cent salt content. However the growing plants did not do well in areas where they were waterlogged in winter. Puccinellia grew under these conditions as it could survive in extremely salty water. This work was continued.

Glasshouse trials showed that using citrus (Washington Naval) grafted on trifoliata rootstock the salt uptake from saline sprays increased with the level of salt in the water and with the length of time of the application. Intermittent spraying gave increased uptake. Citrus grafted on citronelle rootstock did not take up salt from variable salt levels or lengths of spraying. Citrus on trifoliata rootstock reached a level of 1.5 per cent while that on citronelle rootstock only reached 0.25 per cent.

A study of water run-off from a 60-acre catchment was initiated. After a number of years the site was contoured and the run-off compared with the previous experience. Nitrogenous fertilisers were tested to determine their effect on the growth and density of grass on a grassed waterway in a contoured paddock.

The 1963/64 report commented that ‘many of the soils of the Fitzroy flood plain are high in gypsum and sodium’, raising questions about their suitability for irrigation. It also noted that under furrow irrigation techniques there could be a slow build-up of salinity under irrigation.

Thorough land preparation to obtain weed control was shown to be vital on land which had not been fallowed. Ploughing proved better than scarifying. Ploughing as soon as possible after the opening rains was best. In 1961/62 further experiments compared cultivation, trash removal and seeding techniques. Trash removal and disc ploughing gave the best results.

**Plant nutrition**

The demonstration that copper, zinc, molybdenum and occasionally manganese in addition to superphosphate were essential to the development of millions of acres of new land for agriculture, placed plant nutrition specialists under a lot of pressure to provide specialist advice and new information for both farmers and extension officers. Later in the period as the position stabilised, other important work became possible.

Research showing that superphosphate levels could be reduced where super had been applied for a number of years before cropping was confirmed. It was also shown that there was scope for the use of nitrogen in later crops in a multi-crop system. While nitrogen fertiliser use became more common it was concluded in the early years that the use on new land was the most economic. In 1961/62 some 30 trials were carried out from Binnu to Esperance to determine the responses to nitrogen fertiliser, largely on sandy and gravelly surfaced soils.

Phosphate and nitrogen fertilisers were tested under a range of conditions. Rates of application to new land in the medium rainfall districts, time of topdressing phosphate onto pasture, phosphate leaching on sandy-surfaced soils, and residual value of dressings of 1 ton or more were all investigated. In 1961/62 glasshouse trials comparing different copper ores were commenced.

Nitrogen could increase feed available in autumn on dairy farms.
In the early 1960s trials investigating continuous cropping were established from Binnu to Avondale. Three nitrogen sources (urea, sulphate of ammonia and calcium ammonium nitrate) were being tested at five rates. Rates of seeding and rates of nitrogen were being tested at two sites. This was long-term work which made a vital contribution to the new agriculture which developed later.

Nitrogen fertiliser was also tested in the higher rainfall areas on pastures and crops sown for early feed. Substantial early growth was achieved. While the value for some purposes needed to be assessed in grazing experiments the conversion of feed to product was easier to determine in the dairy industry. The effect of nitrogen on production and hay yields in the higher rainfall areas was also tested.

It was noted that lucerne seemed to have a higher phosphate requirement than subterranean clovers.

In 1962 a trial to determine the residual value of potash was established, with the aim of determining the minimum rate which would avoid deficiency. Soil type and management were found to be fundamental to such work. Leaching soils or hay cutting were both dominant issues.

In 1962 it was suggested that a zinc contaminant in super had been important in maintaining the zinc level of previously deficient pastures. Residual values of copper and zinc and availability of sources for pasture and wheat were investigated.

Pasture species trials were carried out with a range of legumes over a wide range of environments.

Molybdenum deficiency was shown to be important in a confined area of the dissected hills associated with the Blackwood River and its tributaries in the Donnybrook, Bridgetown, Nannup and Boyanup districts. It was later found to occur extensively in subclower on some soil types in the Great Southern. Molybdenum had been shown to be required at higher levels for growth of crucifers than for nitrogen fixation in legumes. Grasses were known to have the lowest requirement. It was therefore surprising that it was also found to be deficient on cereals across large areas of the eastern wheatbelt.

Legume species were being compared to test their suitability for use on deeper sands. Different legume species were also being tested for suitability for the drier part of the wheatbelt. *Rhizobium* strains for various legumes and for lucerne were being examined.

In the early 1960s rates of super on clover on new land, maintenance dressings on older clover pastures, and the value of rock phosphate were assessed. It was concluded from this work that the use of fertiliser on pasture used for wool or meat production needed to be assessed under grazing with varied stocking rates. Different fertiliser rates could alter pasture composition and result in quite different results to those obtained under simple plot trials.

As a result an experiment comparing the interaction between stocking rate and phosphate fertiliser was commenced west of Mt Barker in the early 1960s. This experiment continued for a number of years and is reported elsewhere. A similar experiment was established on a different soil type on a property north of Kojonup. This work confirmed that it was essential to test fertiliser rates under grazing.
During the early 1960s CSIRO demonstrated in an experiment that higher stocking rates were possible on developed pasture than was industry practice. This led to widespread testing of stocking rates across the agricultural areas, with a general confirmation of the CSIRO results.

While superphosphate gave a response when applied in the planting hole with young apples there was no response to nitrogen application. Also there had been no response to surface phosphate and nitrogen dressings to grape vines in the Swan Valley.

Soil acidity was a problem causing poor production from cover crops on sandy soils at Caversham and potash deficiency was a problem for lupins, serradella and subterranean clover on a deep banksia sand at Caversham.

Possible toxicity of sprays on vegetables was investigated but no evidence of damage was found.

Experiments were carried out on broadcasting superphosphate as a method of speeding up the seeding process. It was shown that phosphate drilled near the seed was more available to cereals than when it was broadcast. Later work would show that broadcasting was the totally wrong approach to getting value from fertiliser.

**Wheat grain quality**

In collaboration with the Plant Research Division, the Cereal Laboratory studied the effects of variety, climate and soils on grain quality, the effect of nitrogen status of plants on grain quality, and the effect of nitrogenous fertiliser on grain quality and yield. In general the survey confirmed previous findings that the nitrogen level depended on rainfall, soil type and ripening conditions. On average the ‘heavy’ soils provided 1.3 per cent more protein than the ‘light’ soils.

**Horticulture**

The Apple and Pear Export Marketing Plan and subsequent statutory marketing arrangements had lapsed by the end of 1950 and marketing was freed up for the first time in a decade. The apple crops over the decade fluctuated but were generally in the range of 1.0 to 1.5 million bushels of apples, with exports at around 750 000 bushels. Pear exports were in the range of 100 000 to 130 000 bushels.

The industry was concerned about the decline of orchards during the war. The 1953/54 report noted that “the condition of the orchards continues to decline, with more orchards going out of production”. Expansion was limited by the cost of establishment and the time taken to get a return. Citrus also continued to decline. Stone fruit had shown a small increase. Shortage of nursery stock was an issue.

Research on storage issues with apples and stone fruit was carried out through this period. A particular problem was surface scald of Granny Smith apples in storage and the work developed a method of packing and storing to eliminate this problem. In 1953/54 experiments were also carried out to test chemical treatment of Jonathon apples to accelerate maturity.

Control of budburst and foliation on Granny Smith apples with oil sprays in areas with insufficient cold periods was investigated. Increased yield of fruit and increases in fruit size were achieved. Premature fruit drop in citrus was shown to be reduced by 2,4-D application.

In 1955 investigations continued on the use of oil sprays to overcome delayed foliation, plastic packing liners to improve storage, growth promoting agents and the introduction of superior strains of citrus from Victoria and South Australia. In 1957, items under investigation included zinc deficiency of apples at Albany, eelworm levels in replant areas of apple orchards, fruit thinning, use of mulches on orchards, storage of pears and apples and grapes using plastic liners, and superficial scald of Granny Smith apples.

There had been an increase in the planting of young trees, particularly apples, leading to
an increased demand for advice on orchard layout, establishment techniques, pruning and after-care.

Potato production continued as normal, with increased interest in irrigation in the areas outside the major schemes. Some diseases not previously recorded were seen in the crops. Certification of crops for the production of seed potatoes and of seed of the ‘Westreria’ bean took considerable staff time. Officers were also heavily committed to lectures and show judging.

In the 1960s further work was carried out on superficial scald of Granny Smith apples and bitter pit of Cleopatra apples. Sprays of calcium nitrate applied from early November until early February reduced bitter pit from 25 to 11.5 per cent. Calcium chloride also cured the problem. Tray pack and cell packs were compared; both were examined in London, where it was found that the tray pack produced more bruising than the cell pack.

Citrus rootstocks were tested over a period and in 1963 the citronelle and sweet orange rootstocks had produced the largest trees. Troyer citrange were somewhat smaller, with trifoliata generally giving the smallest trees. Extensive apple thinning experiments were carried out during the year. Later citrus rootstock work showed that on soils better suited for citrus, troyer citrange produced good growth, cropping and fruit quality, citronelle had good growth in all areas but produced the poorest quality fruit. Sweet orange showed good growth and moderate cropping. Trifoliata gave the poorest growth but the best fruit quality.

Studies of chloride uptake from saline water are reported elsewhere.

Sodium fluoroysiliclate plus malathion was used extensively for fruitfly control.

In 1961/62, trials were carried out to determine ways of controlling superficial scald and other storage problems of fruit marketed in bulk as opposed to being wrapped before packing. Calcium spays were tested for control of bitter pit.

Breakdown of Yates apples stored in sealed polythene was shown to be due to a low oxygen environment. A range of rootstocks were under test. Chemical thinning of apples was investigated. Herbicides were tested for weed and cover crop control in orchards.

**Viticulture**

The viticulture industry continued through the 1950s, with some expansion into the Bindoon area, which required considerable help for new farmers. Later the War Service Land Settlement vineyards at Bindoon were restructured.

The main influence on outcomes was the conditions around ripening, and for the dried fruit sector, during drying. Little progress was made in dealing with the problem of unthrifty vines. The use of parachlorophenoxyaceticacid (PCPA) was effective in removing the need for cincturing of dried fruit vines. This work was confirmed and recommended to the industry in 1953/54. Subsequently it became clear that cincturing had reduced the vigour of the vines and sprayed vines gave better growth and yield.

New dipping materials developed by CSIRO for drying sultanas were tested and the chemical PCPA was used for setting Early Madeleine table grapes and preventing shattering in Santa Paula grapes.

Special attention was given to grapes in order to raise the standard of export packs. Estimates of crop sizes and maturity dates were made for all crops as a service to marketers and exporters. Advice on storage resulted in 10 000 cases being packed in polythene to achieve improved outcomes.

In 1957 the research program in the viticultural area included studies of the value of different cover crops in different soil and drainage situations, setting Ohanez grapes with pollen sprays, a study of currant grape buds, methods of dipping sultanas, the use of hormones in setting currants, and the propagation of desirable material.
In the 1960s currant pruning techniques, the use of alternative packing material and techniques for packing export grapes, use of gibberellic acid on grapes, and the possibility of using river or tributary water were all being investigated.

**Vegetables**

Potato variety trials pointed to Kennebec being the best for WA conditions. The hybrid Lakelend x Smoothskin looked the best in tomato variety trials. Harvesting trials were carried out with brown onions to test the production of dry onion sets; this was abandoned because it was decided that the process could not be used commercially.

In 1961/62 boron fertiliser was tested in an area where a deficiency was suspected but there was no response. A survey showed that WA potatoes had low solids. Work was being carried out to test the potatoes’ suitability for frozen chips. Tests with ‘topping and tailing’ onions showed improved storage.

Studies of the establishment of peas and of available varieties, cauliflower variety trials, cabbage variety trials, broccoli and Brussels sprouts for snap freezing, and tomato variety trials were carried out.

**The pastoral areas**

The Ord Regeneration Project was started in the early 1960s. Rice trials were carried out at Camballin and buffel grass was being tested on the Pindan. In 1961/62 the department began a regeneration demonstration of denuded country in the Fitzroy Valley.

Lambing and mating trials were being carried out at Abydos, together with pasture management work. Animal studies showed local rams were more fertile and maintained a higher libido than imported rams.

**Animal health and production**

Experiments were carried out on time of lambing and on flushing ewes before mating.

Experiments on poultry meat birds showed that riboflavin was not deficient in the normal diet. Different fattening rations were tested. Of the items tested fish meal appeared to increase growth rate more than other protein sources. This was confirmed in feeding trials during the following year. Rations with an energy to protein ratio of 45 to 1 were favoured. In laying trials there was no comparable response to fish meal. In contrast with the result from meat birds, experiments with layers showed riboflavin was deficient in the ration. Also there was an advantage of including green feed in the ration. Following this early work a full range of feeding trials was started.

Experiments examining time of mating of ewes were established at Esperance and Walebing. Mown and unmown pastures were compared as summer feed for weaners.

Resistance to penicillin was reported in mastitis examinations and vibriosis was identified as the main source of infertility in the dairy herd.

Poisoning of horses by *Crotalaria crispata* rather than *C. retusa* was identified in the Kimberley.

An examination was undertaken of the effects of subterranean clover in a mixed pasture on the fertility of ewes where the clover did not produce gross effects on the ewe. During the period a large experiment was set up at Esperance to compare the effect of different strains of subterranean clover on sheep production and fertility.

Also the effect of weaning lambs several weeks before slaughter on carcase weight and quality was examined.

In 1961/62 an examination of a general ‘ill-thrift’ of sheep was attributed to marginal copper and cobalt levels. A detailed study was continuing. A survey showed critically low selenium levels in pasture throughout the South West. Lupinosis studies continued without any success.

Vibrionic abortion of sheep was reported near Ballidu.
Plant diseases

Root rots of cereals were a serious problem in clover ley cropping. No treatment apart from a cleaning crop had been successful in overcoming it. Depth of seeding was important in achieving good germination. The new rust strain 21-2 had taken Gabo out of the varieties to be sown. This work was continuing. In 1961/62 it was reported that the yellow dwarf virus had been discovered in WA for the first time.

The Pomme de Neige rootstock and plants free of the mosaic virus of Granny Smith and Jonathon apples were developed. In 1961/62 studies of the impact of the virus on tree growth were started. Virus indexing of plums for the line pattern disease had also started.

Studies of fungi involved in apple dieback continued. Tests of fumigation of apple orchards for long-term benefit and as a demonstration of the impact of nematodes were started.

Virus indexing of grape varieties was started in the mid-1950s. Studies of the resistance of grape rootstocks to nematodes began in 1964 and by 1966 had shown two available rootstocks to be resistant. Increased yields following fumigation had reached 28 per cent on sandy soils.

Vegetable disease control measures using old and new fungicides were outlined. The need to produce pedigree seed of the rust-resistant Westralia bean was noted.

Clover stunt virus at Esperance was the only pasture problem referred to. Lime pelleting of inoculated seed was favoured over inoculated-only seed.

In the 1964/65 report reference was made to a joint study of Jarrah dieback by the Forest Research Institute, the Forestry and Timber Bureau, Department of National Development, and the Department of Agriculture. The outcome was the identification of *Phytophthora cinnamomi* as the causative agent of Jarrah dieback.

Entomology

In a changing world in which new chemicals were becoming available but community concerns were increasing about chemical residues in food, the task of the entomologists became more complex. Some recommendations were made despite these constraints.

San Jose scale control measures were recommended. It was found that spider mites could be controlled with organo-phosphate sprays. A recommendation for citrus red scale control was made. It had been shown that fruit fly could be controlled in citrus with organo-phosphates in association with summer oil.

Detailed studies of the life cycle of the webworm in crops were being made. Control of black beetle in potatoes was also being examined. Further work on grasshoppers was started and an entomologist had been located in the Kimberley. In 1961/62 this program continued.

Insect control on the Ord River had started and the webworm complex was being worked out. Before the end of the decade insect control in the cotton crops on the Ord was becoming a serious issue.

Weeds and seeds

Saffron thistle was difficult to control as only about 30 per cent of the seed germinates. Early spraying was necessary. Cape tulip control was difficult because of reproduction from corms; burning reduces the number of corms and it was thought that a hot summer might also have a detrimental effect on their viability. Studies of soursob had started but it transpired that this never became a major problem. Evaluation of new herbicides was being carried out for control of weeds in vegetable gardens. It was found that control of eucalypt suckers was helped by adding white oil to 2,4,5-T. A study of hard-seededness of legumes was started.
Botany
The retired Curator of the Herbarium was continuing to work on the *Flora of Western Australia*, concentrating on the eucalypts. In 1964 it was reported that fluoro-acetic acid had been found in the *Gastrolobium* and *Oxylolium* poison plants. This was confirmed in 1965.

Administration of Acts
The Department of Agriculture had 50 Acts of Parliament under its control. The relevant ones for this period were:

*The Agricultural Products Act*
Products exported to overseas or eastern states markets were inspected for soundness, quality packing and presentation. Products arriving at Kalgoorlie or Fremantle were similarly inspected. This work continued year by year. Air freight of fresh vegetables to Singapore was an important part of the export trade.

*The Agriculture Protection Board Act*
The Agriculture Protection Board continued its activities in cooperation with shire councils and farmers. It had reduced vermin to low levels compared to a few years earlier. Regional meeting of the Agriculture Protection Board to discuss wild dog control. Cooperation with local councils and farmers greatly reduced the level of vermin.

The introduction of myxomatosis had dramatically reduced rabbit numbers. Wild dog scalps had been reduced to 5500, which was a record low. Results with foxes had varied, depending on farmer support.

Grasshoppers had not been an issue and ploughing of egg beds and on some occasions flooding had reduced the potential threat for the following season. Emus, kangaroos and wallabies had also been dealt with. This program had continued to keep the levels of rabbits, dogs and foxes to low numbers. Kangaroos, emus, wallabies, galahs, wild donkeys, wild horses and camels had all caused problems in local areas. The barrier fences had proved to be valuable barriers to vermin access.

*Argentine Ants Act*
The program continued through the period and involved cleaning up re-infestations and dealing with ‘new’ areas. This program continued until 1984.

*Bees Act*
*The Bees Act* provides power to control exotic diseases found in apiaries. American foul brood disease was found in 10 hives, which were destroyed. No significant activity was reported later in the period.

*Dairy Cattle Industry Compensation Fund*
This fund was based on a tax of 2 cents per pound of butter to compensate farmers for cows destroyed after reacting to the TB test. The farmer contribution is matched dollar for dollar by the State. All dairy cows had to be tested after 1 July 1961. During 1961/62 a total of 78 163 cattle in 1634 herds were tested, with an incidence of 0.86 per cent. The first test covering 85 000 cattle was expected to be complete by December 1962; 20 000 cattle from whole milk suppliers showed a reactor rate of 0.56 per cent.

*Dairy Industry Act*
*The Dairy Industry Act* provides power to maintain hygiene and quality standards in factories and on farms in the dairy industry. While there had been a general improvement in hygiene and facilities, cream grading had not reached the desired standard. Farm inspections showed 31 per cent of farms were not meeting current standards.
Fertiliser and Feedstuffs Act
The general standards of fertilisers and feeds were found to be satisfactory, with samples analysed meeting the requirements of the Act. This work continued annually and maintained a satisfactory level of control over the industry.

Noxious Weeds Act
The APB organised comprehensive schemes to deal with caltrop, cape tulip, blackberry, mesquite, carnation weed and saffron thistle. Large areas of blackberry were sprayed, which reduced the infestation dramatically. All the large mesquite trees in the Pilbara were killed and some other progress was made. Small areas of cape tulip and saffron thistle had been controlled and action taken on the larger areas.

Plant Diseases Act
The Plant Diseases Act provided power to control the import of plant material into Western Australia, to inspect orchards and packing houses or to require packing materials to be disease free. It could also require compulsory action to be taken against insects such as the fruit fly. This work continued during the period. Planting material produced in WA was fumigated as required, together with used fruit cases, used bins and fruit despatched to the South West.

Plant Quarantine Act
Imported plant material (fruit or plants) and timber were fumigated as required and in some cases grown on under quarantine. Prohibited material was destroyed. Post offices were also monitored.

Pig Industry Compensation Act
Under the Pig Industry Compensation Act 325 pigs were condemned and the owners compensated.

Soil Conservation Act
The only legal action taken under the Soil Conservation Act related to clearing control in 14 shires in the north-eastern wheatbelt. Since the introduction of controls in 1950, 2219 applications to clear 1,265,697 acres had been dealt with.

Veterinary Medicines Act
During 1960/61, 133 new registrations and 453 re-registrations were approved under the Veterinary Medicines Act; 21 were deferred and two rejected. Similar numbers of stock medicines were registered and re-registered each year.
Chapter 4

1970 to 1994: making the new agriculture

Periods of uneconomic low prices, drought and variable seasons, and the end of significant expansion produced a need for industry restructure and consolidation. The department’s research and extension capacity improved with training and the introduction of new technology. The availability of new agricultural chemicals, supported by research and the development of new equipment, paved the way for a revolution of cropping. Within the department, plant breeding, district office management and research stations were reorganised. Community focus on environmental issues drove the funding of natural resource management and community management of soil conservation and related issues. The Ord River cotton industry collapsed. The regeneration of the Ord catchment was progressively consolidated. The department joined some of the new Cooperative Research Centres.

Marketing issues

While the 1970s was a period of substantial advances in technology and consolidation after the dramatic developments of the late 1950s and 1960s, it was also a period of difficult marketing conditions. The full impact on world markets of the agricultural policies of the European Economic Community (EEC) was starting to be felt. This was exacerbated when the United Kingdom joined the EEC in 1971. The result was the loss of a large part of the market for fruit, butter and lamb to the UK. This situation was aggravated by the United States further destabilising commodity markets through deciding to protect its markets against the European policy of subsidising exports.

The wheat quotas which had been introduced in 1968 had had little effect on production after the rise in world prices in the early 1970s. Wool prices recovered in 1972/73. Unfortunately the beef market weakened in 1974, taking mutton down as well.

There had been dissatisfaction with the arrangements for marketing of lamb. Following a referendum of producers, legislation was introduced to establish the Lamb Marketing Board. The board was given power to acquire all lamb and equalise returns to growers from the export and domestic markets, according to the quality of the carcase produced.

In view of the general financial problems of Australian agriculture, particularly the wheat and sheep industries, the State and Federal Governments decided in late 1970 to introduce a Rural Reconstruction Scheme.

Dairy industry adjustment, which had started in the mid-1960s, continued through the 1970s. Despite Western Australia not being an exporting State, the industry continued to have to contribute to the equalisation of export and domestic returns and was faced with higher costs and a reduction in the subsidy on butterfat.

But by 1982/83 agriculture had a gross value of production of $2 billion for the first time. The eastern states were affected by drought and WA produced 20 per cent of the total Australian gross agricultural product. Agriculture was a key part of the State’s economy, supporting about 25 per cent of the workforce. About 150,000 WA jobs were directly or indirectly dependent on the agricultural industries.
The department

In 1971 there were 24 graduate extension staff supported by 16 technicians in the wheatbelt, operating out of 11 district offices. In the higher rainfall areas there were 12 graduate advisers supported by eight technicians. A number of inspectors and instructors throughout the agricultural areas were concerned with stock inspection, fruit and orchard inspection, and dairy premises and dairy farm inspections. The instructors provided advice on specific issues to producers, particularly in the fruit and dairy industries.

1977 reorganisation

In July 1977 a reorganisation of the Department of Agriculture came into effect. This proved to be the first of a number of changes which would be implemented over the following years.

The main feature of the reorganisation was to consolidate the growing focus on regional services. The first step was to create the major district offices as separate branches, with the officer-in-charge of the district office as the branch head. The staff at these offices was made responsible to the officer-in-charge and their duties on a day-to-day basis were directed by that officer. The officers-in-charge were responsible directly to an assistant director who was part of the senior administration of the department.

Important moves included:

- The Plant Research Division was expanded by the inclusion of seed products, weed agronomy and plant pathology.
- The Plant Production Division included plant breeding, the grain products laboratory, grain inspection services and the control of all research stations.
- The Regional Services Division was created to take over the district offices, which included the advisory staff and all regional offices.
- The Resource Management Division took over all the rangeland responsibilities of the North West Division, the Soil Conservation Service, Soil Research and Surveys, and Irrigation and Drainage.
- The Horticulture Division included fruit and vegetables, viticulture, floriculture and the plant inspection services.
- The Marketing and Economics Branch included marketing, farm management and economic services.
- The Entomology Branch, the Botany Branch, the Information Section and the Library remained independent.

In addition, the department's overall structure included the Agriculture Protection Board, which was responsible to the Minister for Agriculture through the Director, who was chairman of the board.

The Animal Health, Animal Production and Dairy and Food Technology Divisions were responsible to the Assistant Director (Animal Industries) who also managed legislative matters for the department.

The Plant Research Division, Plant Production Division, Regional Services Division, the Information Section and Library were responsible to the Assistant Director (Plant Industries).

The Resource Management Division, Horticulture Division, Marketing and Economics Branch, Entomology Branch and Botany Branch were directly responsible to the Deputy Director of Agriculture.
The Chief Administrative Officer managed all matters relating to the overall administration of the department, including the Accounts and Stores sections. In 1980 the regionalisation process was expanded by the appointment of research officers at Esperance and Merredin, further development of the Animal Breeding and Research Institute at Katanning, and the launch of a farm machinery unit at Merredin to provide research and extension support in farm mechanisation, primarily to the heavily mechanised grain industry.

In response to the demand for general farming information being received at head office from near-metropolitan farmers, a Metropolitan District Office was opened at South Perth to service these requests. As a result, the Kelmscott District Office was closed and its functions taken over by the new Metropolitan and the Midland district offices.

In November 1980 the department held its first open day when the South Perth headquarters were opened to the public. An estimated 8000 people attended, including 1000 school children. The Premier and a number of ministers also attended.

**Reduced funding**

The early 1980s started a period during which the funding of agricultural research and extension was reduced across Australia. There had been a fall over some years in the value of industry research funds in real terms and this was coupled with a cessation of the funds provided by the Commonwealth Extension Services Grant. While this reduction had previously been taken up by State Governments that trend was reversed by reduced taxation disbursements to the states.

As a result, in 1980/81 some traditional Department of Agriculture services ceased and others were modified. In Western Australia this was a particular problem as only 7.5 per cent of Australia’s total research funding was spent at that time in the State. This was despite WA generating 15 per cent of Australia’s gross national agricultural product. Also, much of Western Australia’s production was achieved on recently developed sandy soil which resulted from successful research and extension, but there was a need for much more information about long-term management of these soils. There was also a rapid change in farming practice, making it essential that research efforts be increased, particularly in the drier districts of the State.

While the 1981/82 season saw record gross value of agricultural production, the total resources available for maintaining the department’s research and extension functions did not keep pace with inflation. This resulted in some departmental functions being scaled down. This included less activity at Avondale Research Station, reduction of laboratory services available from the Division of Animal Health and withdrawal of fruit and vegetable quality inspections at the Metropolitan Markets.

The overall outlook was for greater contributions to come from the rural industries for maintenance of research. This trend was emphasised by comments at federal level that agriculture was over-funded. Subsequently, funding for CSIRO was redirected from agriculture to other activities, particularly the environment.

During 1982/83 a dryland research unit was developed at Merredin in response to research demands for the drier areas of the State. The *Soil Conservation Act* was strengthened to help in dealing with land degradation and there was a renewed emphasis on reducing erosion hazards. At the same time every effort was made to achieve the best possible weed control.

Following an internal review in 1982 it was recognised that a reorganisation of the research stations was necessary. To do this, funding would be needed and could be raised by reaching an agreement with Treasury to dispose of some current stations and use the funds raised for acquisition, or modification of existing resources. These changes were made progressively over the
next two years. Some of the older research stations lacked the capacity to focus on current issues while still providing an administrative base for utilising new sites. An example was the absence from existing research stations of soil types of major significance in the eastern and northern wheatbelt. To address this issue the department established a number of research farm blocks. The new research blocks were situated on land leased from farmers or exchanged under lease arrangements. The new research blocks were situated at East Chapman, Mullewa, Salmon Gums, east of Merredin and North Badgingarra.

The department also purchased land at Vasse, south-east of Busselton, to establish a new centre for research, particularly into nutrition of livestock. To finance these changes the department relinquished control of the Woodlands Poultry Research Station, Bramley Research Station, Northam Research Station and Denmark Research Station. The department's beef and dairy research became focused at Vasse.

To offset the loss of the Northam Research Station, the Avondale Research Station at Beverley was upgraded to carry out sheep production work. The work at Woodlands was transferred to the Medina Research Centre. Vegetable research had previously been transferred and integrated with other forms of horticultural and floricultural research at Medina.

To provide for increasing agronomic work on crops and pastures in the higher rainfall areas the department expanded the Mount Barker Research Station by acquiring an additional block north of the existing station. This was partly equipped by transfer of resources from the Denmark Research Station. In early 1983 work directed towards developing sustainable farming systems for the drier areas was expanded when the Merredin Dryland Research Institute was opened.

In early 1984 this regionalisation process was extended further through the transfer of responsibility for most research stations from the Division of Plant Production to appropriate district or regional offices. The officers-in-charge then controlled the extension activities relating to those research stations, organised the related advisory committees, and became more directly involved with their farm management and administration.

To help the divisional chiefs and the district officers-in-charge to implement the department's policy in their areas, the Administrative Division was divided into three branches: Financial and Corporate Services, Physical Resources Services, and Personnel and Management Services.

The Financial and Corporate Services Branch was concerned with financial matters, accounting systems, legal matters including copyrights and procedures such as insurance and some other administrative issues.

The Physical Resources Service was responsible for the department's property and maintenance including buildings and land acquisition, minor works and equipment, staff housing, gardening, caretaking, cleaning, and communication. It was also responsible for supply, transport and engineering.

The Personnel and Management Services included safety and training matters, clerical relief, and five separate sections of personnel, records, word processing, computer services and the library.

In addition a Scientific Services Branch was responsible for the coordination of research funding throughout the department and for submissions to government and other organisations for finance for research.

In early 1984 the new Director of Agriculture saw a need for a change of focus in the country offices. He felt that they should become less involved in providing 'recipe' advice and should take on an important analytical role in studying farming systems, identifying problems and selecting target areas for technical improvement.
There had also been increased community awareness of environmental issues. This was supported by State and Commonwealth Governments, with financial assistance provided to address land degradation problems. During the year 15 soil conservation districts were established and another 10 were proposed, involving farmers and others in the community taking an interest in soil conservation issues. The Soil Conservation Service had been established in 1946. Almost 40 years later, adverse climatic conditions focused minds on the need and the messages that had been out there for four decades.

In 1984/85 there was again little change in the department's structure. However, there was further movement of some research staff to the district offices. At June 1986 the department had a total staff of 1596. Of these, 360 were professional or senior administration officers, 487 were general division, 208 clerical division, 167 temporary and term appointments and 375 wages staff. There were 66 vacancies. The total budget was $75.9 million.

During 1986/87, 80 per cent of agricultural income came from the cropping, 11 per cent from fruit and vegetables and a further 9 per cent from other industries. The industry continued to be under price pressure and in real terms wheat prices were only 62 per cent of those in 1976/77.

Functional review
A functional review of the department started in 1984 and reported to the government in 1987. After discussion with the Minister for Agriculture structural changes included the elimination of the former position of Assistant Director and the promotion of the former chiefs of division to be divisional directors, with full participation in overall policy development. Plant Research and Plant Production were combined into a Division of Plant Industry, and the former independent branches, Entomology and Information, were incorporated into the divisions of Horticulture and Regional Operations respectively.

The Western Australian Herbarium was transferred from the department to the Department of Conservation and Land Management. Recommendation that the Agriculture Protection Board be amalgamated with the Department of Agriculture was not accepted by the government. Both organisations were required to cooperate to obtain maximum benefit from the use of their staff and facilities in the regions. The Argentine ant program was transferred to the Agriculture Protection Board.

The thrust of the functional review committee recommendations was to reinforce regionalisation, which was already well established. This resulted in the appointment in 1987 of seven regional directors covering the whole of Western Australia: the Kimberley, Arid Pastoral, Northern Agricultural, Central Agricultural, South West Agricultural, Great Southern Agricultural and South Coast Agricultural Region.

Over the previous two years the department had undertaken a farm management extension initiative which proved successful both in its capacity to give useful information to farmers and as a general stimulus to the extension activities. The department now looked to complement this initiative with a farm planning and resource management tool called Landman. This was a computer-based farm planning tool which combined both the environmental and economic aspects of farming.

Another change was for the pastoral land inspectors, who had been responsible to the Department of Land Administration, to be transferred to the Department of Agriculture. This enabled integration of the inspection staff with rangeland management staff and provided an opportunity for a close working relationship.

In 1988 a dairy farm model was developed by the Dairy Branch of the Animal Production Division. The model showed that profit could be increased on most farms by adjusting the breeding pattern, feeding more concentrates in summer, and increasing the area of early
germinated pastures in irrigation areas. Feeding was a key issue and intensive research was carried out in that area.

Other key issues were early calving of heifers and maintaining a high reproductive performance so that cows maintained a 12-month calving interval through their productive life. The bacterial quality of milk had continued to improve, with the numbers of farmers with bacterial counts greater than 50,000 per millilitre during a month being reduced to less than half. This resulted in improved shelf life and quality of pasteurised milk and milk products. Departmental officers continued to provide high-level technical advice to dairy factories.

In 1987/88 the Animal Health Division established an Epidemiology Branch to provide a foundation for disease control planning and developed a field-based veterinary research service and a specialist advisory service. Laboratory services were provided at South Perth, and regional laboratory services at Bunbury and Albany.

In the 1988/89 report comparison was made of the financial provisions from State revenue with 1984/85. The 1988/89 budget provided for an apparent increase of approximately $12 million per year, but converted to 1984/85 dollars it amounted to a reduction of some $6 million.

The year 1989/90 was a turning point for the sheep industry. Faced with an over-supply of wool, declining returns at successive auctions and rapidly accumulating stockpiles, the reserve floor price was lowered to 700 cents per kilogram and then abandoned.

Sheep numbers in WA had reached a very high level and had to be reduced. At this time there was also a major disruption to the live sheep trade to the Middle East. All these issues created a period of substantial challenge for the department.

In addition, an outbreak of Queensland fruit fly had to be addressed, there was a substantial increase in footrot in the South West and a major outbreak of plague locusts was expected in the spring. In the fruit industry there was an outbreak of apple scab in the Pemberton–Manjimup area, the first in 40 years.

On 1 July 1989 the approved average staffing level for the Department of Agriculture was 1710 full-time and temporary equivalent (FTE) employees. This had increased by June 1990 to 1810 FTEs. Actual staffing levels ranged from 1614 FTEs to 1861 over the year. Of all employees, 30 per cent were professional, 35 per cent technical, 7 per cent inspectors, 17 per cent administrative and clerical support, and 11 per cent wages.

**Cost recovery**

The increase resulted from funding of additional projects and work by either industry or the Commonwealth and the devolution of responsibility from the WA Department of Services. In 1990, following an extensive review of the cost of supplying the large range of services offered by the Department of Agriculture, the Minister for Agriculture approved a policy based on full recovery of the cost of those services which were delivered on an individual basis without benefit to other persons or the State as a whole. Where such benefits could be identified, such as those charges applicable to import quarantine inspection, suspected exotic plant or animal disease diagnosis, and some aspect of land conservation, the charge would be discounted by the estimated amount of external benefit. The provision of farm managements and improvement information and agricultural research would not be chargeable, falling into the group of services that had a general rather than an individual benefit. Where research and advice were undertaken or given to specific audiences, a cost recovery charge would be imposed. Under this policy, administered under Section 9.2(a) of the Agriculture Act of 1988, all charges were to be reviewed annually and made available to the public in a departmental publication issued early in each financial year.
The 1990/91 report also dealt with the general downturn of the wool and cereal industries due to market failures. This was coupled with a continuing fall in the departmental budgets in real terms both from State sources and industry funds.

**Program management**

There had also been a change in the reporting framework across the Public Service. There was now a need to follow the ‘new age’ management structure of identifying objectives and reporting formally against those objectives. As a result the department adopted a formal system of program budgeting and management. Outcomes had to be related to stated objectives. This process was designed to increase accountability to Parliament and the department’s clients. It was the beginning of more formal reporting requirements which over the years appear to have detracted from the value of the department’s reports. The process seems to have failed to recognise both the professionalism of the staff and the uncertainty of innovative research. The Director noted that the reduced resources would increase the focus on front-line country services.

The department was required to provide performance evaluations. The footrot control program, the Kimberley cattle breeding and management program, the introduction of field peas into the grain industry cropping programs, and the increased number of lambs per ewe were used as examples of the contribution of the department’s research to farmers.

Conservative estimates were that the net income increases due to the department’s research were: footrot control, $7 million; increasing the number of lambs per ewe, $7 million; oat breeding, $6 million; improved Kimberley cattle breeding and management, $1.5 million; and the introduction of a pea crop into cropping programs, $1 million. This gave a total advantage of $22.5 million per year from the department’s work to produce these advances.

It was also pointed out that five projects were reviewed for both the 1988 and 1989 annual reports and were still generating benefits in 1990. They took the increase in farm income from the benefits reviewed over these three years to a minimum of $145 million per annum, which was 150 per cent of the department’s 1990 budget.

Within the department it was decided to formalise the consideration of projects being submitted for funds to industry research funding bodies. This was done through a computer-based program called the Research Evaluation Spread Sheet. It was also decided to test having economists provide advice to principal officers on research directions which could be of greatest value to industry. This was first tested in the Sheep and Wool Branch.

In the light of later proposed changes to the department’s regulatory functions and services provisions it is relevant to look at the situation at 30 June 1991. At that time 17 different regulatory activities and 14 services were provided to industry. In order to maintain contact with industry, 53 liaison committees existed. In addition, 49 Acts of Parliament were administered.

In 1991/92 there was a need to reduce staff by some 60 people. The WA Government offered a voluntary severance scheme which resulted in the loss of experienced staff. Severance packages were offered to 88 staff and 78 offers were accepted.

**Restructure – 1991/92**

The Director General stated that the department reacted positively to the reduced funding environment by entirely reviewing its management structure to reduce administration costs and place emphasis on outcomes. He stated that the steps being implemented involved the development of full program management with a strong focus on industry and market development, and continued progress toward sustainable production systems for all sectors of agriculture in Western Australia. He considered that the restructuring would result
in a unified but flexible organisation better able to handle fluctuations in funding and the rapidly changing needs of government and industry for servicing the rural sector.

The restructure was major, with a reduction of the operational divisions from eight to four. The regional districts were maintained and the Regional Operations Division included land management and the Commissioner of Soil and Land Conservation and his deputy. Resource Science, which had previously been part of a Resource Management Division, was placed in the Plant Industry Division, as was the former Horticultural Division. A Division of Animal Industry was created; it included the previous Animal Production and Animal Health Divisions. The Corporate Services Division was expanded to include information technology, scientific liaison and the business and legislation sections.

The operational divisions became responsible to the Deputy Director General and the Corporate Services Division to the Director General, which was the reverse of the previous situation. Within this structure there were 33 programs which were led largely by the principal officers in the organisation. The heads of divisions did not act as program leaders. In regional areas which were dominated by wheat and wool production, there was a need for a focus on assisting farmers through the rural downturn associated with the fall in wool and wheat prices in 1990. Advisory committees were widely used at regional level.

These programs were packaged into four overall groupings:
1. Industry and Market Development
2. Sustainable Agricultural Systems
3. Industry Support and Assistance

These headings set the direction for the future work of the department. It is doubtful that it needed much redirection later, although the increased emphasis on market investigation had not previously been clearly spelled out. After the 1994 review these same four overall programs were again adopted.

Across the department the availability of increasing computer power resulted in the opportunity to change and integrate activities. This was identified in the corporate services area where the department was rapidly replacing its ageing central computer system and implementing an industry standard hardware communications and database environment.

In April 1993 the wool indicator price fell to 389 cents a kilogram clean. This was below the cost of production for most producers and required focus on issues related to specialist wool producers. The department moved resources to a production and diversification campaign. This was aimed at helping wool growers to adopt more cost-effective production techniques and to identify opportunities to adopt alternative production systems.

The computer program TACT, which had been developed in 1991/92 to help farmers make the best decisions on how the area of crop should change in response to seasonal conditions, was invaluable in this process. It provided information on the probability of different wheat yields and the probability of the different gross margin outcomes given rainfall up to the time of planting. There was a strong demand for information from this model. Another computer model called PADRANK was developed for assessing the profitability of crop on a paddock and crop variety basis.

During 1991/92 the department was also active in assisting new exporters and investigating export opportunities.

By 1 July 1993 the Department of Agriculture had moved to full program management of all activities, which were directed through 33 operational programs, each with clear objectives, planned achievements and outcomes and subject to performance evaluation. During 1993/94 it undertook a comprehensive analysis of these programs. This was done by a small unit which included program leaders and economists. A total of
190 analyses were completed, covering some 60 per cent of the budget. This was an analytical approach but there were significant assumptions. These included estimates of the extent to which the results of research would be taken up, and market and climatic uncertainty.

In the 1993/94 report reference is made to the problems of obtaining a proportional amount of funding from the industry-funding corporations. This funding was not in proportion to the gross value of production, which determines the levy contribution for each commodity. This was largely due to the concentration of national scientific research in wool technology, biotechnology, grain, and meat product research in the eastern states. This meant the Western Australian research effort was reduced by the double-edged effect of not having the research personnel and infrastructure and not receiving funding proportional to the size of the industry serviced.

The Director General stated that the future work of the department across the whole spectrum of research, development, extension and regulatory activities would be closely aligned to market opportunities. He commented that over the past two years the department had changed its emphasis from an organisation driven by a production-based research to one with a sharper focus on marketing.

**Seasonal conditions**

Generally favourable seasonal conditions were experienced from 1950 to 1970 in the agricultural areas but not in the two next decades. While 1970 was satisfactory and greatly assisted recovery from the 1969 drought, the remainder of the 1970s and the first half of the 1980s contained more poor years than good ones.

In 1970, good rains particularly in the north and west Kimberley regions ensured good seasonal prospects. The Gascoyne experienced considerable cyclone damage in February but there was no river flow until good rains in the late summer and autumn of 1970, when the river ran on two occasions. Conditions further south-east remained dry, particularly in the Goldfields, which was in continued drought.

The 1971 season started poorly in the agricultural areas despite heavy general rains in March. By the end of June rain was needed over most of the wheatbelt. However, the season finished well and September and October were cooler and wetter than normal, which saved the State’s cereal crop. However, pasture growth remained poor. For the pastoral areas a worsening drought situation in the eastern Goldfields was the dominant seasonal issue.

In 1972 rain in the main cereal areas did not fall until the last two days of May and some pockets had little rain before mid-June. The season finished early and while the planted cereals increased, production fell because of poor yields.

Barely 3 million hectares were sown to wheat in 1973. Heavy and widespread summer rain fell in the pastoral areas. This brought relief to drought-stricken areas in the Murchison, north-eastern Goldfields and Kalgoorlie–Nullarbor regions. In the agricultural areas the season finished well and resulted in record cereal yields from a record area planted. The high prices for grains, ample pasture and firm meat prices maintained confidence in the sector.

In the South West the excellent season of 1973/74 temporarily lifted some depression felt in the dairy industry, where inflationary trends in costs, the progressive removal of the subsidy on butterfat and delays in resolving Western Australia’s claims for relief from equalisation payments were causing problems.

The year 1974/75 was hard for farmers because of an inflationary climate and instability in some export markets. There were also dramatic increases in phosphate prices and a collapse of the beef market. Sheep meat prices also dropped but wool prices were maintained through the reserve price scheme. The wheatbelt had an
average year, with low winter rainfall reducing yield slightly.

However, 1976 opened very dry with below-average rainfall across most agricultural areas through April, May and June. By mid-August, 16 shires in the northern and eastern wheatbelt had been declared drought-affected and three partly drought-affected. Good rains in August and September allowed some crops in the drought-affected areas to finish, and also replenished farm water supplies.

In 1977 it was another dry year. By October, 20 per cent of the State’s wheat growing area was declared drought-affected. Grain production was further reduced by very heavy rain in the eastern and south-eastern areas. The fruit industry was affected by hail and storm damage in February.

Further damage occurred in early April when cyclone Alby devastated extensive parts of the South West. Following a very hot dry April, soaking rains were received in the South West. However, by the end of June 1978 drought conditions in the north-eastern areas were the worst on record.

In the 1978/79 summer a total of 167 farms were drought-declared in nine northern and eastern shires. The Mullewa, Morawa and Perenjori shires contained 137 of these farms. The drought problem continued in north-eastern areas in 1979/80 when Morawa, Perenjori and Mukinbudin were wholly drought-declared and a further 18 partly drought-declared. There were also critical feed shortages in seven shires of the central wheatbelt.

In 1980 winter rains failed in many agricultural areas. Generally rains were better in the northern region than in the previous four years. Overall, 42 shires in the north-east, eastern and south-eastern wheatbelt were declared wholly or partly drought-affected. For some farmers it was the fifth consecutive year of drought and for many it was the third or fourth of the last five years.

Opening rains were late in many southern districts in 1981 and this coupled with cold conditions and severe sandblasting of newly emerged pastures and crops resulted in abnormal pasture shortages early in the winter. Landsat images in August 1980 indicated that about 44 000 ha of cropped area in the central South Coast were severely sandblasted, where crop failure was total.

Government assistance was available to drought-affected farmers. As previously, aid was given in the form of loans at concessional interest rates, subsidies for the cartage of fodder and stock and the provision of water. Further assistance was provided to clear sand from fence lines, water catchments and dams in affected areas. However, enough rain fell in many inland districts to effectively overcome the drought conditions that had existed since 1976. The Drought Consultative Committee was able to revoke the drought declarations of most of the shires which were still declared in 1980/81. In some districts rains virtually cut out at the end of August and resulted in 10 shires being declared disaster-affected. It also resulted in a critical stockfeed shortage which was compounded by a late start to the 1982 winter.

After a late start, the 1982 winter rains were reasonable and allowed farmers to sow a record area of crop. However, pasture in most livestock districts germinated late and made little growth through the cold and relatively dry mid-winter. Valuable late rains in September and October made a record cereal crop year, although few district yields were above average. Unfortunately rains were not enough to help pastures and big areas of the Great Southern and South Coast experienced acute feed shortages which worsened through the summer. This resulted in significant areas being drought-declared due to a shortage of feed.

The 1983 season was very difficult for most farmers in agricultural areas. Regular winter rains did not start until 1 July, causing severe feed problems and reduced crop yield.
Growing conditions were good for crops and pastures in July, August and September but rains cut out almost completely in October. This reduced crop yields to drought levels in the eastern wheatbelt and some parts of the north-eastern wheatbelt. Severe feed deficiencies on the Esperance sandplain caused that area to be declared drought-affected for the first time. In all, 1200 farmers were affected in 1983/84. In contrast, heavy November and December rainfall caused further crop losses and delayed harvesting. However, farmers recognised that stored moisture would benefit the 1984 crop.

The 1984 winter started early in May and in most areas the May rainfall was twice the annual average, which produced an abundance of sheep feed for the first time for years. The season proved to be the best for nearly a decade. It brought good livestock returns and high grain yield. While the early break was welcomed, the heavy May rain made it difficult to control weeds. A drier June relieved this problem. Crops looked excellent until a dry finish reduced yield potential, particularly on heavier land in the eastern wheatbelt. In the south coastal areas the rainfall pattern was the reverse of other agricultural areas. A clear break did not come until late June. Satisfactory rains through the remainder of the year resulted in good crop outcomes.

In 1985 winter started late throughout the wheatbelt. In some districts no opening rains fell until after the first week of July. This resulted in stockfeed shortages and delayed crop sowings. The central wheatbelt was the most affected with some shires being drought-declared because of severe feed shortages. Conditions improved in late winter and spring but rains came too late for heavy soil areas of the north-eastern and eastern wheatbelt. Wheat production fell dramatically with only the higher rainfall South West, the Great Southern and South Coast receiving average winter seasons.

In February 1986 cyclone Rhonda brought heavy rains to most agricultural areas. The winter opened generally well throughout the wheatbelt, South West and South Coast in May. However the Great Southern and Lakes districts received much less rain and by the end of June were relatively short of feed. Good seasonal conditions were generally sustained and crop yields were average or above-average and the total harvest was only exceeded by the record of 1984/85.

In 1987 the break of season was the best for many years and cropping was completed by the end of June, but by late July a dry area had developed in the lower Great Southern. Widespread good rains in late July improved prospects. However a poor finish resulted in an average crop and average to poor pasture in parts of the State, which deteriorated over summer to expose some areas to wind erosion.

An early break and good follow-up rains in 1988 gave good feed conditions but some areas were too wet for planting crops.

In the early 1990s the Commonwealth Government policy on drought changed. The government adopted a view that drought was not a climatic aberration which warranted financial support, but was one of the seasons which farmers must expect and manage in their overall farm financial planning. From a strategic viewpoint this added to the management risks farmers had to contend with. Both weather uncertainty and price uncertainty became bigger factors for farmers.

**The pesticide residue issue**

In May 1987 the detection of unacceptable levels of organo-chlorine pesticide residues in consignments of beef exported to the United States threatened the major meat export market. Several areas of the South West were identified as significant sources of residues. This was associated with a historical widespread use of organo-chlorine pesticides on horticultural crops.

The Department of Agriculture had the lead role in dealing with this problem, which was largely south of Bunbury. All organo-chlorine
pesticides were deregistered for any agricultural or horticultural use. Farmers were required to return unused stocks of these pesticides and the government instituted a buyback scheme. It was necessary to identify affected land and to determine in consultation with the owners how this land would be managed into the future. In the affected areas veterinary officers and advisers spent 80 to 90 per cent of their time working on the residue problem. Subsequently a research program was undertaken to determine the behaviour of organo-chlorines in plants and animals. By June 1989 abattoir and field monitoring had detected 699 properties running cattle with residues greater than 50 per cent of the maximum residue limit. After investigation and changes in farm management 432 properties were released from quarantine. Altogether, more than 46 000 tests were carried out on samples from 74 per cent of the cattle properties in WA.

The department provided assistance to farmers in:

- purchase of contaminated trade cattle
- compensation for animals condemned at abattoirs
- partial or complete herd buy-out where an owner wished to reduce his/her stocking rate or to leave the cattle industry completely.

The cost of these measures was met from the Cattle Industry Compensation Fund. Financial assistance was also provided to eligible farmers in the form of interest subsidies to use on commercial loans up to $50 000.

**Issues in the period**

**Regional issues**

During 1990/91, issues promoted throughout the south-west of Western Australia included servicing of pesticide-affected farms, improved dairy and beef production efficiency, sustainable land use, and development of productive pasture systems based on improved varieties of perennial and annual pasture species. Development of catchment management plans was important in the Peel-Harvey and related catchments where sandy soils and eutrophication were a problem. In other catchments, plans were developed as part of the overall natural resource management program.

On the South Coast nutrient pollution in the Albany harbours was significant and required land use planning to reduce fertiliser seepage.

Esperance Research Station, where 40 per cent of land was salt-affected, was redeveloped. A drainage system was installed to alleviate flooding of lower lying parts, a major revegetation program was introduced, and cropping in a higher production cropping rotation to use as much winter rainfall as possible was implemented. This provided a demonstration of an option for managing these difficult issues.

**Climate impacts**

In 1980 the below-average rainfall in many areas caused wheat protein levels to be above average for the fifth successive year. This resulted in deliveries being divided into a Northern (Western Australia) ASW which had a high protein and Southern (WA) ASW which had lower protein. Nevertheless, record production of the Australian soft and Australian hard grades of wheat were achieved in terms of protein levels. Oats were of generally satisfactory quality, and increased lupin production enabled some exports.

**The new cropping industry**

The period from 1970 to 1990 saw the greatest change in the methods of crop production. For thousands of years crops have been sown on seedbeds prepared by ploughing and cultivating. A second major aim of seedbed preparation was the control of weeds which would otherwise compete with the crop and might even smother it. In
the early 1970s drought and reduced stock numbers, coupled with better returns from continuous cropping, resulted in a move away from the clover ley system of farming. Progressively the industry moved to continuous cropping without a pasture phase. The rate of this movement depended on solving the questions of weed control and the need for any system to be sustainable. Where the pasture phase was still being used the focus shifted to a system which reduced the grass content of pastures. Grasses were serious weeds in crops and many also carried cereal disease. The department’s research changed to focus on increasing the clover content of pastures through management, and reseeding where necessary.

`hidden` impact on the crop plants of the selective sprays, any carry-over of the herbicide effects if the area was to be cropped again next year and what long-term opportunities or risks were involved in this revolutionary change. Farmers soon started to test whether seeding could be done in some seasons before the opening rains. When this was shown to be possible under some circumstances it established firmer dates for seeding, and built in a longer growing season.

The clear advantage of the new approach was that, even if the farmer waited for the first rain, he sowed his crop with one pass considerably earlier than was possible when weeds had to be controlled by cultivation. This meant that the growing season could be extended by up to three weeks. Moisture loss due to cultivation was avoided and more moisture was available for crop growth.

In 1978, 40 000 ha were sprayed for weed control and seeded by direct drilling and a further 1.4 million hectares were sprayed for broad-leafed weeds, annual ryegrass and wild oat control. In 1981 this had increased to 565 000 and 3.7 million hectares respectively. The estimate in 1982 was that 1 million hectares would be direct-drilled and more than 4 million hectares sprayed for weed control. In 1982/83, 2 million hectares of crop was sown using this method. Further details of this process are in Chapter 7.

The cereal breeding program had to adjust. While the grain breeding programs continued to concentrate on disease resistance and yield and quality improvement, there was now a need to develop midseason rather than early maturing varieties. Testing for herbicide tolerance in new varieties was also needed. Crop varieties had to be tested or retested under different climate and soil conditions as well as different lengths of growing season. For details see Chapter 7.

The Australian Wheat Board introduced a varietal control scheme for the 1980/81 harvest, based on a trial approach in the previous year. Growers were required to

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**A canola crop at Dowerin. Departmental breeding was the basis for the development of canola as an important oilseed suitable for medium and higher rainfall areas.**

In the mid-1970s it became commercially possible to selectively or totally control weeds by spraying with herbicides. This meant that instead of ploughing after the first rains to control germinating weeds, these could be quickly killed by spraying with a broad spectrum herbicide. Once the crop was planted and growing, any surviving weeds could be controlled with a selective herbicide without any damage to the crop.

Issues remained such as how much cultivation was needed to provide the necessary seedbed, what cultivation was needed to release nutrients from the soil organic or inorganic matter fractions, any
name the variety of wheat delivered for each load. Incorrect naming could attract a penalty. Differential prices were paid depending on the assessed quality of the varieties.

Lupin breeders were making progress in the search for varieties with resistance to the fungal disease *Phomopsis*, but two new lupin varieties released in 1986 had no resistance. One of the varieties grown by seed producers in 1986 outyielded the standard variety by 14 per cent. In 1987/88 the first phomopsis-resistant narrow-leafed lupin was released. It had higher protein and lower alkaloid content than previous varieties.

![Lupins became a major component of the minimum tillage continuous cropping which revolutionised cropping through the late 1970s and 1980s.](image)

In 1986/87 it was shown that lupin yield had doubled between 1960 and 1985.

Rapeseed breeding was also proceeding well. In 1987/88 the breeding program had imported a gene for complete blackleg resistance from the wild mustard plant *Brassica juncea*. This, combined with the field resistance already present, gave a high level of resistance. Advances were also made in improving oil quality, and resistance to shattering. This meant that the rapeseed breeding material was in great demand around the world. Details of this work are given in Chapter 7.

Surprisingly, in 1988 it was reported that rapeseed production was recommended only in a restricted proportion of the south-central higher rainfall area. This recommendation appeared to be due to concerns about environmental hazards on sandy-surfaced soils rather than concerns about the suitability of the available crop material. It severely restricted the potential for the industry. Experiments in 1987 had been started in the Katanning, Kojonup and Pingrup areas.

By 1987/88 the production of pedigree seed from research stations ceased and basic seed was supplied to a total of 191 registered seed growers for production of commercially-registered or certified seed. There were five wheat, three barley, four oat, two triticali, four lupin and one rapeseed cultivars in the scheme. The supply of pedigree seed to farmers had been started after the 1911 drought when many farmers lost their seed, and this had continued for 76 years.

The need to settle on a new crop rotation and to develop suitable varieties to match that rotation was a major challenge. Research in the early 1980s seeking a sustainable rotation had found that a year of crop followed by a year of pasture was not maintaining yield. In the northern agricultural areas lupins appeared to be providing a solution but the varieties available at the time were not successful in southern areas. But by 1982 farmers were using lupins increasingly in their rotations on light land, with the total production reaching 180 000 tonnes. Lupins increased from 490 000 ha in 1985 to about 900 000 ha in 1987.

The continued development of new non-shattering lupin varieties with higher yield and low alkaloid, made the lupin the legume
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of choice for sandy-surfed soils in the new continuous cropping rotation. It was shown that both lupins and clovers contributed to the growth of the cereal crop through providing residual nitrogen from their nitrogen fixation. The lupin, with its growth habit and longer growing season could virtually eliminate grass, and had a greater hygiene impact in medium to lower rainfall areas than clover. This was important as it reduced or eliminated the ‘take-all’ problem from the following wheat crop. A normal clover pasture did not have this ability because of its grass content.

The first lupin variety with significant resistance to brown leaf spot was released to seed producers in 1995. It was adapted to the northern and lower rainfall regions and because of its consistent low alkaloid content was expected to replace the existing variety for human consumption. Three lines of albus lupins were tested in variety trials across WA.

There was a particular interest in the field pea as a possible legume in the rotation for heavy soil types. A research program started in 1984 demonstrated great promise for this crop. It was shown to be better adapted than lupins on heavy or shallow soils, particularly in the lower rainfall areas. The use of peas in the rotation was shown to have a big effect on the following wheat crop due both to the fact that they did not remove nitrogen and contributed nitrogen through Rhizobial fixation. There may also have been an effect due to stored moisture since peas are a shallow-rooted crop. Peas complemented rather than competed with lupins as an alternative to wheat. The area sown to peas rose from 9000 ha in 1986 to 50 000 ha in 1987. Other crops such as chickpeas, lentils and faba beans and different lupin species were also being investigated. Further comment on lupin and pulse breeding is in Chapter 7.

By 1982 there was evidence of improved structure on a clay loam at Merredin Research Station under continuous cropping with minimum tillage compared with deterioration under traditional cultivation. This made this technique attractive for those soils where it had been difficult to maintain structure. Yield comparisons showed that on heavy soils minimum tillage planting gave equivalent yields to traditional methods. However on sandy-surfed soils the traditional approach had shown an advantage over minimum tillage. This was thought to be due to poorer seedbed preparation.

In 1985/86 tillage research using a machine which would cultivate and sow in one pass without unduly disturbing the soil surface was started. This machine was a modified standard combine on which the conventional cultivation points were replaced with narrow points working 10 cm deep with the seeding tubes held back to allow seed and fertilisers to be deposited close to the soil surface. Tests showed this machine could produce better yields than conventional scarifying and seeding and much better results than direct drilling with a standard combine. By 1986/87 the crop agronomy research program was emphasising alternative crops, tillage and cereal agronomy.

The department’s agricultural engineering group confirmed previous surveys of boom sprays and showed important consistent faults in several brands. A new approach to the installation of electric fences was being examined and a saltland planting machine had been developed. These were all useful additions to cropping and general farm management.

Another issue identified at much the same time was the development in some light soils of a compacted layer resulting from the previous traditional cultivation. These soils gave substantial yield responses to deep ripping with specialised machinery which caused minimal surface disturbance. The effect of deep ripping appeared to last for at least three years, although the benefit seemed to drop off progressively on a year-by-year basis. In 1983/84 and 1984/85, work proceeded on development of equipment which would minimise the cost of deep
ripping. Deep ripping research results in 1986 showed that across the State, 52 trials on light and medium soils gave an average increase of 31.2 per cent in yield. On medium yellow loamy sands where deep ripping had been recommended for several years, the average response was 76 per cent.

Deep ripping to break a developed hardpan and allow proper root and moisture penetration was important in many areas.

The results from the Esperance district confirmed previous data that deep ripping should become recommended practice on deep fine white sands and sand over gravel. On these soils the average response to ripping was 49.5 per cent.

Planting into stubble. As thinking changed on the role of stubble residues this practice became widely used.

Re-examination of the impact of stubble retention through 1985/86 found different results to the historical attitude to stubble retention. It was shown that retained stubble assisted in moisture penetration and reduced evaporation on fine-textured soils, increasing yield substantially when compared with areas where stubble had been burnt.

Later in the period farmers were looking at reintroducing pastures. This was done partly to control weeds which had developed resistance to the selective sprays and partly to offset the cost of nitrogen fertilisers. While the main pasture legumes had been varieties of subterranean clover, other legumes were becoming more important. Two new medics, Serena and Circle Valley, had shown potential to improve production on moderately acid light soils. They were also suited to the heavy grey clays of the wheatbelt. The availability of new Rhizobium strains which allowed medics to grow on acid soils resulted in thousands of hectares being sown to Serena and Circle Valley, particularly across the Great Southern. Research workers were now seeking varieties with a wider range of maturity.

A new medic, *Medicago murex*, was under test for lighter soil types. It had the potential to grow on more acid soils. Hard-seededness became an important characteristic because increased cropping required a longer period between the pasture phases. This reduced the capacity of plants without sufficient hard seed to produce a dense pasture after a period of crop.

Resistance to attack from redlegged earth mite was given high priority in the development of commercial cultivars of subterranean clover. An early maturing introduction from Spain showed good tolerance and was immediately introduced into the crossbreeding programs.

During 1992/93 the Cooperative Research Centre for Legumes in Mediterranean Agriculture (CLIMA) was established. The department was a partner and a substantial part of the pasture legume breeding program was transferred to it. The first cultivar of *Medicago sphaerocarpus* (sphere medic) was released to seed producers in 1993, with subsequent distribution to farmers in
1994. It was expected to provide a pasture legume option for moderately acidic loams and sandy loams in the medium rainfall wheatbelt where cropping was frequent. More details of the pasture breeding program are provided in Chapter 7. For many years the department conducted seed certification schemes. In the case of subterranean clover this involved the inspection of paddocks to ensure purity of the variety and the restriction of seed gathering to those paddocks. Samples of the seed were then taken and checked for germination and purity. The industry became more complex and in 1983/84, 40 cultivars were certified. During the 1985/86 summer seed growers produced 1970 tonnes of certified pasture legumes seed, of which 1470 tonnes were subterranean clover and 380 tonnes burr medic.

**Modelling**

During this period the department developed a family of models. Work started on the prediction of yield. The agronomy group was developing a computer model using rainfall and other data from previous years to give producers some indication of likely yields. The growing complexity and cost of herbicides resulted in the department developing a computer model to help select the best-cost option from the available herbicides. It was called *Weed Cost*. The phosphate-nitrogen model was further improved to help farmers make fertiliser decisions on a paddock basis, and a root growth model was developed as a research aid. This is dealt with in more detail in Chapter 7.

**Extension**

During 1990/91 a crop variety sowing guide and technical manual for wheat producers titled *The Wheat Book* was produced and sent to growers. The wheat/lupin rotation was promoted for the South Coast, with lupins proven to be a key break crop to reduce the take-all problem. A booklet on weeds resistant to herbicides was published. Disease control in legumes continued to be an important issue.

In all industries the department provided extensive information services. These were organised on a regional basis. Issues being promoted in regional groups in cropping areas were sustainable farming, farming for soil types and the need to adjust farm enterprise mixtures in relation to the prices, having in mind the range of opportunities available.

**Some problems for specialists**

**Entomology**

The Entomology Branch was faced with continuous challenges of insect damage to commercial crops, pastures, gardens or livestock. In the post-war years there was a continuous flow of new synthetic insecticides. While these provided new tools, some insects develop resistance to new chemicals quickly. The rate of development of such resistance depended, at least in part, on the speed of the completion of the insect's life cycle. Biological control of pests and weeds had been a long-term activity of the department, with some notable successes. It had slipped out of focus with the advent of the new synthetic insecticides. However, as their limitations became more apparent the interest in biological control increased.

Significant projects for the Entomology Branch during the period were:

- Control of aphids to limit virus transfer.
- Control of fresh fruit infestation by Medfly.
- Forecasting sheep blowfly strike and examination of the practicability of using an ultra-low volume gas application of synthetic pyrethroid pesticides as a jetting agent against the sheep blowfly. This proved to be effective in treating sheep in full wool as they ran through a specially designed race equipped with an electronic eye to activate the jetting mechanism.
Biological control programs aimed at the weeds dock and doublegee. A predator of dock from Morocco, which had been fully tested against it becoming a threat to non-targeted plants, was released in June 1991. In 1994 it was reported that 23 populations of the dock control agent were established in WA. New release technology was used which had increased the potential for establishment of introduced predators by several fold.

In 1988/89 biological control of Paterson’s curse became possible due to the introduction of small leaf mining moth from France. In 1994 it was reported that a root boring weevil for control of Paterson’s curse had become available for national distribution from Victoria in late 1991. After a colony had been established in Perth, 1650 weevils were released at four selected sites.

The department's entomologists introduced a parasitic wasp in an attempt to control the blue-green aphid. This aphid was first detected in WA in June 1979 and by 1981 was recorded from virtually every pasture growing district from Geraldton to Esperance. It caused serious damage to lucerne, subterranean clover and annual medics. The multiplication of the wasp was aided by the continuous availability of lucerne through the summer. Up to 74 per cent of the aphids on plants in a paddock of Hunter River lucerne were parasitised in 1981. The predator (*Aphidius ervi*) was released in other districts but did not prove as effective on subclover because of the difficulty of surviving the summer; other approaches were being examined.

Work was proceeding on combating a weevil pest of lucerne, which became important to lucerne growing areas.

Eradication programs for Argentine ants, green snail, and the European wasp were in place. Mediterranean fruit fly had been successfully eradicated from Carnarvon.

Development of improved baits for grasshopper control, and examination of the environmental conditions which result in plague locust development.

Development of techniques to reduce insect problems in stored grain.

Introduction of six parasitic wasps which were predators of 11 species of caterpillars which attacked cereals and a wide range of broad-leafed crops.

Screening of alternative chemicals to replace the organo-chlorine insecticides which had been banned for agricultural purposes.

Controlling insect pests on a range of new crops such as field peas, lupins and rapeseed. The investigations were concentrating on cutworms and budworms and aphids in lupins, and pea weevil, cutworm, budworm, and redlegged earth mite on field peas.

Biological control of the cowpea aphid which attacked medics and subterranean clover and other legumes, through introduction of a tiny wasp from India.

Eradication of the Queensland fruit fly which involved intensive baiting and a sterile-male release program.

Eradication of codlin moth, which was detected in 1993 in Bridgetown.
• Release in 1993 of two biological agents, a mirid bug and a mimosestese beetle, as parasites on Parkinsonia in the Kununurra region. The wet season had killed the mirid bugs and efforts were being concentrated on the mimosestese weevil.

**Plant pathology**

Like the entomologists the plant pathologists faced a continuing stream of enquiries about endemic diseases of crops, gardens and pastures. The scope for biological control was limited and the major tools were fungicides and management or breeding designed to avoid a particular problem. Some issues during the period were:

- the discovery and development of an acid-tolerant *Rhizobium* for medics
- the development of screening tests for two important diseases of wheat
- the identification of the relationship between soil-borne inoculum of *Pleiocheta setosa* and root rot of lupins
- enzyme typing to distinguish species and strains of *Rhizoctonia*
- identification of a fungicide which would control rust on susceptible crops
- demonstration that low rates of superphosphate led to rapid build-up of ‘take-all’, providing a possible explanation for the serious problems on new land farms having low phosphate levels
- demonstration that there was no resistance to take-all among known wheat varieties
- demonstration that simple spray-topping before the end of the season had no value in the control of take-all
- demonstration that seed treatment of barley using the commercial fungicide, Baytan, proved effective in controlling scald, powdery mildew and smut diseases
Weed control and weed science

Weed researchers were focused on the new cropping systems. The department was heavily committed to biological control and the weed agronomists were working with other specialists in programs to bring biological control agents into WA which would help control specific weeds. In the meantime chemical control was essential. In 1982 a cereal weed spraying chart listed 27 herbicides to control 34 weeds of cereal crops.

The post-war availability of modern herbicides revolutionised weed control in crops. Wild radish (left) was missed by the spray.

Significant weed control issues were:

- low-cost control of weeds in lupins and chemicals for weed control in field peas
- low-cost control of summer weeds such as melons
- control of skeleton weed in the grain growing areas. A study of the weed's ecology found that it was liable to be a problem across most of the wheatbelt but the south-eastern wheatbelt to Esperance appeared to be at particular risk
- the testing of some cereal varieties for sensitivity to herbicides continued
- demonstration that a selective herbicide could control radish in lupin crops. With radish control it was estimated that lupins could be grown on an additional 500 000 hectares
- demonstrating that the very successful Kulin variety of wheat was sensitive to the herbicide Glean. This herbicide was used over a million hectares of wheat in 1986
- identification of wheat and barley varieties tolerant to a herbicide for brome grass control. With development the chemical could make control of this weed in cereal crops possible
- demonstration that a combination of chemical and cultural treatments before seeding could control capeweed
- development of control strategies for weeds in peas, tailored for specific soil types
- continued work on grass control in cereals together with continued calibration of models to improve their accuracy
- demonstration of the potential to control Parramatta grass, kyllinga sedges and onehunga, through the availability of a new herbicide, Oust. All these plants are serious weeds of turfs and playing fields
- the identification of a new herbicide effective on blackberry. It had the advantage of being non-toxic, substantially cheaper, odour-free and not subject to vaporisation, which had been the case with 2,4,5-T
- demonstration that goats could control saffron thistle. The effective control of this weed would release 225 000 hectares of land for crops
- the demonstration that early spray-topping gave improved control of annual ryegrass toxicity (ARGT)
- analysis of pastures and fodder crops for organo-chloride residues in the South West showed a marked interaction with soil type and the level of residue in the plant
- the finding of Kochia scorparia in late 1992 initiated a joint Commonwealth–State eradication program, which was progressing satisfactorily in 1994.
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Horticulture

Fruit

In the mid-1970s apple-growing, the major fruit industry, entered a period of adjustment following loss of markets in Europe and rising freight costs. There was also some dissatisfaction with the varieties supplied, coupled with competition from other southern hemisphere growers and stored fruit from European suppliers. It was a national problem but WA and Tasmania were more affected because of their reliance on exports and the major varieties grown.

The apple crop was about 2.46 million boxes and the pear crop was 285,000 boxes in 1981, but the industry was seriously affected by the failure of the major juice producer to handle the previously nominated intake of 800,000 boxes. With the export market reduced to 413,000 boxes, large quantities of apples were forced into cold storage at the end of June.

Restructuring of the apple and pear industry was discussed at national level. The accepted proposals were price support for apple sales to ‘at risk’ markets, tree removal, replanting and reworking with approved varieties, production of rootstock material to assist growers in a replanting program based on red varieties, postharvest research and research into integrated pest control.

The WA industry considered it necessary to reduce Granny Smith production immediately by removing bearing trees. Departmental officers were closely involved in the tree-pull scheme. During the year more than 56,000 trees were removed and compensation payments for this and establishing new varieties reached $416,000. In 1982/83 some 83,200 apple trees were pulled and 12,000 reworked.

The department reviewed soil and fertiliser use in apple orchards, based on 20 years of research, and identified an appropriate basis for fertiliser dressings for tree health and cropping. It emphasised the need for a liberal and well balanced fertiliser program. It was also accepted that there should be a soil management system which combined ‘no till’ with strip herbicide spraying. This had proved better than the widely adopted clean cultivation practices.

The department also experimented with new trellised planting systems which reduced land costs and allowed for machine management of plantings.

A fruit variety improvement scheme was initiated under which trees were established at Stoneville Research Station as a source of true-to-type virus tested rootstocks. New selections of pome and stone fruit were tested after import from other states under quarantine. Departmental officers continued their involvement with industry in the development and testing of machinery to reduce the costs of operations such as pruning and harvesting. One such machine was designed as a mechanical harvester on the Tatura trellis.

In 1983/84 the Fruit Branch research strategy was based on industry needs for improved varieties, better production systems and improved storage, handling and marketing. This work was driven by close contact and discussion with fruit growers and with related industries. The main projects were:

- storage improvement, testing the proportions of carbon dioxide and oxygen required in controlled atmosphere storage
- investigation of tree training systems to bring younger trees into crop
- more flexibility in replanting with improved varieties, making harvesting easier
- the development of new varieties of all conventional fruit crops in order to replace poorly performing varieties or those with marketing disadvantages
- examination of alternative fruit crops. Kiwi fruit, pecans, non-astringent persimmons, Asian pears and a number of others were tested. This was the strategy for the remainder of the period.
In the mid-1980s there was limited distribution of the department’s new apple varieties Cripps Pink and Cripps Red for trial and evaluation purposes. These were seen as having excellent potential for export and proved highly successful. More than 1000 trees were distributed to growers. The fruit is now internationally renowned by the trademarked brand names Pink Lady™ and Sundowner™. In 1986 the Minister for Agriculture opened a new Horticultural Research Centre. The 107 ha centre was situated 7 km south of Manjimup in country typical of where a high proportion of the State’s quality horticultural crops are grown.

The report of 1986/87 referred to continued work on stone fruit and citrus varieties, opportunities with Asian pears and a number of other alternative crops, growing cherries on the Tatura trellis, and continued postharvest work with plums.

By 1988 the focus on market development through reducing the cost of export was having some results. Apples had been sent in bulk bins for some years. Now the focus was on container loads of apples to the United Kingdom either in bulk bins or bulk-filled containers. Containers packed with bulk bins would hold the equivalent of 570 cartons whereas a container bulk filled with apples would hold the equivalent of 700 cartons. Larger apples were still required to be forwarded in cartons. Experimental shipments of 50 containers in 1987 attracted some complaints but further orders were placed for 1988.

In 1987/88 on-farm trials were carried out using watering regimes during summer which had been developed on research stations. Yield improvements of 100 to 200 per cent were achieved as a result in the avocado industry. Avocados were being promoted for south-west coastal areas where underground water was available, but irrigation had to be managed carefully because of competition for water supplies and potential eutrophication.

Experiments in 1992/93 were expected to satisfy Japanese requirement for disinfestation of citrus, opening the market for mandarins, tangelos, ruby grapefruit and lemons.

The Cripps Red apple was released in 1985/86 under the trade name Sundowner™.

Exports of Pink Lady™ and Sundowner™ apples to Taiwan and Europe started the reinstatement of WA as an exporter. Exports totalled 60 tonnes.

As a result of inconsistent quality the plum industry started to lose its share in the South-East Asian market. The Summer Fruit Council introduced a quality management system based on maturity indices developed by the department. This increased exports by 20 per cent to around 200 000 cartons, coupled with an increased price.

**Vegetables**

Most vegetables were used in WA, with about one-sixth of the gross income coming from exports to Asia. At this time exports were increasing and had grown over the previous 10 years from about 1000 tonnes to over 4000 tonnes.

During 1992/93 the Horticulture Export Development Council implemented several initiatives. Several crops were examined to determine how to improve their export performance. A committee of user groups was established for discussions on policy issues with the airlines. It also investigated potential new markets in South-East Asia. Exports were largely melons, potatoes and
tomatoes with some new exports including a hybrid cauliflower.

Vegetable research centred around reducing the cost of production. The Vegetable Branch’s research focused on new varieties, fertiliser use, crop rotation, irrigation, disease resistance and marketing. Two new potato varieties, Geographe and Bremer, were released with the potential to lift yields by 30 per cent.

There was ongoing work on assessing the value of virus-free seed stock of potatoes. A serious problem occurred in 1986/87 when the potato cyst nematode was discovered at Munster. A further infestation was found at Munster in 1987/88, but no others and the eradication campaign was high priority.

The opening of a vegetable processing operation at Albany was an important development. The commitment of Edgell-Birdseye to establish a frozen French fry plant at Manjimup, designed to process more than 50 000 tonnes annually, was a major boost to the industry. These developments focused research into this expanding part of the industry.

In 1987/88, 61 varieties of potatoes, mainly yellow-fleshed, had been imported as tissue cultures for assessment. In addition, two varieties which were showing promise for export to Hong Kong and Singapore were produced to permit test-marketing. A major research program to provide a blueprint for production of French fry potatoes began together with work on a range of varieties and species of vegetables considered to have export potential.

Surveys had shown a large market for high quality seed potato sales in Asia, where the industry had increased by 400 per cent in the past 30 years. Possible markets included the Philippines, Thailand and Vietnam.

In 1992/93, in consultation with Edgell, the department investigated grower fertiliser and watering programs. They identified the opportunity for considerable savings on fertilisers and expected 35 per cent of the growers to adopt the new strategies, with a saving of at least $250 000 a year.

**Flowers**

There had been rapid expansion in the wildflower and general floricultural industries through the 1980s. In response, the department initiated a number of research projects on propagation, tissue culture, postharvest handling and nutrition covering all exported species. In 1983/84 the gross value of ornamentals and flower crops was about $30 million, including about $3 million from exports.

The wildflower export industry continued to expand. A total area of 1200 ha, covering many species, was under intensive cultivation. There was an estimated further 1000 hectares of wildflowers in State forests and on private land which were used for flower and foliage production.

In the period the department began experimental work with both Western Australian wildflowers and commercially-grown flowers for the cut-flower industry. This included studies into the intensive year-round production of species such as roses and gladioli. Trial work also began with Sim carnations in tunnel houses. This demonstrated the value of simple glasshouse structures in improving returns from carnations.

Opportunities for new export of Geraldton wax and Morrison as pot plants were investigated. The department also examined the development of a standard potting mixture for floriculture. It was involved with the selection of kangaroo paws for disease resistance, easier propagation, flower quality and a wider range of maturity times.

Fertiliser experiments were conducted on a range of wildflower species. This work continued, with investigation of methods of handling wildflowers after harvest, the value of native plant tissue culture, evaluation of various conventional methods of propagation of wildflowers and assessing the potential of a range of native species for commercial development. A national wildflower workshop was held in Perth and a wildflower field day.

Separately a home garden information section was established as a service to the
public. The centre, established in 1976, received 125,000 calls up to mid-1981. In 1981/82, 56,596 enquiries were received and in 1986/87 more than 37,000.

**Viticulture**

The viticulture industry was worth about $25 million in 1983/84. Wine was the dominant product, with table grapes worth $2 million and dried fruit $1 million. Over the period a well-established research program dealt with problems and opportunities for the industry including:

- testing of new clones and varieties of dried fruit, wine and table grapes
- studies of fertiliser requirements
- virus indexing
- herbicides for vineyards
- weed control and vine management
- development of vineyard establishment techniques
- evaluation of rootstocks, particularly for nematode resistance
- evaluation of the impact on quality of growing grapes in a protected environment
- examination of the role of cool storage at harvest in improving the quality of wine grapes
- demonstrations of windbreaks to protect plantings on properties of table grape growers
- demonstration that spur pruning of white grapes should be done just before bud-burst.

Research was also conducted on issues such as the causes of serious damage to early varieties in vineyards in the South West and dormancy studies on varieties at Margaret River which showed difficulties with limited winter chill.

The Swan Research Station played a major part in building up planting material for new varieties and the distribution of nematode-resistant rootstocks.

In 1977 the department had piloted the establishment of grape growing in the Manjimup district and this provided an alternative industry for some growers.

Fertiliser studies were also important to the industry. They were coupled with extensive leaf and petiole and leaf sampling which indicated a serious decline in major nutrient levels.

In 1985/86 fertiliser trials confirmed remarkable responses to both superphosphate and nitrogen on vineyards at Margaret River and Frankland River. An extension program was undertaken to encourage vignerons to start fertiliser programs using up to 2.5 tonnes of superphosphate and 300 kg of ammonium nitrate per hectare to correct fertiliser deficiencies.

A half-hectare environmental greenhouse for table grape research was completed. Work included testing table grape varieties introduced through quarantine. Dried fruit clonal selections were examined and two imported clones proved more productive than local selections. Imported varieties from the United States, as well as Australian-bred varieties, were released to industry after rapid evaluation and negotiation of distribution agreements.

Crimson seedless grapes were selected by the department.

Trial plantings of table grapes were made outside the Swan Valley. The Red Globe variety from the United States completed quarantine and was available to growers.
Grape variety recommendations were made to the industry based on market demand and likely return. Research showed that the leaf roll 3A virus could improve berry size in table grapes. Four Emperor clones, Queen and Flame Seedless varieties had shown berry size improvement of at least 11 per cent following inoculation.

Table grapes became more important as new varieties were imported and established. New and improved standards were developed to reflect consumer requirements. A variety and rootstock evaluation trial under irrigation at Manjimup demonstrated the potential to obtain high yields of good quality fruit from premium varieties grown in the area.

The viticulture section also conducted chemical analyses of wine for extension, research and certification purposes. During the year a wide range of commercial lines was analysed and advice given to producers. The industry was also supplied with propagating material from established clones of a wide range of grape varieties during the year. Buds, rootstocks and cuttings were distributed. Over the period the section provided comprehensive extension services to producers of wine, table grapes and dried fruits.

**Postharvest**

The postharvest section of the Horticulture Division was expanding its services to industry in relation to handling of fruits and vegetables and ornamentals. One of the research issues was the use of plastic film wrapping on melons. Others included the evaluation of plastic films which were claimed to absorb ethylene, calcium treatment of fruits to extend their postharvest life, prevention of flower abscission from Geraldton wax, and treatments of cut flowers to satisfy importers' quarantine requirements.

**Animal industries**

**Animal health**

The Animal Health Division continued to operate a number of important services for the State's livestock industries. These included processing applications for cattle tags, processing claims under animal compensation arrangements, diagnosis and advice on a range of stock diseases, inspection of abattoirs, diagnosis of diseases or nutritional deficiencies based on laboratory analyses, and quarantine and export inspection. These services resulted in laboratories receiving 54,000 specimens for testing during 1983/84.
A footrot eradication campaign had been in place for some years. In the early 1980s there was optimism that it was close to success. Unfortunately there was a substantial increase in the apparent incidence of the disease in the mid-1980s which required an intensive control program during the summer and autumn. This new outbreak caused widespread industry concern, with 293 properties in quarantine. Fortuitously a new test for virulent footrot—the protease test—had been developed which could differentiate between the virulent and the benign footrot types. This test was accepted nationally as the diagnostic yardstick for virulent ovine footrot. This greatly facilitated work on the problem.

The importance of the diagnostic and research work of the division was also apparent. In 1982 the toxin produced in annual ryegrass toxicity (ARGT) was identified in joint work with CSIRO. A new test was developed for leptospirosis and a live vaccine was developed for salmonellosis. Both these developments were relevant to human health.

Experimental work on cattle productivity suggested that there was a substantial reduction in liveweight of young cattle due to worms.

During the period brucellosis was eradicated from Western Australia under the national eradication program. The Kimberley was declared free in 1980, when no disease was detected there. By 30 June 1984 southern herds were tested again, confirming the area’s freedom. The whole State was declared brucellosis-free in February 1985.

The National Tuberculosis Eradication Program started in the south of WA in 1970 and southern areas were declared provisionally free in 1976. It was extended during 1981 to the Kimberley and restrictive controls operated on store cattle moving into the southern provisionally-free area from 1982. By 1984/85 the incidence in the region, estimated from abattoir samples, was 0.02 per cent. The program continued in the pastoral areas where the disease was found on three stations in the Pilbara and eradication procedures were put in place. Similarly, TB infection detected on farms at Albany and Mundijong was slaughtered out. The Kimberley achieved ‘impending freedom’ status in 1992.

Numerous tests were carried out in the departmental laboratory and during the 1970s it was found that less than half of the abattoir samples were positive for TB. As a result the laboratory embarked on research that improved the culture of *Mycobacterium bovis* and the precise identification of the organism using a variety of DNA techniques. It subsequently became the National Reference Laboratory for Bovine Tuberculosis in July 1992, giving it an Australia-wide role in ensuring the correct identification of TB in samples. In 1989/90 an infected beef herd was diagnosed in Harvey. The whole herd was slaughtered, together with all goats on the property. Five further herds were identified through traceback. In total, 475 cattle in two shires were slaughtered.

In March 1980 an outbreak of cattle tick fever on a property at North Dandalup killed 28 of 54 cattle. The previous recorded occurrence of tick fever in south-western WA was in 1922.

In 1987 a liver fluke-affected animal was detected at an abattoir. Through traceback to the farm of origin, officers identified a number of other infected animals on the original property and on a neighbour’s properties. Control measures were implemented and in 1989 eradication was claimed on the basis of farm inspection and testing with abattoir traceback as a safety net.

In 1988/89 a decision was taken to quarantine deer from New Zealand. Concern was held about the possible import of a parasitic worm, *Elaphostrongylus cervi*. In 1989/90 an animal was detected with the parasite and appropriate action taken.

In 1990/91 the animal health programs were assessed, based on an analysis of outcomes against objectives. A set of performance
indicators was prepared and the issues and trends outlined. This analysis showed that in the cattle industry there was a need to place emphasis on the Pilbara region in the National Tuberculosis Eradication Campaign.

Falling wool prices increased the need to promote the financial benefit of the eradication of lice and footrot in sheep. The improved focus provided by the protease test facilitated this. In addition, a range of animal welfare issues needed to be addressed.

**Dairying**

The 1970s was another period of rapid adjustment in the dairy industry. In March 1971 there were 815 farmers producing milk and cream for manufacture and 558 farmers producing milk for the domestic milk market; 55.8 million gallons (251.1 million litres) of milk were produced for all purposes. This was significantly lower than the record year of 1964/65 of 62.4 million gallons (280.8 million litres).

By March 1980, 38 dairy farmers were producing milk or cream substantially for manufacture and 585 farmers producing market milk. A total of 48.5 million gallons (218.3 million litres) of milk were produced. These changes reflected both adjustment in the industry and the increased use of milk for market milk and special liquid milk-based products in response to the change in dietary habits, with the community using margarine instead of butter as their preferred spread.

In 1979 the department opened a new laboratory in Bunbury, which provided the opportunity to modernise herd recording. Farmers were offered a wider range of services and owner-sampling was introduced along with an extension effort to increase use of the scheme. Farmers using the scheme rose from 26 to 42 per cent over two years.

A survey of farmer use of the herd recording results showed that 54 per cent used them for mastitis control, 31 per cent for knowledge of yield, 43 per cent for feed requirement, 46 per cent for culling and 38 per cent for breeding. In 1986/87 under the Dairy Herd Improvement Scheme more than 27 000 cows were tested, representing 40 per cent of the State's cows from 47 per cent of the herds. The dairy feed service continued to offer comprehensive information on the most profitable feeding strategies.

As the focus of the industry shifted from butterfat to whole milk, Friesian cattle became the dominant dairy breed.

There was continued focus on the quality of milk. This had always existed but with the change in the 1960s to whole milk collection and the modernising of the facilities on farms greater progress was made through the 1970s and 1980s. In the dairy industry the average standard plate count for all farm-level milk received in WA had dropped from 31 000 to 23 000 cells over the two years to 1980/81 and reduced further in 1981/82 to 18 000 cells.

The department surveyed iodide levels in milk which could originate from the iodophor disinfectants used in cleaning milking machine equipment. During the 18 months, 9 per cent of the tankers sampled contained more than the arbitrary safe limit for iodide. After consultation with farmers the levels dropped substantially to well below the standard.

Pasteurised milk showed a high level of compliance with standards at the treatment plant but the level of compliance at shops averaged between 76 and 82 per cent. This
was reflected in surveys which showed that a significant proportion of product in the shops did not meet the best keeping quality standards to conform to the use-by date.

Although testing showed that the quality of WA milk had improved and was extremely high by Australian standards, the Dairy Branch continued to focus on quality. In February 1987 a new milk quality scheme was introduced. Under the scheme milk from a dairy farm was sampled twice each month by tanker drivers and the sample examined in the laboratory. If a dairyman had more than three bacterial counts greater than 50,000 per millilitre in any 12-month period, a price penalty was imposed. The penalty increased with the number of counts over 50,000 in any 12-month period. It was found that 20 to 30 per cent of all high counts were caused by mastitis pathogens. Under this program there was a steady reduction in bacterial counts to an average of 14,500 cells per millilitre.

The traditional work of the Dairy Branch in maintaining the quality of dairy produce and milk produced on farms ceased in 1987/88. The branch became responsible for dairy research related to farms and product development. The Dairy Industry Authority became responsible for quality controls, using price incentives. A senior member of the department's staff was transferred to the Dairy Industry Authority to set up the arrangements for quality control.

The advisory role on quality to farmers remained with the department. There was a focus on mastitis control even though WA milk was shown in 1991/92 to be the best in Australia.

During the period the branch developed a whole dairy farm model which optimised the use of all dairy resources and activities together, to give the best financial performance for the individual enterprise.

The 1990/91 report refers to the development of a computer program, Dairyfeed, which helped producers to make decisions about grain purchases.

An analysis showed that in the late 1980s the structure of the industry was much better in WA than in other states. WA dairy farmers had a cash operating surplus 40 per cent above farmers in any other state and they supplied more milk per farm. A three-tier milk pricing structure enabled them to produce the quantity of milk for which there was an economic market. Significant sideline activity accounted for more than 30 per cent of their total cash receipts and production per cow was higher due to better feeding practices.

Research was undertaken to improve the effectiveness of the protein in lupins fed to dairy cows. This work aimed at reducing degradation in the rumen. If this was achieved it was expected to increase the demand for lupin grain and would improve animal productivity.

The branch also continued to provide advice to factories, which was particularly important to smaller factories and milk processors. Even larger factories with their own technical staff made use of departmental officers.

During the mid-1990s considerable interest developed in the establishment of a sheep dairy industry in WA. A key was to develop potential producers and processors at the same time. This was difficult and the industry did not develop.

During the late 1980s and early 1990s dairy industry study groups developed in a number of centres. Beef groups also developed and were a valuable means of information exchange. The Margaret River group attracted 250 farmers to its activities during 1992/93.

Analysis showed that the rapid growth of the dairy industry between 1989 and 1994 had been driven by the adoption of the department's advice and services. Milk production per cow rose from 3,773 to 4,690 litres and total production rose from 245 million litres in 1988/89 to 344 million in 1993/94. This compared with the record 1964/65 production of 280.8 million litres when the number of dairy farmers was much higher.
**Food technology**

Work by the Food Technology Branch had shown that animals which suffered reduced stress were likely to yield meat which stored better. It was also shown that pig skins could be tanned into attractive leather provided the fat and bristles were removed early in the tanning process.

Apple crisps which were sliced and dried without other sweetening or flavouring were produced. There was some interest from commercial producers in this product.

The group also looked at the colour of peanut shells. Retailers were concerned that peanuts from the Ord River lacked the traditional brown shell of peanuts from Queensland. They found that the brown colour could be produced if peanuts were treated with ammonia gas just before roasting.

In the mid-1980s the Food Technology Branch was investigating better use of sheep skins, developing a pork product for the Singapore market, examining the possibility of automated carcase break-up of pigs and lambs, and examining livestock handling issues which affected the taste of meat.

In 1987/88 they investigated producing paper from barley straw and concluded that a 50 000 tonne unit would be economic.

In 1990/91 there was reference to industry taking up the work on sheep skins.

In 1985/86 the branch was involved with further work on finishing Kimberley cattle. Fattening Brahman cross cattle from the Kimberley was seen as a means of increasing the productivity. Indications were that Kimberley cattle with a higher proportion of Brahman blood would fatten satisfactorily but at a slightly higher weight. By 1990/91 the department was satisfied that a reliable system for finishing pastoral cattle in the south under both grazing and feed-lot conditions was available. A full-scale extension program taking in all beef producing areas was conducted, resulting in a very large increase in the number of cattle brought south for finishing. In 1992 it was
found that finishing Kimberley steers was more profitable than finishing south-west steers.

By 1990/91 a long-term program on the Ord River Research Station had shown that substantial gains in efficiency and profitability were possible through improved weaning practices. Weaning at both the start and end of the dry season increased branding percentages from around 45 to 85 per cent. In addition, cow mortalities were reduced from around 18 to 9 per cent. Breeding from Brahman bulls also increased the growth and survival of calves. A number of producer demonstration sites helped in the promotion of this management concept. In 1991/92 it was reported that this approach, which had been well demonstrated on the pilot properties, was being adopted in whole or in part by a number of other properties in the Kimberley.

The beef genetics and technology experiment at Wokalup Research Station had opened the way for planning an embryo-based selection system which had the potential to double the rate of genetic progress in a breeding herd.

It was shown that some urea fertiliser could provide both a useful elemental supplement and control the daily amount of grain supplement accepted by cattle from the self-feeder. In common with the dairy industry there was a focus on reducing the degradation of the higher protein content of lupins in the rumen.

In line with the policy of developing computerised models for complex estimates, a profit-maximising beef cattle feeding model was nearing completion in June 1985.

During the period there was a general thrust across Australia for the development of a carcase classification system for the beef industry. A system was established but research continued, seeking a system which gave an accurate estimate of fat distribution through the carcase. In WA a carcase classification group was established to develop and promote the use of objective description for the marketing of livestock carcases and meat. The officers monitored carcase classification in abattoirs, trained abattoir personnel in using the system and sponsored the introduction of market development by specification and branding for both the domestic and export trades. A survey of the beef industry in March 1981 showed that the classification was firmly established at the retail and wholesale levels of the industry.

In 1986/87 a new national industry body responsible for product description and quality assurance, called Aus-Meat, was established. It saw WA as having the most comprehensive and complete system for carcase classification of any state and requested the department hand over responsibility for monitoring the various schemes. Two officers were seconded to Aus-Meat to assist with its early work.

In 1993/94, work on the use of a feed additive, virginiamycin, had shown it reduced the gram-positive bacteria in the gut of an animal. These bacteria produce lactic acid, which can cause grain poisoning.

Other work with beef cattle showed that silage is a better way to conserve high quality roughage than hay. It is easy to store without deterioration if conserved properly.

**Sheep industry**

Generally the sheep industry in Western Australia was in good condition through the 1970s and 1980s, following the price recovery in 1972. Production levels were affected by difficult seasons such as 1980/81 and 1983/84 but were generally satisfactory. Major concerns were annual ryegrass toxicity, facial eczema and sheep lice. Lupinosis continued to be important and there was evidence that it could be avoided if the lupins were made into hay. However, the collapse of the price support scheme in 1990 ushered in a very difficult time for the industry. Increased intensity of cropping, driven by the changed cropping systems and relatively high returns from grains, caused sheep numbers to fall sharply by 1995.
During the 1980s the research and extension activities of the Division of Animal Production were in the following areas: sheep nutrition and reproduction, the effects of worms on productivity, the use of hormones to increase fertility in ewes and growth rates in wethers, the behaviour and management of sheep in export feedlots and during shipping, pastures and the grazing animal, selection for fleece-rot resistance, feral goats and cashmere production, methods of grinding shearing combs and cutters, prevention of acidosis (sometimes called grain poisoning), dust in feedlots, the impact of nutrition on wool growth in autumn and the value of ammonia-treated grain to increase protein content.

A computer model was developed to help with vital decisions such as how many sheep to run in a paddock, and how much phosphate fertiliser to apply. The model looked at prices and costs and calculated the point of optimum return based on wool production as influenced by the effect fertiliser rate and stocking rates had on pasture production.

In the sheep industry the footrot eradication program continued, with varying numbers of properties quarantined at any one time. In December 1985 the live export holding yards were declared quarantined areas, which gave farmers an outlet for healthy sheep from properties which were in quarantine. In 1988/89 the footrot program was set back by a major outbreak in the high rainfall areas from Boyup Brook to Augusta. The number of properties under quarantine doubled to 113, which was about 1 per cent of the sheep farms in WA.

A study of diseases affecting sheep during live export to overseas markets indicated that a range of diseases, probably present before the livestock came on board, became evident when the sheep were placed under stress. The cause of death was largely due to starvation (about 50 per cent), salmonellosis 25 per cent, loading injuries 10 per cent and deaths due to the farm of origin 5 to 10 per cent. Problems due to actual transport appeared to be negligible.

Extensive resistance to the nematicides used to control worms was found in many sheep flocks. Resistance of the barber’s pole worm in particular continued to be a problem for many sheep flocks. A survey of farms by private veterinarians showed that 83 per cent of farms had worms resistant to the chemicals used for drenches in sheep flocks in 1985/86. In 1986/87 a major campaign was launched in an endeavour to control the incidence of resistant worms on farms. Management was recommended as a control measure with drenching onto stubble paddocks in summer proving effective in achieving control.

The Animal Health Laboratory was investigating the congenital disease causing muscular dystrophy in sheep. As part of this program the laboratory entered into a cooperative project with Queen Elizabeth II Medical Centre.

In laboratory studies researchers were trying to develop a simple blood test which could identify flocks infected with cheesy gland. By 1985/86 considerable advance was made in developing this test, which was highly sensitive in detecting infected animals.

Development of a vaccine for dermatitis was being worked on, but by 1986/87 no definitive results had been achieved.

It was demonstrated that while zinc was an essential element, toxicity could also be developed; this had also occurred in the United States. Researchers were checking on the likely causes of lameness among young sheep fed cereal grain for long periods. Lack of calcium in the diet appeared to be a contributor.

During 1986/87 legislation was passed requiring sheep producers to contribute to a fund for lice eradication. This program involved routine testing of clips, formation of wool producer lice eradication groups within each shire and assistance to owners to eradicate infestations. This work was funded by a contribution of $50 from each grower. In 1988/89 some 75 500 wool samples were examined. In 1987, 36 per cent of the flocks...
had lice; in 1988, 32 per cent and in the third year 28 per cent.

Experiments with crossing Booroola ewes with ordinary Merino rams were generally unsuccessful because of the higher death rates of newborn lambs which were twins or triplets. This indicates the difficulty of managing multiple births among Merino mothers in an extensive farming system.

The 1988/89 report refers to the use of two products—fecundin and regulin—which increased lambing percentages by up to 40 and 25 per cent respectively. Fecundin affects hormone balance and increases the number of eggs released and twins. Regulin improves the conception rate of ewes and also increases the number of twins.

Separately, work showed that the body weight of ewes at mid-pregnancy was an important factor in lamb survival. At the time some two million lambs died in WA each year between lambing and weaning.

Experiments with sheep subjected to very cold conditions immediately after shearing showed that covering with a plastic cover was sufficient to protect them from death but if uncovered they could only maintain body temperature for about 10 hours.

Researchers identified six separate causes of a white muscle in carcases. They showed it could be due to selenium deficiency, lupinosis, vitamin E deficiency, muscular dystrophy, over-driving of sheep or an unknown cause apparently associated with unsupplemented cereal diets.

In 1986/87 research showed that an additive, flavomycin, could increase wool growth by as much as 20 per cent without increasing fibre diameter. The additive could also increase the liveweight gains by up to 30 per cent. The department lodged a patent application for use of this additive. Progress in commercial development of devices which slowly release the additive to grazing animals made this technology technically feasible.

Work using stubbles for sheep feed had shown that location, species and variety can all affect the digestibility and chemical composition of the straw. This work continued through to the end of the decade.

The first half of 1990 was a difficult time for the department and the industry. Wool prices fell throughout the wool selling season and large surpluses were accumulated against the original reserve price. The reserve price was lowered to 700 cents per kilogram and finally abandoned in June. The Wool Corporation was subsequently abolished, together with its associated organisations. There was also a disruption in the live sheep trade to the Middle East, which was not resolved by the middle of the year. These problems resulted in the department having to work with farmers throughout WA in devising strategies to deal with the reduced income from sheep.

In 1990/91 the Sheep and Wool Branch was reorganised into seven programs covering research objectives, as opposed to generic grouping into disciplines. These programs were analysed for industry benefit and it was concluded that increased lambing percentage and decreased fibre diameter were likely to give the greatest benefits. It was not stated whether this conclusion was different from what might have been arrived at by simpler means.

A major innovation in response to the collapse of the wool market in 1990 was the development of a Wool Industry Strategic Extension Program. This was developed to extend the immediate and long-term implications of the wool industry changes to wool growers. To support this program 33 Farmnotes were prepared and distributed to 190 advisers and private consultants from December 1990 to May 1991.

Some pen work with sheep grazing salt-tolerant plants showed that a mixture of half saltbush and half chaff gave the best result. It seemed to confirm farmer experience that giving sheep access to dry pasture as well as saltbush gave best results.

At the Animal Breeding and Research Institute the main issues were comparison of
Merino strains and, in a cooperative project with Merino breeders, breeding higher fertility Merinos. As a result 450 potentially high producing sheep were transferred to the institute as foundation stock. The institute also carried out embryo collection and storage which advanced that process. It was also developing a pilot reference scheme for stud Merino rams. This process systematically tested young rams against reference sires from many studs, to allow researchers to accurately compare rams from different studs.

By 1984 the institute had five registered studs. These were the 'Bred to Breed' studs and 'Body Weight' studs with horned and polled selections. The fifth stud was the base flock. These flocks were providing semen back to the participating studs. Special mention was made of the sire referencing program. While this was controversial, it was considered that the results revealed important issues which the industry could not reject.

Demand in other states had resulted in valuable links with the WA scheme. The scheme identified rams of superior breeding value, which might otherwise have escaped the industry's attention.

Research was undertaken to determine if there was a genetic basis for the production of tender wool in Western Australia. Work on ewe and weaner nutrition and on immunisation to increase fertility was also undertaken.

In 1992 it was reported that long-term trends showed that 10 more lambs were obtained for every 100 ewes joined than in 1960 and 0.6 kg more greasy wool was cut per adult sheep at stocking rates similar to those of 30 years ago. Tender wool proved to be a problem at wool sales, with 36 per cent of the offering affected. This had been an issue ever since a substantial industry was established.

Early results from a large-scale grazing project at Tenindewa on a red clay loam soil showed that Parabinga barrel medic and a mix of Serena and Santiago burr medics produced 50 per cent more dry matter than Cyprus barrel medic. Parabinga also produced 110 per cent more seed than Cyprus and 40 per cent more than Serena/Santiago. These results suggested that the new medic was capable of carrying 60 per cent more sheep without penalties in wool production and liveweight than Cyprus pastures.

In 1993 the department joined the Cooperative Research Centre for Premium Quality Wool. The centre was established to look for ways to strengthen wool fibre. Separate research at the Animal Breeding Centre indicated that fibre diameter distribution is a heritable characteristic which can be selected for.

The CSIRO wool research laboratory also showed that tender wool could be processed as well as other wools if the settings on the card were appropriate.

Work with phomopsis-resistant lupin stubble showed that this was a good diet for weaners. It was calculated that if half of the seven million weaners were grazed on lupin stubble it would yield an extra $15 million for the industry.

In 1993/94 it was reported that a vaccine for lumpy wool had been developed and was being field tested.

### A possible goat industry

In the early 1980s there was an international shortage of cashmere fibre, raising interest in the development of an industry in WA. A survey of the State's feral goat population suggested that nearly a million goats producing varying amounts of cashmere could provide the potential for breeding and selecting for top-quality cashmere production. A trial carried out with progeny of unselected feral does mated to upgraded cashmere bucks from New South Wales gave varying yields. These ranged from 1 to 140 grams, as many of the goats had shed their cashmere before shearing.

In 1984, bucks from three sources—Bernier Island, Faure Island and commercial
sources—were mated to mainland feral does. All progeny were monitored for liveweight performance and fibre production. Preliminary data suggested that at nine months old progeny from the island sources grew longer down and produced heavier weights of down, while their mean fibre diameter remained similar to that of the progeny from commercial bucks.

In 1986/87 it was reported that an estimated 60 000 goats were being farmed for cashmere in the agricultural areas and that numbers could reach between two and three million by the year 2000. During the year WA growers dispatched 5 tonnes of goat fibre to the Australian Cashmere Growers' pool when total Australian production was 38 tonnes.

Research projects in progress included genetic improvement using goats captured from the offshore islands, the use of goats in saffron thistle control and examination of the impact of goats on vegetation in the pastoral zone. Early indications were that goats had a lesser impact on more palatable species in the pastoral zone, as they spread their grazing over a wider range of species.

In 1984/85 a new disease, caprine retrovirus, was identified; it was affecting the export market for some goats.

The 1988/89 report referred to the development of a premium quality young goat meat market in both Australia and overseas. This resulted from an industry development program undertaken by the department. A trial shipment by air of chilled product was well received in Italy. It was forecast that between 10 000 and 15 000 carcasses could be available over 12 months.

In 1991 a decision was made to eradicate goats from the pastoral areas. The population was unknown but estimates were as high as 2.5 million. In the first year 450 000 were captured. Suitable animals were sent for slaughter and the remainder shot.

In 1993 mohair and cashmere prices fell to very low levels. Between 1988 and 1993 the number of goats on agricultural properties fell by 45 per cent.

**Pig industry**

Work by the Intensive Industries Branch continued on lupin kernel meal and sire referencing in the pig industry. Carcase quality issues were being examined. The Animal Health Laboratory confirmed that the industry in WA was carrying a severe form of atrophic rhinitis. This problem caused twisting of the snout and bleeding and could affect growth rate.

In 1984/85 the group continued its service to industry by testing pigs for growth rate, depth of fat and providing a selection index. Almost 9000 pigs were tested under this program. Highlights of the research program were the sire referencing and evaluation pilot study and a study of lupin seed digestibility. Separately an investigation of a dietary enzyme response was initiated. In this investigation, growing pigs were fed restricted diets, including a protected dietary enzyme. There was significantly improved feed efficiency and growth rate. It was proposed to examine whether the growth rate change was due to increased energy or increased amino acid supply.

Research reported in 1986/87 for the pig industry referred to the study of initiation of early puberty in young female pigs. It had been found that exposure to a mature boar stimulated puberty. An investigation was started to determine the underlying reasons for the boar effect. Carcase classification was another area of research. A pig health monitoring scheme implemented in 1987 identified the major diseases present in WA pigs.

Researchers were also examining the effect of levels of nutrition on the speed with which sows returned to heat after weaning. They were particularly interested in the mechanism which caused better-fed sows to come into heat earlier.
Poultry
The main work in the Poultry Branch continued to be related to feed issues. One special issue was the effect of lupin meal in increasing the moisture content of droppings. It was estimated that if this could be overcome, the use of lupins would be greatly increased. Research showed that low nutritional density reduced egg production. The value of lupin seed as an alternative to meat meal was also investigated. Differences in the lupin meal from different varieties were tested because lupin meal is a major component of feed within the industry. The conclusion of this work in 1984/85 showed that lupin seed of either species was a suitable replacement for part or all of the meat meal in a layer ration.

Work was also undertaken on the use of a protected enzyme in increasing the efficiency of feed in broiler rations. Field peas were tested as a protein source for layers. A possible alternative yolk colour additive in an algae from the Pink Lakes, near Esperance, was investigated. A preliminary trial tested rapeseed meal from a new variety but it appeared to slow growth rates on chicks from day-old to six weeks old.

In the poultry industry the production of eggs was balanced to domestic demand through a licensing system introduced in the early 1970s. While the laying industry marketed $24 million worth of eggs, the chicken meat industry grossed more than $60 million.

A problem of bruising of chickens during the early stages of processing was examined in 1984/85. It was shown that this was caused within 12 hours of entering the processing chain and almost certainly during the catching and transporting process.

Egg marketing was deregulated in NSW in 1989, which made deregulation in WA inevitable. In 1992 it was reported that South Australia had been deregulated and the WA industry subsequently followed.

The industry was faced with the introduction of a new code of practice, which could increase production costs. The department was to study the impact of this change on the birds.

Emu farming
Emu farming was identified as a potential livestock enterprise. By 1989/90 there were 18 commercial emu farms in WA and a research unit was established at Medina. This followed a department initiative in facilitating negotiations between a number of government departments to remove regulatory barriers which previously prevented farming. There were early indications that there was a good demand and acceptance of emu meat and that the leather and the eggs were also in demand on both the domestic and export markets. The trial flock established at Medina Intensive Industry Station produced 20 eggs per season compared to the normal 10.

Research on feeding and management provided standards for the industry. The Department of Agriculture helped the working party by carrying out taste tests, while the Health Department considered health issues. The conclusion was that the meat would be accepted by the public and would not present a health risk provided normal processes were followed. In 1993 the first product became available and contracts were signed for sales of $6 million. The department worked on reducing skin damage and improving the marketing of meat. As part of this work it moved to have a series of cuts officially registered for national use.

Kangaroos
There was also a move to have kangaroo meat approved for human consumption. An earlier report from a working party had shown that a consumer taste panel had assessed kangaroo as being acceptable. The health assessment found there was no danger provided the meat was prepared to agreed standards. On this basis action was taken to legalise the sale of kangaroo meat for human consumption. This required amendment to the Health Act to allow
ministry inspection protocols to be put in place.

**Apiculture**

The work of the apiculture section focused on flora regeneration and queen bee production. The queen bee unit was the largest unit in the world, due to Western Australia's disease-free status. In 1984/85 the breeding program, which had been in progress for five years, had developed superior stock, and the section was distributing this breeding stock to the industry.

There was an interest by beekeepers in the department making a subjective assessment of the cost of production. A subsequent survey indicated an average reduction in financial liquidity from 92 to 28 per cent in the industry over the previous two years.

**Aquaculture**

In 1987 the Fisheries Department sought assistance in providing a health service to the growing aquaculture industry.

**Resource management**

**Rangeland management**

Rangeland management in the semi-arid pastoral country and the Kimberley was an important component of the department's work over four decades. Mineral exploration and mining, tourism, cattle shipment and cattle grazing were the major forms of land use in 93 million hectares of pastoral rangeland in Western Australia. The low and variable rainfall which characterises the environment meant that recovery of the soil and vegetation was slow after disturbance or excessive use. Over half the WA cattle herd was in the pastoral areas. The productivity of these animals fell well below the potential demonstrated by research.

Improvements resulted from the introduction of *Bos indicus* blood lines but more intensive management was required to achieve potential productivity.

The Resource Management Division was in a position to give rangeland management advice to 450 separate pastoral businesses. Officers had surveyed about 500 000 sq km of station country for vegetation types and rangeland condition and had produced quality maps plus guides for future use by a sustainable pastoral industry. These surveys provided the technical information, resource maps and documentation needed for both stock management and mining operations. A monitoring system covering many of the land systems was introduced.

In 1983/84, work included the use of the restored catchments for grazing management studies at the Ord Regeneration Research Station. A new grazing study at Carnarvon was established to determine the stocking rate which could be applied to Gascoyne bluebush pastures in good and poor condition. Monitoring of range condition in a number of areas also began.

Computer-based economic models were developed which could be used with portable computers in the field. Other models were developed by the University of WA and CSIRO.
sustained with proper management. In 1982/83 the government committed to undertaking this regeneration and voted the necessary funds. A soil conservation district was declared and soil conservation district committee was appointed to oversee the project. Work began later in 1983.

On the Ord River catchment, the western side of the river was protected by fences and a major destocking program began in 1984/85. Nearly 12,000 cattle were removed. At Kununurra, the shrub leucaena was tested as the basis of intensive cattle grazing under irrigation. Fitzroy River regeneration work was continued, with eight cattle stations taking part in a major regeneration scheme.

A large-scale grazing trial was undertaken in the mulga zone north of Kalgoorlie to determine the impact of goats on the vegetation. Investigations were also carried out of the impact of sheep grazing on a mulga association in the area and a trial was established to test the effect of grazing sheep on the species composition. A monitoring program to measure vegetation change was also established in the Carnarvon basin. Extension work with the pastoral community was continued, largely based on the importance of sustainable management of the pastoral resource.

Through National Soil Conservation Program funding, the Murchison land management project was in its second year. The previous year had seen a good response from pastoralists. The work was helped by a survey of the range resources which described some 47 per cent of the 70,000 sq km catchment to be in poor range condition. Of this area, 1400 sq km was severely degraded and eroded. The indications were that the members of the Murchison Land Conservation District were beginning to address land management strategies to promote sustainable land use. At the date of reporting over 30,000 of 47,000 sq km were covered with range monitoring sites. The remainder were to be covered in the following year.

**Landsat technology**

In the area of soils, water and land use, Landsat imagery was being used in resource management and conservation. It was also examined for identifying saline areas. Farm plans were produced and a rangeland survey was carried out in the Exmouth and Shark Bay areas. Further surveys were completed in the Gascoyne, Ashburton, west Kimberley and eastern Nullarbor. This Landsat technology had also proved valuable in identifying areas affected by waterlogging in the Great Southern. The 1989/90 report referred to one 27,000 ha catchment in the agricultural areas where about 32 per cent of the crops were affected by waterlogging, with yields less than one-fifth of those of the unaffected crops. It seemed likely that in the upper Great Southern waterlogging cost cereal farmers tens of millions of dollars each year.

Pastoral property management plans had also been important, as had rangeland monitoring of the management sites.

After a review of siltation of the Ord River dam the department was commissioned to develop a management plan for the Ord River catchment with the long-term aim of achieving a reduction in the silt reaching Lake Argyle. It was anticipated that a draft for comment would be available by the end of 1992. The study reported in 1992/93 showed that 80 per cent of the silt from the Ord catchment came from channels and gullies rather than sheet erosion.

In the broader catchment, management plans based on station plans were being developed. Plans for the stations along the Broome coast were completed and it was anticipated that plans for the Ord and Fitzroy catchments would be completed in 1992/93.

A positive aspect of the department's ongoing planning and infrastructure development program was a dramatic improvement in range condition of the Fitzroy River frontage since the 1980s. Despite the recent period of drought this improvement was a direct outcome of reduced grazing pressure, and infrastructure.
expenditure of $15 million. The infrastructure included fences and water supplies and resulted in about 500,000 ha of river frontage land being totally destocked or being under a system of strategic grazing management.

To help pastoralists manage their rangelands, the department developed a grassland monitoring system which provided detailed information on condition trends of the State’s grasslands in the summer rainfall pastoral zones.

In 1994, resource inventory surveys of the east and west Kimberley had been completed on 65% of the leases. Surveys of 80% of the productive leases were completed and 40% of the leases in the north Kimberley.

Also in 1994, four land conservation district committees had been formed in the Kimberley. Through group meetings, field days and the provision of group leadership training, a sound foundation was developed for a unified industry working effectively towards the goal of sustainable land use and sustainable profits.

**Soil conservation**

Soil conservation legislation was amended in 1982 to strengthen its provisions and provide for the formation of landcare groups within soil conservation districts. An attempt was made at that time to obtain an in-built land tax to fund soil conservation work, but was rejected by the government backbench.

In 1983/84, 15 soil conservation districts were formed with another 10 proposed. This increased focus was doubtless driven by the serious wind erosion on the South Coast following the 1983 drought. In 1984/85 a further 24 districts were formed, with another 28 proposed. These districts and the associated advisory committees played a major role in providing a focus for soil conservation. In June 1988 there were over 80 soil conservation districts established or in the process of being formed, 11 of them in the pastoral areas. The National Soil Conservation Program provided substantial funds and a major boost to soil conservation activities in WA.

By 1990/91 there were 129 land conservation districts either gazetted or in the process of gazetted with more than 80% of agricultural and pastoral areas within the boundaries of these districts. Smaller catchment groups were also developed within the larger districts. The focus was on sustainable land use and there was a heavy demand for land resource information, particularly specific hydrogeological advice. High water use agronomic and vegetation options to reverse hydrological imbalances were needed. There was increasing demand for advice from other departments, particularly the Environmental Protection Authority and the Department of Planning and Urban Development.

In 1984/85, geophysical methods developed for the mining industry were being used in studies of salinity, remote sensing continued to be used in the study of land use, and the grazing value of halophytic shrubs was further tested under a range of stocking rates.

The results of work on dune stabilisation and extensive studies of on-farm water supplies were reported. Soil conservation research workers were developing a coastal lands classification and land use capability system. They planned to provide various government departments and private agencies with advice on planning and management of coastal regions, particularly beaches and dunes.

During 1984/85 the Commonwealth Government allocated $611,000 to WA for soil conservation work under the National Soil Conservation Program. The work covered included construction of earthworks, regeneration of degraded pastoral lands, development of solutions to land degradation problems, estimates of the cost and extent of land degradation, studies of agronomic options to reduce salinisation, examination of the causes and management strategies for wind erosion, development of a system of land evaluation for rural residential
development, employment and training of officers, development of a quantitative basis for recommendation on methods of surface water control, studies on the extent of erosion on land planted to vegetables and land degradation in a lupin–cereal rotation. These programs fitted the aims of the national program, which were:

- that lands be used within their capability
- that decisions and activities be based on whole catchment/regional land management concepts
- that all land users and governments meet their soil conservation responsibilities
- that effective cooperation and coordination develop between all sectors of the community
- that the whole community adopt a soil conservation ethic.

In 1985/86 the soil conservation program investigated the erosive potential of rainfall, the development of seepage-intercepting drains to control waterlogging on flats, the effect of flood control structures on the groundwater level in associated soils, land evaluation for tourism and urban development, the protective effect of stubble on wind erosion, the impact of gypsum in improving the structure of degraded heavy soils, and the cause and effect of compaction layers in areas of loamy sandy soil.

There was pressure on the industry and the department to formulate and implement agricultural production systems which were profitable, but not degrading in the long term. In 1984/85 further studies of the water erosion of vegetable growing soils in the Manjimup and Donnybrook areas were undertaken. There had been concern for some years that cultivation by potato farmers on sloping sites had resulted in severe water erosion. The requirement to deal with such issues resulted in the department diverting resources increasingly to the general area of landcare. Country officers were involved in servicing a remnant vegetation scheme, notifications of intent to clear, land use assessments for planning purposes and the support of the land conservation districts. The Soil Conservation Branch's activities during 1987/88 included:

**Land capability assessment**

Land capability assessment had become a major additional activity over the previous three years. It involved collecting and using soil survey information, and interpreting properties of the soils to determine if they were suitable for specific land uses; this could be for farming or other forms. The information collected could finally be transferred to a computer-based geographical information system which was capable of generating maps and plans from that information.

There had been an increasing demand for soil survey data and land capability assessment. This was expected to expand further, as the State Planning Commission had released a draft rural subdivision policy which was based on land capability assessment. If this was accepted, all new local government authority planning schemes would require assessments of land capability.

By 1990/91 four land information and assessment surveys had been carried out. These were in the Darling Range, Busselton/Margaret River/Augusta, Geraldton for rural residential, and horticulture in the Swan Valley. The outcomes of these assessments were incorporated into the Landman farm planning initiative.

Sixteen catchments in the South West were selected to test the effectiveness of altered land use on catchment water balance. The preliminary work required a soil survey, geophysical survey and the installation of 145 piezometers.

**Waterlogging in the upper Great Southern**

Based on Landsat imaging and other evidence that waterlogging was the cause of lower than expected crop yields in some
higher rainfall areas it was decided to examine the extent of waterlogging in the upper Great Southern. Some 200 shallow wells were installed. These were monitored to determine which parts of the landscape were most susceptible. Overall the most severely affected areas were the floodplains beside the Hotham River. The next most waterlogging-prone landscape unit was on the duplex soils of the hillslope. Some 60 per cent of shallow wells recorded some waterlogging during 1987, which was a lower rainfall year. The most effective discrimination of waterlogged areas was achieved with an airborne multispectral scanner which measured the light reflected back from the soil and plant surfaces. This instrument showed that about 33 per cent of wheat and oat crops grown on the soil were affected by mild waterlogging despite the dry year.

**Wind erosion**

Dry conditions in the winters of 1983 and 1987 resulted in poor pasture growth and overgrazing in some areas during the summer. This gave rise to extensive wind erosion. Studies of the amount of stubble needed to be retained in an area to counter wind erosion found a variation between species; estimates were 750 kilograms per hectare for cereal and 1500 kg/ha for lupins. Pea stubbles proved to be poor protection because they did not remain anchored in windy conditions.

A new device was developed to assess the amount of soil detached in various farming operations. It showed that heavily grazed light land had 41.45 tonnes of soil per hectare detached and vulnerable to being blown away. Clover seed harvesting on the same type of soil resulted in the detachment of 101 tonnes per hectare.

Personnel were required to develop farming practices to overcome this problem, which was particularly serious where it was aggravated by water-repellent soils. The wind events during 1987/88 increased concern that current land management systems were not capable of sustaining the land resource.

**On-farm water conservation**

The Irrigation and Water Resources Branch continued its work on on-farm storage. Good rains between August 1985 and February 1986 resulted in the conservation of a large amount of water in large earth tanks. In 1981/82 the department had purchased a reverse osmosis desalination unit to test its capacity to convert saline water to water which was suitable for household and stock purposes.

In 1984/85 work on conserving and managing water supplies for the drier and more difficult environments continued. A water supply demonstration involving four farms was completed. Site selection and construction were studied for light land and related to the criteria for non-leaking dams on the sandplain and for soils associated with granitic rock. A computer model capable of designing roof run-off collection systems for farm households was also developed.

**Hydrological studies**

Hydrological studies on wheatbelt catchments were continuing. Investigations of the effectiveness of interceptor banks showed no downslope impact. A catchment at Cuballing (500-550 mm rainfall) was subjected to different cropping rotations including lupins in one rotation and subterranean clover in another, to determine whether there was any difference in the amount of water escaping the root zone. It was planned that a further catchment at East Perenjori would be studied and full hydrological measurements made.

A number of catchments were investigated accordingly in 1985/86. The variables were a change in cropping rotation, planting trees or planting lucerne. At Newdegate it was possible to study a catchment in a natural state and record data for some years before it was cleared in late 1985. It was possible in future years to measure the hydrological changes since clearing. Direct
measurements were made of water use by a range of plants. During the year it had also been possible to make a comparison between lucerne and wheat in adjacent paddocks where the lucerne was grazed rotationally as part of the normal management program. On a full-year basis lucerne used 433 mm of water while wheat used 231 mm. Rainfall for the year was 384 mm, of which 241 fell during the wheat growing season. These results demonstrate that lucerne should be capable of reducing groundwater recharge.

Soil type also affected a plant’s ability to take up water. Crops grown on loams and gravelly clays used one and a half to twice as much water as crops on nearby sandy soils because the sandy soil did not have the capacity to hold the water before it moved past the root zone.

In 1987/88 there was increased concern that the current land management systems were not capable of sustaining the land resource. Salinity remained a major issue and one estimate was that 2.4 million hectares of agricultural land could become affected by salinity, with a large proportion developing over the next 30 years.

The problem of eutrophication of coastal water bodies due to phosphate and nutrient leaching from adjacent agricultural land continued to cause concern. Although the Peel-Harvey estuary had been recognised as a problem for some years, work by the Environmental Protection Authority and others identified problems in most of the South West and South Coast estuaries. In particular, significant damage was occurring in the Wilson Inlet and the Princess Royal and Oyster harbours on the South Coast.

In 1989/90 the outcome of a survey of growers’ irrigation systems in the Peel-Harvey estuary was reported. None of the systems surveyed were regarded as achieving a level of efficiency which would pass a range of internationally accepted standards. The outcome was that farmers were advised on how to improve their systems, on fertiliser use and on irrigation scheduling.

In 1987/88 soil surveys began in the catchments of the Kalgan, Sleeman, King, Hay and Denmark rivers to determine the current phosphorus status of the soil. This project was part of an overall program to establish integrated catchment management systems.

The soil survey showed that about half of the soils sampled had a high phosphorus status and required no additional phosphorus to produce at a level equal to 90 per cent of the soils' maximum production. This, together with the fact that nearly half the soils were sandy and would require spring sulphur prompted CSBP into releasing a new form of coastal superphosphate which had less phosphorus but nearly three times the sulphur content of ordinary superphosphate. Nearly half of all samples were quite acidic and could need applications of lime in the near future.

The Resource Management Division was also looking at the development of sustainable systems for coastal sand irrigation. It was anticipated that the requirement driven by horticultural industries would increase over the next 25 years and there was concern about the development of eutrophication. It was claimed that leaching of nutrients would damage the groundwater. Experiments with trickle irrigation showed better yields and quality were obtained with rockmelons using 120 per cent evaporation through trickle than was obtained with rates of 120 or 180 per cent evaporation through sprinklers.

A survey of market gardens in the near Metropolitan Area which had moved onto the poorer pale yellow and grey sands has shown that a dressing of 66 to 150 tonnes per hectare of red mud from the alumina industry would virtually eliminate phosphorus leaching. This was part of the overall program for catchment management and control for the Peel-Harvey catchment. Work continued through 1994.
Work was also carried out for the Merredin Shire involving the building of 100 km of absorption banks on the contour on 7000 ha of farmland east of the town to protect the town from flooding.

Sand dune reclamation was also being carried out.

Salinity
During 1983/84 a virgin land assessment was carried out in the Mount Beaumont area where 33 000 ha of land was proposed for release. Detailed chemical and physical analysis of the four dominant soils showed that nearly two-thirds of the area comprised soils containing relatively high salt concentrations. On this basis the branch concluded that the area was unsuitable for release for agriculture.

At Esperance Research Station 1600 metres of drainage tube was installed in a deep drainage project in February 1981. Five parallel lines of perforated drainage tube were installed at 1.7 m deep at a spacing of 40 m and the drain flow and salinity and watertable levels were monitored. Following good rains in May and June drains were discharging about 36 cubic metres per day of water containing 17 000 mg/L of total dissolved salts. By November 1981 the watertable had dropped to drain level across the whole of the drained area.

The effectiveness of deep drains installed by farmers was being monitored and at four sites watertable drawdown had been confined to a band 5 to 10 metres either side of the drain.

In 1982/83 tests, river saltbush and wavy-leaf saltbush carried sheep at about one and a half times the capacity of stubbles, and marsh saltbush carried twice as many sheep as stubble. The marsh saltbush had been rested in 1982 but the other saltbushes and bluebushes had been hard grazed for four successive years. In 1983/84 a breakthrough was achieved in that a selection was made from river saltbush which appeared to reseed itself in an established stand. It was named Bencubbin.

In 1985/86 it was reported that nine salt-tolerant shrub species and ecotypes had been selected for their growth at four sites. This had resulted in a number of species being selected for further work. Two ecotypes of grey saltbush made a very rapid growth and had a very favourable prostrate growth pattern which formed a circular spreading mat over the ground, providing good protection against erosion and helping to prevent salt accumulation due to surface evaporation. The plants also took root where branches contacted the ground. Other shrubs including three ecotypes of river saltbush and wavy-leafed saltbush had also done well.

Planting trees on an area in the Narrogin district in rows across salt-affected and marginally salt-affected land was shown to lower the watertable but did not have any effect on watertables other than that immediately underneath them. Trees were being tested for their role in salinity control.

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Six thousand lucerne trees (Cystisiu prolifer) and six eucalypt mallee species were tested in various locations and catchments. These studies were continuing in 1987/88.

Magnetic induction units were being used to measure areas which were saline, marginally saline or potentially saline. In 1988/89 proposals were also outlined for the use of airborne geophysics to map out areas of some 30 catchments in the landscape across WA. The technique could identify areas requiring special attention.

In 1988/89 a program to protect the Denmark River from further salinisation began. The farmers operating some 8000 ha of agricultural land in the northern part of the catchment agreed to embark on an integrated catchment management program to stop further degradation of the land.

The treatment of sandplain seeps, which constitute a significant component of salinity in the eastern wheatbelt, was also reported. Experimental work had shown that these seeps could potentially be controlled by quite small plantations of trees above them to use the shallow surplus groundwater.
The 1991/92 report refers to the redevelopment of Esperance Research Station as a demonstration of sustainable farming systems for the south-east sandplain. The proposal included fencing to soil types, drainage works and the planting of 21,000 trees in strategic locations. The objectives were to reduce the effects of waterlogging and ponding and to provide protection for fragile soils and reduce the groundwater table. High yield crops, improved perennial and annual pasture, and salt-tolerant species were developed for appropriate landforms.

**Plant research and agronomy**

After the major work on plant nutrition through the 1940s, 1950s and 1960s the current period was one of consolidation and integration of the knowledge base, and investigating the impact and opportunities of the new agriculture in the cropping zones. Issues of particular interest were the residual value of trace element applications, nitrogen use in the new rotations, the phosphate economy in soils after years of topdressing, leaching of phosphate from sandy soils and the development of diagnostic techniques. Much of this work is dealt with in Chapter 7.

The residual value of copper and zinc was re-examined. While there did not appear to be a case for repeat applications of copper, the zinc situation was different. It was affected by differences in the zinc content of the rock phosphate used in the manufacture of superphosphate or the use of concentrated phosphate fertiliser which contained little zinc. It was also observed that soils differed in their capacity to release zinc to crops and pastures, causing current tests for zinc level in soils to be insensitive. The nutrition section was seeking to identify soil characteristics which would help to indicate areas of zinc deficiency.

The group's work had revealed that soil applications of copper were not necessarily well enough distributed to totally overcome the deficiency but that later cultivation overcame this problem. Some work had shown that sprays could be used to overcome copper deficiency but that zinc was best applied to the soil rather than as a foliage spray.

A cooperative program between the Department of Agriculture, the University of Western Australia and Murdoch University after 1985 produced a new tissue analysis procedure to diagnose accurately copper deficiency in grain crops. The accuracy of this test was confirmed in later work. Research had suggested that high levels of nitrogen could increase the need for copper to prevent the development of copper deficiency in cereals. Later this nitrogen-induced copper deficiency was shown to be very rare and nitrogen fertilisers did not normally induce copper deficiency on copper-treated soils.

The collaborative program with the University of WA also produced a satisfactory diagnostic technique for molybdenum deficiency in wheat. On extensive areas of sandplain in the eastern and north-eastern wheatbelt, there was evidence that initial dressings of molybdenum were only available for one or two years. For this reason the department examined the case for measuring the molybdenum absorption capacity of the soil as a basis for recommendations on the frequency of molybdenum dressings.

The plant nutrition section re-examined the manganese levels needed to overcome manganese deficiency, as it was shown that cereal varieties differed in their ability to take up manganese from the soil. This was seen as an avenue for finding ways to improve the efficiency of manganese fertiliser. Work showed that mixtures of manganese sulphate with acidic nitrogen fertilisers were more effective in correcting the deficiency in wheat than either of these elements alone. This would have been expected.

The 1985/86 report suggested that boron toxicity in barley was quite widespread in the wheatbelt but yield was not affected.
The group was aware that an increasing number of fertiliser mixtures were being offered to farmers without reliable information on their use. Considerable time was taken up in testing the usefulness of these mixtures against the extravagant claims made for them. The general conclusion was drawn that it was difficult to substantiate these claims.

As a precautionary measure alternative water-soluble phosphate sources were being examined against the possibility that the existing supplies of phosphate rock may not remain available.

It was observed that phosphate was leached on some soils where this would not be expected, and a program was established to identify the factors responsible for this uncharacteristic leaching behaviour. However, the major concern continued to be with the leaching from sandy soils in river catchments. Work in the Harvey, Serpentine and Murray River catchments showed that phosphorus entering the inlets could be reduced by 30 to 40 per cent through modifying superphosphate applications and replacing ordinary superphosphate with the new coastal superphosphate. Coastal super was a granulated mixture of super and phosphate rock.

The work on estuarine pollution was continued in 1985. Evidence from this research showed that on soils with an acid pH, no iron oxide and no clay, rock phosphate was likely to give a useful growth response. This was an ongoing problem and in 1991/92 control was an important part of the extension program for the region. Vegetation traps along the banks of streams or at the end of drains, changed fertiliser regimes and red mud treatment of very sandy soils were all part of the program.

Research was also started to examine the impact of acidity. Many soil types in the agricultural areas are naturally acidic and pastures and modern cropping practices tend to increase this acidity. In 1983/84 the group was studying the potential for using various rates of lime to neutralise acidity where problems had been identified. However, it was not expected that in general it would be economic to apply lime.

In 1985 a small group was put together to develop computer models dealing with a number of annual issues. These included a strategic fertiliser model to deal with recommendations for nitrogen and phosphorus fertilisers applied to crops and pastures; a tactical nitrogen application model to deal with use in cereal cropping and to take account of the influence of season, soil type and history; a pasture production model to examine summer seed dynamics, germination patterns and the balance between species in pastures; and a superphosphate times stocking rate model to examine sheep production in relation to the supply of superphosphate to pastures at varying stocking rates.

The 1986/87 report commented that soil testing to predict phosphate fertiliser requirements was unreliable. Research had shown that even across small areas, although the tests were unreliable they were used as a matter of course within the industry. Further work was planned in an attempt to improve the accuracy of these tests.

In the same year it was reported that the NP Decide model had been improved in two major ways. These were that specific paddock features could be taken into account, and that allowance could be made for possible seasonal effects in the choice of a fertiliser strategy.

During the year three research tools studied were:

- a predictor of monthly pasture availability as affected by climate, soil type, crop rotation and grazing management
- a simulation model of the roots of the wheat crop and the way they interact with the environment, particularly the location of water and nitrogen in the soil
- a model of soil and nitrogen reactions and their effect on leaching and uptake of
nitrogen. This work has direct application to the NP Decide model.

An important discovery during 1987/88 was that plants growing from seed with a high phosphorus content grew and yielded much better than those from seed with a low phosphorus content. How important this might be in the field depended on further work.

In 1988/89 the approach to placing phosphate fertiliser in narrow bands below the seed was shown to be more effective than the conventional banding of seed and fertiliser together. Wheat yield was increased 14 per cent when fertiliser was buried 4 cm below the seed. A lupin crop sown the following year with no additional fertiliser produced double the yield of a crop sown using conventional seed and fertiliser placed together at planting. The results were probably due to the deeper-placed phosphate remaining moist longer and staying available to the roots for a longer period.

In cooperation with the University of WA an improved soil test for aluminium was produced.

The use of peas in the rotation was shown to have a big effect on the following wheat crop due both to the fact that peas do not remove nitrogen, and they contribute it to the soil through Rhizobial fixation. There may also have been an effect due to stored moisture, since peas are a shallow-rooted crop.

Work undertaken with tagasaste on deep sands showed that the species had a capacity to support livestock. Fertiliser trials identified the critical level for plant tissue tests and demonstrated the effect of superphosphate on feed production, carrying capacity and feed value. On the Dunmar Research Station 2000 head of cattle had been carried on 1400 ha of tagasaste over the dry summer of 1993/94. This work attracted a lot of farmer attention and increased sowings were expected in future years. Research projects on the performance of steers on tagasaste had been started.

The department also developed a furrowing technique for planting crop on water-repellent sands, which are quite extensive on the west and south coasts. The appropriate procedure was to plant the seed in the bottom of the furrow and push the repellent sands into the adjacent ridges. Following rain, water flows off the ridges and concentrates on the floor of the furrow, which can give germination on quite light rainfall. Lupin yields were increased by 40 per cent using this technique.

The Ord River

As a direct result of research conducted since 1977 (when the cotton industry failed) a double cropping system of agriculture was developed for the Ord River Irrigation Scheme. The components included soya/mung beans in the wet season and sorghum/sunflower in the dry season.

The horticulture area expanded specifically for production of out-of-season vegetables and fruit for southern markets. This development continued to maintain the Ord area for most of the next decade.

High sugar yields continued on the pilot farm but difficulty remained in obtaining approval for commercial production. During 1981/82 the WA Government issued a prospectus inviting interested commercial organisations to submit proposals for the establishment of a sugar industry on the Ord. The government received six detailed proposals, five based on crystal sugar and one on ethanol production.

Overseas activities

There was a strong demand from overseas for the expertise within the department, in terms of both Western Australian agriculture and its administrative approach. This resulted in four overseas projects starting during the period. In order to manage these projects efficiently the government agreed to establish a small independent agency which was called the Western Australian Overseas Project Authority (WAOPA). This was...
created after projects in Libya and Nigeria were established.

**Iraq**
An agreement was signed with the Iraqi Government in 1979 for the development of dryland farming in northern Iraq. This also involved Western Australia having access to Iraqi genetic material for wheat and medic species. The medic species were tested in WA and some appeared to have promise for use in Western Australia’s agriculture. A range of strains of *Rhizobium* bacteria came with the medic material, some of which proved to be valuable in WA conditions.

**Thailand**
In conjunction with the University of WA, the department participated in a project aimed at decentralising agricultural research to 19 regional agricultural centres in Thailand. The overall project had World Bank support and management was funded through the Australian Development Assistance Bureau (ADAB) under the name of Australia’s Contribution to the National Agricultural Research Program (ACNARP). Basically the Thai department in the project was to be reorganised along similar lines to the Western Australian department, with a strong regional research component. Selected Thai postgraduate students were trained to MSc and PhD level at the University of WA.

**Nepal**
Western Australia took part in a major project to upgrade Nepal’s livestock industry. Nepal graduates were trained in livestock health maintenance and extension and related laboratory work in the Department of Agriculture. Six had completed their training and returned to take up positions in their country by June 1982. During the year four department specialists visited Nepal to advise on pasture production, extension management and laboratory techniques.

**Libya**
A project in Libya was established in 1974 by agreement between the Governments of Western Australia and Libya to develop more than 200 small farms to a fully productive stage. The program proceeded satisfactorily despite some administrative difficulties. It was basically a demonstration of the ley farming system used in WA at the time. The major difference was that the base legume was barrel medic and not subterranean clover because the soils had high pH. The project benefited WA in that the extensive Libyan medic collection which was tested in Western Australia became available to the State.
Chapter 5

1995 to 2008: a change of focus

The political aim during this period was for the Department of Agriculture to become more focused on issues beyond the farm gate. A major review of the department and associated organisations made significant changes in the structure of the three relevant organisations. While internal changes were relatively small, loss of key staff and uncertainty about leadership and job security seriously damaged morale.

A key decision that advisers should not deal with farmers on a one-to-one basis progressively broke down the close relationship between departmental officers and farmers. This in turn shifted the focus more towards research and less on farmers' day-to-day issues. All this was coupled with reduced government funding. Nevertheless some good work was done in traditional and post-farm gate areas. Natural resource management moved progressively from local areas to catchments. New technology and improved facilities improved research support. At the end of the period cereal breeding was privatised.

The department

In the early 1990s a major review of the Agriculture Portfolio was undertaken covering the Department of Agriculture, the Agriculture Protection Board and the Rural Adjustment and Finance Corporation. The review was initiated in September 1993 and the report was submitted in October 1994. While its recommendations were progressively implemented over the following 18 months it is hard to see that they made any substantial difference to the overall thrust of the existing administrative structure except for the effect on the Rural Adjustment and Finance Corporation and the Agriculture Protection Board. The review did however introduce an internal financial management system which proved inappropriate for a research and extension organisation.

The first part of this chapter deals with the recommendations, implementation and outcomes of the review, followed by a brief discussion of the overall situation of the department at that time. It then deals with the activities within the framework provided by the review.

During the period there was a major change in the basis of reporting to a system which embraced some of the ‘modern’ administrative theory. This increased the administrative load on the department, with doubtful improvements in accountability. It certainly would have diverted resources from the ‘front line’, to work required to satisfy the central agencies.

In November 1994 the then Director General of the department resigned, apparently because of differences with the Minister on the implementation of the recommendations of the review. A new Director General was appointed during 1994/95 and in his June 1995 report he commented that: “… future priorities will reflect a strong market orientation to research and development, a commitment to the sustainable development of agricultural production and land use and a renewed commitment to protection of the agricultural resource. There will also be a stronger focus on the delivery of services from regional bases”. A similar statement had been made by his predecessor in 1993 and would be made by his successor.

During the period there was a significant shift of focus. This had started in 1992/93 and was driven by a perceived need to help smaller and developing industries with the
costly task of finding markets and identifying market need.

The identification of market opportunities was also important to the grain industries. This had been achieved within the existing framework of physical and professional resources of the department. There were major gains in the grain export and production area where improved plant breeding capacity was able to develop cultivars to meet new market needs.

Work in the wool area was undermined by lower prices, leading to a progressive reduction in the size of the industry. In the horticultural area export marketing of vegetables was significantly reduced in Asia by competition from China. Some other industries were helped to develop but this did little to offset some of these difficulties.

**The 1994 Portfolio Review**

The Hussey Review of 1994 was commissioned by the Minister for Primary Industry, Monty House. It was written in general terms and dealt with aspirations which, while commendable, were inherently difficult to turn into defined activities. However, it did recommend major changes to the focus of the department and the way in which the organisation was managed.

The review recommended the adoption of a structure which divided the department into four major divisions:

- **Policy and Planning** included strategic planning, program definition on industry lines, outcome statements, budget allocation to program managers, program evaluation, and industry program coordination.
- **Programs** included industry focus supported by advisory arrangements, funding to achieve program outcomes, strong emphasis on regional program delivery and regional level program integration by regional management, with some program managers located at regional level.
- **Technical and Regional Support** included skills, labour and infrastructure required by program managers. The majority of funding was from program managers with some direct funding from the department for infrastructure not required by individual programs.
- **Corporate Services** included clerical and administrative support organised on a user-pays bureau basis.

The reviewer saw the new structure being program-driven with a regional and industry focus. The three main programs identified were:

- Trade and market development
- Industry support including the Rural Adjustment and Finance Corporation (RAFCOR)
- Protection.

In the change, the RAFCOR Board was seen as a program manager purchasing its requirements from the Corporate Services Group or the market.

The Agriculture Protection Board was seen as an advisory group advising on the integrated protection services. The protection services would include vertebrate and plant pest control, quarantine and animal and plant inspection. The viewers saw a need for greater on-farm focus for vertebrate and plant pest control.

The possible inclusion of landcare and sustainability as part of asset protection in a broader definition of protection was flagged.

The intention was that the Planning and Policy Office refine the current programs and that these refined programs form the basis of budget allocation in 1995/96. There was a focus on fully costing programs for allocation of resources.

It was claimed that the recommended systems and structure would allow the organisation to function in a more commercial manner. It was also claimed that the existing system was over-managed. The review recommended the introduction of contestability as the basis for allowing private suppliers to compete to provide some services. A challenge for the Executive was to develop workplace agreements which
would encourage more flexible working conditions and a need to focus on customers.

The new arrangements required a Technical Services group which would:

- provide technical staff, resources and infrastructure for statewide and regional programs
- supply the services required by the programs.

It was recognised that a small group would need to implement the proposal. A program was broadly spelt out with the key implementation steps seen to be:

- establishment of a Ministerial Advisory Council to demonstrate determination to involve the industry more fully
- the specification of job mandates and selection of the management team to lead the portfolio
- establishment of the Office of Planning and Policy to initiate the process of program definition. The outcome specification was that the new program structure should be confirmed in time for budget considerations in 1995
- once the program structure was more tightly defined, attention would need to be given to definition and establishment of the proposed technical services groups
- completion of a support unit viability study of the corporate services area was needed to benchmark and establish the appropriate level of service likely to be required by the new structure
- upgrading of management information services would be necessary. These new systems should reflect the program management requirements of the new arrangements
- infrastructure planning and renewal planning should proceed to ensure that a long-term view of the best use of the asset base is available to management.

In reality, when it was analysed, the structural effect of the review was to marginally change the structures and approaches already in existence. The main thrust was a greater market-based focus. The department had in fact had a 'market-based' focus for much of its existence because it saw its customers and market largely as the farming industry. Marketing in terms of domestic and export markets was seen as a function of the private sector. Over the previous decade the department had become involved in market investigations and facilitation. It had also focused research on particular market needs.

The review also recommended the concept of contestability to obtain funding for programs within the department as a formal process. This was new and provided difficulties in areas where outcomes are difficult to measure. Contestability had always existed in the department as an informal process.

**Major recommendations of the review**

The review recommended that the organisation develop:

- a strong leadership and corporate culture driven by a clear vision for the role of the portfolio agencies and resources
- a comprehensive focus on market requirements through all of its activities and programs
- strengthened strategic planning and policy development and structural separation of the program definition from the delivery
- partnership with the industry that accesses industry advice and liaison at both ministerial and local/regional level
- a clear program management approach characterised by the application of the business unit model of management and an accountable management structure to replace the department’s current matrix management structure
- a simplified program structure with a clear orientation in all activities (including R&D)
towards the achievement of policy and program outcomes linked to the portfolio objectives

- development of a work environment which values and rewards initiative, effort and excellence, recognising and building on the commitment of staff
- increased opportunities for private providers and industry to provide services through the program framework of the portfolio
- substantial program level integration of the RAFCOR and APB boards within the portfolio in the 1995/96 financial year
- integrated activities to achieve whole farm, regional and industry agricultural outcomes
- programs to emphasise and locate and resource the regional presence and impact of the portfolio.

The review recognised a need to communicate to industry stakeholders and agency staff on the implications of the proposed restructure and the broad thrust of the changes proposed.

**Adoption of the recommendations**

The 1994/95 annual report showed that the recommendations of the review were substantially accepted and being introduced.

The department listed four broad objectives which reflected the government's policy priorities:

1. Identify market opportunities and develop new and improved products to enhance profitability of the rural and allied industries.

2. Develop agricultural and pastoral production systems which optimise economic returns, while conserving land resources.

3. Implement assistance to agriculture and to help rural and allied industries to manage risk and uncertainty.

4. Minimise the impact of diseases, pests and weeds on the agricultural and pastoral industries and to ensure the maintenance of safety and quality standards in agricultural products.

The report again stated that over the past four years the department had changed its emphasis from one predominantly driven by production-based research to one with a much sharper focus on marketing. Improving productivity remained an important element but it needed to be tailored to the expectations of a much more discriminating and complex market. In future the department would be closely aligned to market opportunities.

The report commented that the development of Western Australian agriculture had been based on technologies developed to match the climate and soils. These technologies were unique and arguably the most efficient in the world. It also stated that the department contributed to the development of sustainable farming systems to ensure that the productivity of the resource base could be maintained or improved; it was involved in the protection of industry against the introduction of pests and diseases; and had programs for the control of endemic pests and diseases.

As recommended by the review, a Policy and Planning Office was established and the principles of program management were adopted.

All activities were undertaken as interdisciplinary projects within the four programs:

- Industry and market development
- Sustainable agricultural systems
- Industry support and assistance
- Protection, regulation and control.

All the department’s activities were initially located in 33 operational programs. There were several operational programs under each agency program, directed at achieving planned outcomes.

Each operational program had set objectives and outcomes and achievements with an economic focus, and:
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- was subjected to benefit-cost analysis
- had a program leader responsible for coordinating and reporting the delivery of outcomes
- had an industry committee to advise on priorities and to which the program was accountable.

Each member of staff was located in one or more operational programs and shared responsibility for the delivery of outcomes.

The functions were described as:
- conduct of research to develop the existing and new technology which will help rural industry to maintain economic viability
- development of new products and handling or processing techniques
- provision of essential diagnostic services
- development and promotion of sustainable land use systems which maintain and improve the basic soil, vegetative and animal resources
- regulatory activities designed to protect rural industries, primary producers and the land resource.

Some regulatory activities were funded by the Commonwealth Government.

The department continued to charge for services, based on full cost recovery with some discounting if a component of public good could be identified. Apart from its overall research and advisory services the department provided animal disease diagnosis, cereal testing, government loan assessment, analysis of wine and certification of grapevines and seeds, plant disease diagnosis and seed testing.

During the year the second major policy initiative of contestability was flagged for later full introduction. This was competitive tendering for funding by programs and contracting between the program and the funding body to achieve certain outcomes. This process was totally within the department. Within Corporate Services several business service units were identified and the initial stages of competitive tendering and contracting began. A review of the department’s costing methodology was undertaken to complement the contracting and tendering process and to accommodate Treasury costing requirements.

During the year the department vigorously pursued further advancement of the business unit concept. This involved the identification and combination of existing similar service delivery areas into 'meaningful and functional' commercial units. This resulted in the realignment of 21 traditional delivery areas into 11 commercial units.

In 1996/97 the operational functions of the department were carried out under three headings:
1. Industry and Market Development
2. Sustainable Rural Development

Each of these programs was divided into delivery programs or sections. There were eight delivery programs within Program 1; Program 2 was based on six regional groups stretching from the South Coast to the Kimberley; Program 3 used the Agriculture Protection Board to manage and provide funding support and guidance. The board was aided by its 10 zone councils covering the State, with regional advisory committees within each zone.

The Office of Policy and Program Planning was responsible for strategic planning, budget allocation and evaluation, and policy development. It also managed ministerial issues, legislation and government business.

By 30 June 1995, the department had 38 per cent professional, 30 per cent technical, 7 per cent inspectorial, 16 per cent clerical and administrative, and 9 per cent wages staff. It had also implemented the Clockwork human resource management information system to replace its previous Personal Information Management System.

As a result of the 1994 review, the department (1613 full-time equivalents or FTEs), the Agriculture Protection Board (257
FTEs) and the Rural Adjustment and Finance Corporation (23 FTEs), were merged in July 1996 to form Agriculture Western Australia. Total staff of the three organisations at that time was 1893 FTEs.

The approved annual staffing level for the new organisation at 30 June 1997, including staffing for externally funded projects and functions for the Commonwealth, was 1768 FTEs. This comprised 1304 funded from Consolidated Revenue, 209 funded from Commonwealth programs and 255 from Rural Industry Grants.

A voluntary severance package offered in November 1996 resulted in loss of 119 positions. The loss was a significant and unfortunate outcome of the review, particularly as it included a number of senior and experienced officers who were the leaders, mentors and trainers of younger staff.

A total of 1714 staff members were employed at 30 June 1997, compared with the 1768 FTEs allowed. Of these, 856 were based at South Perth with the remaining 858 staff in country offices, research stations and inspectorial checkpoints throughout the agricultural and pastoral areas. The staff consisted of 568 (33 per cent) professional officers, 557 (32.5 per cent) technical officers, 169 (10 per cent) inspectorial staff, 323 (19 per cent) administrative and clerical staff and 97 (5.7 per cent) wages staff.

The amalgamation of RAFCOR with the department varied from the original intent of its establishment as an independent organisation. This was to keep the adjustment decisions outside political interference and separate from the research, advisory and inspectorial role of the department. By this time the rural adjustment schemes had largely finished but there was a need to administer exceptional circumstances funding and a number of similar activities. The amalgamation of the APB with the department may have had some advantages but these would have been small following the changes from the 1987 review.

Communication across Western Australia was dramatically enhanced through investment in a statewide communication and financial management information system. This facilitated the transfer of functions to regional and district offices.

As part of the decentralisation of the department 10 new Community Agricultural Centres were developed. These were designed to bring the delivery of agricultural support services closer to industry and to support local community development. They were the first part of a program to establish 40 community and cultural centres over a three-year period throughout Western Australia. The 10 centres were at Mullewa, Morawa, Wagin, Boyup Brook, Coorow, Gingin, Jurien Bay, Narembeen, Darkan and Wongan Hills. These offices were small, with two to four staff, and were distant from Agriculture Western Australia’s established offices. Not many more of the proposed offices were established in later years, probably due to staffing problems.

Again, the establishment of these offices was a departure from the policy set 40 years earlier to avoid small offices because of the generally improved performance of officers where support was available in dealing with complex issues. The later policy that officers should not initiate contact with farmers on a one-to-one basis seemed to remove the need for a greater distribution of staff in rural areas. By mid-2008 only 11 centres are listed outside previously established offices and research stations with four or fewer staff. Only two of these had professional staff.

In 1996/97 the total operating cost for Agriculture Western Australia was $137 026 million. Revenue for services and trust fund receipts was $44 438 million with the net cost of the department to the State being $92 588 million.

The Director General commented that there had been a distinct shift from bureaucracy to business. This had been accompanied by new opportunities to establish collaborative projects with industry. He also stated that strategic alliances between producers,
processors and exporters in the State and with markets overseas, had allowed the development of new products from Western Australia for the supermarket shelves in Asia.

In 1996/97 the department maintained a formal contact with the rural industry through some 66 committees, some of which were statutory and some related to statutory functions. Others were liaison committees of one form or another. The department was also responsible for the administration of 46 Acts of Parliament relating to agricultural matters.

In his introduction to the 1996/97 report the Director General commented again that:

- The agency had refocused its activities on the market, with particular emphasis on market needs driving research and development.
- The agency had established industry and regional partnership groups in each program area, comprising industry, business and community representatives to provide direction for the government's investment in agriculture.
- This process allowed the agricultural and rural sectors to have some input to the delivery of government support which had previously not been possible, but would be an ongoing part of the agency's planning.

It is not clear whether this change had greatly different outcomes when compared with the structure and industry committees existing before the review.

In his review the Director General pointed to a key component of the increase in agricultural productivity being the increase in yields in the cereal sector. This in turn had been driven by research and development and farmer innovation, which had led to a total change in crop production. The department's contribution to market access included the release of higher yielding varieties, with an emphasis on identifying new quality-discriminating markets.

It is doubtful if the 1994 review had any impact on these achievements except possibly to slow them down through loss of key staff.

The Director General also noted that while the wool market had been weak, sales of WA wool to India had increased rapidly. He attributed this to the department's drive in research and market development to establish direct links between the WA wool industry and the Indian mills.

There was a further advance in the development of the department's biological research capacity with the opening of a new biotechnology laboratory at the State Agricultural Biotechnology Centre at Murdoch University. The laboratory was to undertake collaborative research on new and existing molecular techniques. This was to include screening for identified quality traits and disease resistance to support plant breeding, and to support quality assurance and compliance initiatives in agriculture and fisheries.

In 1996/97 it was stated that the process of separating core policy and advice functions from operational services had continued. A review of the corporate services support at district offices identified those required locally and separated these from those that could be provided from South Perth. Corporate Services support for competitive tendering and contracting continued. A number of information services were outsourced, with a claimed saving of $970 000 or 27 per cent of the former costs over three years.

The milestones and targets of the First Enterprise Agreements which were entered into were achieved, providing the staff with an 8 per cent pay rise. Negotiations for the second enterprise bargaining agreement were in progress in 1996/97.

Following the formation of Agriculture Western Australia a new financial operational system based on the Funder, Purchaser, Provider model was introduced. This approach had been introduced by the Deloitte Company, which had provided
substantial advisory services to the review. It had originally been used in the United Kingdom. In Agriculture WA the Office of Policy and Planning was the Funder, the Industry Resource Protection, Sustainable Rural Development and Industry and Market Development Programs were the Purchasers, and Program Services and Corporate Services were the Provider. The principles underlying the model were based on:

- the need to separate policy, program prioritisation, and service delivery functions
- ensuring the policy developed by the Funder was aligned with agreed government policies and outcomes
- enabling the Funder to allocate budget to the Purchasers
- facilitating the determination of outcomes
- requiring each program to achieve its key performance indicators
- ensuring appropriate contestability in the provision of services
- facilitating a commercial client-focused approach by the internal Provider, Program Services and Corporate Services, in the delivery of projects on time, within budget and to agreed quality standards.

This system proved to be administratively clumsy and unsuited to a research organisation. It was finally abandoned after a change of government in 2001. Department personnel reported that it also reduced cooperation and sharing of short-term workloads between programs.

In 1998/99 it was reported that Support Services continued its investment in self-renewal and continuous improvement. This was facilitated by the establishment of a Business Improvement Team and further expenditure on developing policies and procedures and systems, together with substantial investment in staff training. It was claimed that the new arrangements provided a more robust and productive environment.

The particular areas of activity for Support Services were: training and staff development, staff recognition and reward, equal employment opportunity, disability services, occupational safety and health, hazard-based initiatives, workers’ compensation, the government’s two-year plan for women, standards in human resource management, asset management, internal audit, finance, information technology, freedom of information, records management, contracts and procurement (including fleet management), corporate services restructure and pricing policies. No information was available on how these issues were prioritised or the extent to which they were subjected to the form of competitive discipline used in the rest of the department.

In recognition of the increased risks associated with contracting, a specialist Contracting and Procurement Branch was created.

The staff level at 30 June 1999 was 1655. There was a trend towards more inspection and this was reflected in the distribution of positions. Professional staff were reduced by 44 (7 per cent), technical staff were reduced by 30 (6 per cent), the inspectoral staff were increased by 94 (72 per cent) and the administrative and clerical staff were reduced by eight (2 per cent). Wages staff were reduced by 22 (39 per cent).

The actual numbers were professional 624, technical 444, inspectoral 225, administrative and clerical 354, wages 68, for a total of 1715. During the year the FTEs numbered 1655.

The approved staffing for the three organisations amalgamated to form Agriculture WA for the year before the amalgamation was 1893. The loss of FTEs in the four-year period was 178.

Over the next decade, as the impact of the 1994 review and the previous focus on a program-based management system took effect, there were substantial changes in the overall regional organisation. These changes are dealt with in more detail in Chapter 8.
effect the objectives of the 1977 review were reversed and district offices appear to have become places to house staff rather than integral units of the department. In fact there seemed to be a loss of the historical integration of units throughout the department with the introduction of program management. The ‘new age’ approach appeared to divide rather than unify the divisions responsible for their implementation.

There was also a significant centralisation of field research facilities and the number of research stations was reduced. In the South West this started in 1982 when Denmark Research Station was transferred to the Education Department and Bramley was closed. Wokalup was then transferred to the Education Department. In the horticultural industries Stoneville and Swan were closed. The result was that Vasse and Manjimup remained as the only research stations in the South West. However, they were very well equipped and capable of high quality research.

Previously, the Vegetable, Poultry and Pig Research Stations had been centralised at Medina. Floriculture was added later to that group. In the wheatbelt there was gradual erosion of available field facilities. Northam was transferred to Curtin University in the 1982 review; Newdegate was downgraded and largely leased; Chapman was sold; Avondale was transferred to the National Trust; Badgingarra was being transferred to a community group; Salmon Gums was closed; Esperance operated at a very low level; and Wongan Hills was largely leased after cereal breeding was privatised.

Merredin appeared to be functional. Mt Barker, which operated largely as a medium rainfall station, was fully functional.

This left the department with few dedicated field research facilities in the wheatbelt. It was argued that this increased flexibility at a lower cost because district offices were well equipped and could undertake on-farm work as required. Certainly, closure of these facilities reduced the department’s capacity to undertake any long-term studies or to demonstrate new technology on a large scale. The wisdom of these decisions will be tested by the future.

The departmental offices in the South West outside of Albany where advisory (development) officers were based were Bunbury, Waroona and Manjimup. The Busselton, Harvey, Pinjarra and Bridgetown offices had closed. The dairy inspection service, once run by the Dairy Division and then by the Dairy Industry Authority, became the responsibility of the dairy companies. When the Dairy Industry Authority was responsible, the department still provided advice to farmers and factories. This contact appears to have been lost. The district offices in the wheatbelt appear to be maintained.

In 2006/07 the agricultural and related industries listed under the agriculture, food and fibre sector produced $5.5 billion. The cereal industries produced 44 per cent of this income, 22 per cent came from meat and animal exports, wool produced 12 per cent, horticulture including sugar 11 per cent, and dairy, honey and eggs accounted for 3 per cent, while pulses, pastures and oil seeds accounted for 8 per cent.

The value of exports of agricultural and food and fibre products from Western Australia amounted to $4.2 billion. Cereals provided 54 per cent, wool 13 per cent, meat and animal exports 22 per cent, horticulture 4 per cent, pulses and oilseeds 5 per cent, and dairy, honey and eggs 2 per cent of the total value.

The State Government outlined desirable outcomes for Agriculture Western Australia as to:

- increase competitiveness and profitability of the agriculture, food and fibre industries
- improve ecologically sustainable development of the agricultural industry
- manage biosecurity effectively
- provide services to the food and fibre industry’s development
• provide services to rural business development
• provide services to agricultural resource management and
• provide services to biosecurity.

In carrying out its responsibilities the department shared some funding and responsibility with other agencies. For example, in the National Action Plan for Salinity and Water Quality, which was jointly funded by the Commonwealth and State Governments, the Department of Agriculture was the lead agency together with the Department of Environment and Conservation.

Results were reported against agreed outcomes, efficiency indicators and financial targets.

The sources of departmental funding were the State Government 48 per cent, Commonwealth Government 24 per cent, research grants 15 per cent, revenues 8 per cent, and other sources 5 per cent.

Utilisation of the department's budget by category showed the allocations were: employee expenses 37 per cent, grants 34 per cent, supply and services 14 per cent, capital use 4 per cent, depreciation 3 per cent and other expenses 8 per cent.

If the budget was divided on the basis of the area of service, agricultural and resource management received 44 per cent, food and fibre industry development 28 per cent, biosecurity 26 per cent and services provided to the Rural Business Development Corporation 2 per cent.

If the budget was divided on the basis of service to industrial areas, grain programs received 43 per cent, horticulture 20 per cent, wool 13 per cent, meat 8 per cent, trade and market development 10 per cent, new industries 3 per cent and dairy and apiculture 3 per cent.

The total staff at 30 June 2007 was 1660, of whom 703 (42 per cent) were professional, 431 (26 per cent) technical, 336 (20 per cent) were administrative and clerical, 53 (3 per cent) wages and 137 (8 per cent) inspectorial.

**Departmental activity**

The report stated that agriculture and the department were operating in an environment in which:

• consumer demand was leading to international and national agreements which increasingly specified standards for the consistent supply of safe, quality, environmentally friendly and ethically produced food and fibre products
• global sourcing of food and fibre products and progressive deregulation of international trade was intensifying competition for market share and premiums
• there was an impact of greenhouse development and policies and dryland salinity on agricultural productivity and the land available for traditional agriculture
• there were strong pressures on agricultural activity to control its impact on environmental values
• international trading policies were requiring trading partners to scientifically justify any biosecurity constraints on trade
• the adoption of new food and fibre production biotechnology would increase the intensity of production and become a major driver of change
• regional communities continued to experience population decline and associated reduction in core infrastructure
• community demand for services at state and federal level were placing pressure on availability of funds
• a concept of multi-functional agriculture had resulted in countries supporting agricultural businesses for non-economic objectives which would continue to distort markets
there was a cost/price squeeze on farm profitability through prices for commodities falling in real terms
risk management techniques were needed to deal with the range of risks to which agriculture is exposed
climate change had emerged as a major issue.

In his 2007/08 overview statement, the Director General stated that the aim of the department was to provide the best possible service in order to make a valuable contribution to the sustainable future of the Western Australian agriculture, food and fibre industries. In order to do this the department was reviewing and updating its strategic plan and processes. It aimed to develop a monitored, evaluated and performance-measured framework in order to more effectively assess progress and be in a position to confront the many challenges and issues that would impact on it.

He also stated that the focus of the new strategic plan was on how the department was going to do its business rather than what it was going to do. He saw the impact of climate change and rapid advancements in food and fibre technology as ensuring that the department continued to experience exciting and challenging times. The department also initiated a staff development project to ensure staff quality was maintained in a tight labour market.

The targeted staff level for the department in 2007/08 was 1598. The average staff level for the financial year was 1499. The decrease was due to a reduction in the number of externally-funded projects. Of total staff, 42 per cent were professional, 25 per cent technical, 8 per cent inspectorial, 22 per cent administrative and 3 per cent wages.

In 2007/08 the department established a program for involvement of indigenous Australians. Activities included maximising the department's capacity to work with indigenous land managers, arranging for departmental policies, products and services to provide for indigenous needs, expanding indigenous employment and managerial opportunities within the department and the agricultural, pastoral and land management industries, and providing new services with a goal of achieving equity of service and outcomes for indigenous customers.

**Seasonal conditions**

The years 2000 to 2002 were very difficult climatically; 2003, 2004 and 2005 experienced average to above-average rainfall, but 2006 returned to very dry conditions; 2007 was a year of great contrasts, with southern producers and rangeland managers benefiting from good production conditions coincided with good prices for most commodities. At the other end of the scale, northern and eastern wheatbelt producers suffered through another dry season with very low production levels. Exceptional circumstances assistance was granted in a number of these years. In 2007 the scheme was extended to cover 37 regional shires and the WA Government provided $9.3 million in a dry season’s assistance scheme.

The department published a graph on the change in annual rainfall comparing the rainfall from 1976 to 1999 with 2000 to 2007. This showed that most of the State had a rainfall reduction of at least 5 per cent. Some 25 per cent of the agricultural areas had a reduction of from 5 to 10 per cent and probably 15 per cent of the areas had a reduction of between 10 and 20 per cent. About 10 per cent had increases, largely in the Esperance Shire, with the eastern section having increases of more than 20 per cent.

In the period 2000–2007 department was or had been part of seven cooperative research centres (CRCs). These were Legumes in Mediterranean Agriculture, Bio-control of Vertebrate Pests, Premium Wool Quality, Quality of Wheat and Wheat Products, Weed Management Systems, Sustainable Development of Tropical Savannas and Plant-based Management of Salt Affected

**Activities during 1995 to 2008**

**The Services Program**

The Services Program was established as the department's principal Provider within the Funder, Purchaser, Provider model as part of the implementation of the 1994 portfolio review. As the Provider this program was responsible for managing almost all of Agriculture Western Australia’s scientific, technical and inspectorial staff—about 1330 of the 1650 total employees (initially).

The Services Program consisted of an executive director with a line management structure which included 10 service units. Seven of the units controlled large numbers of staff in service-oriented groups. The remaining three, which were responsible for regional services, business services and special projects, operated across the department. The seven service units with large numbers of staff were divided into discipline groups and business units, each with a strategic discipline, service product and/or geographic focus. Each of the discipline groups was headed by a discipline leader. The role as the discipline leader normally took 30 per cent of the occupant’s time. Regional representation and coordination was achieved via 24 district leaders, again on a part-time basis.

During the year the program finalised project documentation and completed negotiations to undertake 370 projects with a total value of some $127 million. This proposal, which was introduced to simplify and give improvement in the overall management of the department, appears to have introduced many complexities. It was not continued beyond the change of government in 2001.

The activities listed below should be seen as indicative of the actions taken over the period and not as a definitive list.

**Marketing and extension**

During this period the department was the main provider in Western Australia of contracted agricultural research that examined various aspects of rotational farming, cropping and sustainability practices, plant pests and diseases and new crops and pastures. The information generated was released to farmers and agribusiness via a range of media and modern communication methods such as interactive adult learning settings and the internet. The products and information generated were enabling broadacre agriculture to have greater flexibility and agricultural biodiversity than 20 years earlier. These products involved:

- development of systems for improving market intelligence flowing to grain growers, including intelligence on the value of different qualities of wheat and methods of estimating the quality of the wheat to be delivered
- demonstration of the role of pastures in cropping systems
- investigation of all markets of interest, researching new markets and development of activities directed at improving exporters' knowledge
- joint studies with the Mid-West Labour Marketing Advisory Council and the Mid-West Development Commission on options for regionally-based processing and marketing of agricultural produce
- a display at the Dowerin machinery field days with a market focus on grain legumes, canola and Awassi sheep as alternative products for wheat farmers
- development of the Crop Check management group which brought together 12 key organisations and industry sections, drafting a business plan leading to an effective partnership between industry, the department and the commercial sector, securing endorsement of consulting groups and obtaining funding to develop a crop analysis system, instigating a radical
approach to empowering the group to manage crop analysis

- a deliberate program to improve collaboration with agricultural consultants and other agribusiness personnel. In one year a program of workshops attracted 300 attendees.

**Small landholders services**

Traditional clients had been commercial producers, but services were extended for nearly 50,000 rural landholders with small holdings, engaged in a wide range of agricultural activities, both commercial and sub-commercial. They controlled an estimated 650,000 hectares of land, often in areas of agricultural and environmental significance. To assist these landholders, the department set up an enquiry service in 2003/04 and organised field days and workshops.

Over the four years to 2007/08 it delivered and facilitated more than 150 learning events for small landholders, with more than 4000 people participating. These workshops dealt with managing stock, stock identification and animal husbandry, protecting waterways, revegetation and weed management. In April 2008 the department organised the first national small landholders extension practitioners forum.

During 2003/04 the service to clients was refined with the establishment of a dedicated telephone service for producers and consultants. This service streamlined access to the department’s products and services, covering crops, pastures, livestock, animal health, horticulture and general agricultural production. The service was known as Agline.

The department’s Pest and Disease Information Service responded to around 11,000 enquiries during a financial year.

Staff managed the provision of assistance for farmers suffering from unpredictable events.

All of these activities were in addition to the publication of a wide range of pamphlets, brochures and booklets on major issues of concern to farmers.

**Trade and Development Program**

In 1998/99 emphasis was on the development of strategic alliances across a number of industries in Asia. Market research and feasibility studies were undertaken to assist industry with relevant information. The department also launched Focus Taiwan in November 1998 to strengthen the links between the Western Australian and Taiwan food industries.

Other activities related to efforts to increase markets for pig meat, participation with primary producers, processors and retailers in workshops and seminars and making a contribution to the Memoranda of Understanding developed between the WA Government and those of Jordan, Egypt and Taiwan.

The department also completed a pre-feasibility study for construction of a modern abattoir in the Kimberley. In the event this was not built.

The department also provided assistance to some small companies, and gave advice to a number of companies on export opportunities. Executive support was provided to the Grain Export Licensing Authority, which included advice on policy, operational procedures, the conduct of market research and analysis to assist in the assessment of applications for special export licences.

In April 2007, the Biofuel Task Force completed a report on industry activity which included research on alternative oil seeds, design of an industrial wheat breeding program, establishment of a biofuel website and the preparation of several articles. It also helped one company to establish two ethanol plants in WA with a productive capacity of 190 million litres. Each plant would require 500,000 tonnes of grain feedstock annually.

As part of its overseas activities the department won and successfully managed
a number of international training and consultancy projects in Asia and the Middle East.

It also assessed opportunities for summer fruit exports to India and the UAE and investigated the market for plums and nectarines.

Manjimup apple growers marketed red apples to India using the bulk transport technique developed by the department.

Mango exports to the UK and Europe started, with new sea freight technologies. Carnarvon growers were trying a new table grape bred by CSIRO and evaluated by the department to develop an export market.

**Wool/Live Sheep Program**

As in previous reporting the samples of departmental activities which follow are meant to be indicative and not complete records. During the period there were a number of notable successes for the program which included:

- attracting early-stage wool processing to WA
- management to ensure wool is prepared and handled in accordance with the customer’s requirements
- sale of wool through a quality assurance scheme
- development of a vaccine for lumpy wool
- research resulting in reduced death rates during export of live sheep
- development of two decision tools—‘lamb planner’ and the first of a family of tools to assist in the adoption of perennial pastures called ‘Evergraze more Meat from Perennials’; perennials were also seen as a method of reducing nutrient and water loss to aquifers
- demonstrating the value of lupin stubbles for feeding weaners over summer
- demonstrating that uniform fibre thickness was a genetic and hereditable characteristic which opened the opportunity for farmers to control feed supplies to meet pre-determined target fibre diameter
- developing groups of growers selling direct to processors to shorten the wool supply chain, coupled with in-shed testing of wool to guarantee quality
- examining the influence of variability in fibre diameter on the ease of processing of wool and the value of in-shed sampling
- development of a prediction model to estimate hauteur based on the fibre diameter profile
- modelling to determine whether it was profitable to select replacement ewes by in-shed measurement
- demonstration that felting is a heritable character and an opportunity for breeding for lower shrinkage
- establishment of a protocol for on-farm testing and selection of fleeces on the basis of fibre curvature
- testing in 2001 of new technology of feeding fungi to sheep for worm control
- preparation of models to make comparisons of prices received by growers and between different selling centres for wool of comparable characteristics
- finding that genetic resistance to worms was available in the Rylington flock
- beginning the development of measurement of pasture growth rate and availability by satellite.

The department started several collaborative studies with major overseas processors, with the aim of developing a special relationship with Western Australian wool, such as had been achieved with Indian processors. This included demonstrations of WA wool to processors, and studies of removal of contaminants. In one case there was collaboration with an Italian processor to produce a fabric designed to achieve excellent ‘next to the skin’ comfort based on in-shed testing of the raw product.
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The Wool Design Laboratory. The department shifted part of its research focus to post farm gate opportunities, including studies of options for the wool industries.

In Europe, collaborative studies were carried out between a major Scottish wool spinner and the WA wool industry. Professional officers visited Europe to initiate the development of partnerships; these were established with several carding, combing and spinning machinery manufacturers. A detailed technical paper showing that WA wool processed as well and at times better than predicted was presented to a major international wool conference. Experimental work was continuing on increasing wool staple strength.

On-farm evaluation projects began at the break of the 1996 season. Thirty-seven on-farm evaluations were conducted, with the aim of improving farm productivity by application of new information and the use of new pasture plants. This work continued throughout the period.

In 1998 fine fibre-end wool (autumn-shorn) was taken through to garment manufacture, and evaluation was organised through UK retailer Marks and Spencer. This program continued through the period. Wool fabric made from ‘fine end’ wool was released in Italy in July 2006 and received wide praise at the yarns trade fairs in Europe.

A strategy was launched to improve returns through supply chain partnerships, which meant an increase in direct marketing, to reduce the inherent costs of the multiple changes of ownership.

The department registered a provisional patent for rotor spinning of 100 per cent wool in May 1999. This followed trials with a German machinery manufacturer. Its commercial production would substantially reduce the cost of spinning. Tests reported in 2001 showed this system was commercially useable.

Processing trials with a French carding machinery manufacturer using Western Australian wool were extremely successful, pushing efficiency of throughput to a new level. Trials with spinning long hauteur wool at an overseas mill under supervision proved this type of wool could be handled satisfactorily. This should have resulted in the removal of the discount this wool experienced in the market.

On-farm work pointed to the desirability of maintaining a flat fibre diameter level throughout the season, avoiding thickening in periods of plentiful feed.

Trials at Katanning using wethers showed marked differences in production between blood lines. Wether comparison trials were carried out up to 2000.

Concerns with increasing European controls on pesticide residues in wool scours were noted.

The department was part of a group which succeeded in obtaining a new Sheep Cooperative Research Centre for Western Australia. This centre focused on improving the whole-of-garment comfort from wool, increasing the yield of meat from lambs while retaining eating quality, expanding research into control of stomach worms and establishing a nucleus flock as part of a progeny testing scheme for both wool and meat sires linked to similar flocks in other states.

Initial research into breeding breach strike-resistant Merino sheep was advanced successfully. The department has opposed mulesing and eliminated it from its animal management practices. While this could be a sound policy decision it has caused management difficulties at field level.
In a farmer-based trial comparing production within a wether flock it was shown that large differences existed between the top and bottom producers, providing an opportunity to markedly increase profitability. Feed requirements for lambing ewes were also being tested under field conditions.

At farm level new pasture species were becoming available from the breeding and selection program. During 2001/02 the department released an early maturing yellow serradella, a redlegged earth mite-resistant gland clover and a soft-seeded biserula. Seed of a hard-seeded PVR selection of French serradella was being built up.

The Meat Program

Beef

In 1999 the department, in association with Meat and Livestock Australia, decided to spend $1 million over three years to implement a national beef grading scheme called Meat Standards Australia. Industry support and cooperation were outstanding, with all sectors giving strong support.

The effect of hormone growth promotants on meat quality was investigated. Key findings were that carcase weight rose without increase in fatness, although beef from treated cattle was not as tender as untreated cattle, and marbling was reduced.

Achievements included the demonstration of successful beef production on tagasaste. This success was the basis for the promotion of tagasaste for the sandplain soils of the West Midlands where pasture plants struggle to provide satisfactory grazing. The use of tagasaste in the farming system for both sheep and cattle was being developed.

In 2001 work to examine the feasibility of lot feeding beef on the western sandplain, central wheatbelt and Esperance was reported. Other work showed that supplementation of steers and heifers with home-grown grain produced economic benefits from cattle grazing perennial grasses in the Esperance region.

Research also suggested shifting calving time from autumn to winter could be an advantage.

It was noted that experimental work was still proceeding on fattening pastoral cattle on irrigated leucaena in the Kimberley.

Experiments and demonstrations with controlled grazing of beef cattle in the South West showed that stocking rates could be increased by up to 30 per cent. The potential increase in production came from the transfer of technology from the dairy industry. This involved the use of nitrogen fertiliser, conservation of the spring flush and possibly some finishing with grain supplements. A hindrance to adoption of this program was the market power of the supermarkets and the absence of firm contracts to encourage the necessary investment.

There was also a focus on the use of perennial legumes for increased production and higher water use in the higher rainfall zone. The use of kikuyu was being promoted. As in the other programs a network of international scientific contacts in countries with similar climatic conditions was established.

A Singapore Beef Alliance was formed by the cold storage supermarkets, wholesalers and producers to promote premium quality Western Australian beef under the brand name of 'Nature's Choice' for the South-East Asian supermarket trade.

Work on the efficiency of conversion of feed showed that all beef herds had a range of efficiency from which to select. Feed intake was an important selection criterion because it had been shown to be independent of growth rate. Selection for efficiency was a major way to reduce the feed costs of fattening steers. The saving could amount to $65 per head.

It was shown that glycogen, not pH, was the indicator of dark cutting meat. Therefore steers should be kept on a high plane of
nutrition before slaughter to ensure an adequate level of glycogen in their systems. The work also showed that feedlot steers could be transported for up to 10 hours and still maintain high levels of glycogen. The department completed work on the establishment of objective benchmarks that described consumer perception of meat colour during shelf displays.

The use of virginiamycin to prevent problems related to gram-positive bacteria when grain alone was fed to cattle was potentially important to the feedlot industry.

It was shown that the dropped ovary pregnancy control technique was potentially valuable in the Kimberley.

It was reported that strategic alliances for live cattle export had been established. Work was also carried out to ensure higher standards of animal welfare in the trade. Investigations were in progress to reduce the ammonia level on ships exporting live cattle.

The department carried out a large beef project investigating maternal productivity of beef cows at the Vasse Research Centre. This was one of only two locations as part of the work of the Beef Cooperative Research Centre. A project involving 200 beef cattle, investigating the function of genes in controlling post-mortem tenderisation of beef had been completed.

Sheep and goats

Five meat breeds were introduced from South Africa: Dorpa, white Dorpa, South African Meat Merino, Dohne and Africaner. These new sheep breeds were being tested for suitability for the pastoral areas in 2001. The department participated in a national program to develop standards for eating quality of both sheep and pig meat to parallel the work done with beef.

The requirements of potential export customers for live sheep appeared to have been met with the implementation of a successful scabby mouth vaccination campaign. This resulted in a significant reduction in this problem in live sheep unloaded at export destinations.

The first commercial export of Awassi-cross lambs was reported in the late 1990s, as the introductions came out of quarantine. Another first was the shipment in the late 1990s of first-cross Boer goats from Winderrie station at Gascoyne Junction to Malaysia, to demonstrate the superior growth rates, quality and lower mortality of the Boer-cross domesticated progeny. A promotion was also held in Kuala Lumpur to create awareness of WA goat meat. This program continued through the period, with record shipments reported in 2000. This work also showed that goats did not cause the anticipated damage to vegetation.

Dogs continued to be a major problem of small animal production in the pastoral country.

Interest in cashmere did not continue. Selection for cashmere production was continued at the University of WA farm at Allendale and higher yielding goats were developed.

Planning was proceeding to replace the Midland stock saleyards, with the establishment of the new yards at Muchea.
Dairy and Apiculture Program

Feed for dairy cows which produce throughout the year is a high cost, particularly on dryland farms over summer and autumn. For this reason the program focused on reducing the cost of the nutrition from before 1996/97. The aim was to reduce the cost, which amounted to about 30 per cent of total income at that time, and to increase stocking rates in order to increase profits. The work at Vasse Research Station helped farmers get better value from their pastures.

It was part of the overall industry focus on increased intensification of the livestock industries, associated with increased cropping and reduced areas and the opportunity to use lot feeding systems for finishing livestock.

A ‘protein plus’ program improved the milk protein received by processors. Collaborative work with CSIRO and the University of Queensland and others showed that time of calving, length of lactation and summer feeding were all factors affecting protein levels.

Some bacterial spores were shown to be resistant to ultra-high temperature treatment and investigations were started to identify their nature and source. While the level appeared to vary seasonally, some farm supplies consistently contained more spores than others. Since the spores appeared to originate from the teats during milking, careful washing and drying was tested and it reduced contamination by 70 to 80 per cent.

A bacterial identification service established on a cost recovery basis for producers with bacterial counts in their milk above the premium level was used by half of producers. An automated bacterial counting device installed by the Dairy Industry Authority allowed rapid tests.

Later the authority was abolished as part of the dairy privatisation program across Australia. Control of milk quality became the responsibility of the companies, who used price penalties to maintain quality. The department collaborated with De Laval Pty Ltd to assess the practicability of pre-milking sanitisation of teats. Pre-milking treatment improved shed and milk hygiene in summer and autumn.

A nutrient strategy, 'Dairy Catch', was developed for waste management on dairy farms and tested on four commercial farms. Pasture research directed at increasing the utilisation of paddock feed and decreasing waste was set up at the Vasse Research Station to study pasture utilisation on dryland dairy farms. The future dairy industry could well be on dryland farms south of Busselton, where underground water is available for sprinkler irrigation of summer pastures.

During 2008 the Minister for Agriculture opened the department's new dairy research facility at the Vasse Research Centre in Busselton.

A dairy pasture utilisation and production project was completed, with 86 per cent of surveyed producers rating the project as successful in helping to improve production. The productivity and persistence of new legume species (Caprera crimson clover and Cefau arrow-leaved clover) had been demonstrated. A book on perennial pastures for Western Australia, released in June 2007, detailed the current state of knowledge and prospects for perennial pastures in Western Australia. Three new pasture legume cultivars were also released.

A review of dairy industry legislation was completed in accordance with the national competition policy reform. The industry was deregulated in 2000 and the government offered a $27 million assistance scheme to help farmers adjust and to help develop markets for the dairy manufacturing industry.

Cereal Program

The change to the cropping system and increased information about market requirements and opportunities for accessing niche markets with specific quality requirements focused the Cereal Program on time of maturity and specific qualities as
well as disease resistance and yield. Fortunately, due to the reorganisation in the 1970s, coupled with substantial improvement in facilities since, there was capacity to cope with these new challenges, which involved matching grain quality to end users' requirements. During the period 11 new wheat varieties, three new oats and a new feed barley were released from the breeding program. These were in addition to the wheat varieties Eagle Rock and Tammarin Rock, and the malting barley Hamelin which were released separately. Details are given in Chapter 7. The German company BASF produced two back-crosses of wheat varieties with added resistance to herbicide. Collaboration with the CRCs for Molecular Plant Breeding and for Value Added Wheat and with the Murdoch University led to a Centre of Excellence titled 'The Centre for High Throughput Genetic Analysis', enabled the department to establish a joint centre for the state of the art of high throughput molecular screening for its grain breeding programs. Triticale was being examined as a significant stockfeed. The possibility of a durum wheat industry being developed was also examined.

A number of other actions guided the breeding program. Some of these were:

- hosting a group of Japanese wheat experts to the cereal laboratory to improve their knowledge of Western Australian grain products
- arranging for three staff to work in Singapore for 10 days to obtain an insight into Asian food products
- organising an expert to visit commercial processors and plant breeding organisations in the United States and Canada, to gain a better understanding of the quality requirements of oats for human consumption. This provided the base to breed cereals which the market wanted
- arranging to collaborate with the CRC for Wheat Quality in a study of potential for on-farm quality assurance
- promoting the importance of wheat quality to producers at a series of seminars, attended by 1000 growers
- development by the Cereal Laboratory of a simple test to characterise starch quality, to be used for selection of wheat varieties for noodle production
- researchers at the biotechnology centre identified a gene marker to assist in the selection of varieties with improved quality for Asian noodles
- research showed that a non-host crop would significantly reduce the number of cereal cyst nematodes in one season even where initial numbers were very high; these were more effective than resistant cereal crops.

The new production technology introduced during the late 1970s and early 1980s resulted in Western Australia’s average crop yield increasing at around 50 kilograms per hectare per year over the 1990s. The Cereal Program was also promoting packages to help growers to produce hard wheat, Udon noodles, soft wheat and malting barley.

Overseas visitors testing noodles. Cereal Chemist Graham Crosbie is second from right. The wheat breeding program had shifted focus to breeding to meet market needs.

Research had shown that significant benefits to cereal grain yield and protein content were available from well-managed medic pastures on medium and heavy soils in medium to low...
rainfall areas. In 2002 two new wheat varieties, Wyalkatchem and Harrismith, were released.

New global developments in research technology were adopted together with the use of genetic engineering and biotechnology to advance the breeding program. The double haploid technique was adopted to help the cereal breeding program, and marker-assisted selection was also used to identify promising crop crosses having desired characteristics.

The statement was made that "The main reason for Western Australia’s relatively high rate of productivity improvement was that its agriculture was dominated by grain production, which improved significantly over the decade. Several factors have contributed to rapid growth, including new crop varieties, new rotational and cropping practices and improved crop technology. More rapid varietal assessment and selection was aided by the development of near infra red (NIR) grain quality assessment and the development of grain markers linked to important breeding attributes”.

Agriculture WA was the main provider of new varieties for many crops and through its lead association with the Centre for Legumes in Mediterranean Agriculture (CLIMA), also of new varieties of lentils and Lathyrus.

Agronomic work included the use of gypsum on difficult grey clays, managing pastures in phase farming, the further use of raised beds for waterlogged areas, and studies of stubble management.

The department released an electronic directory ‘Tools to Assist Decision-making’ on its website to provide farmers and advisers with 40 tools for decision-making on various aspects of farming.

Work focused on weed control strategies in 2001 to counter the development of herbicide resistance. In 2007 a new publication Integrated Weed Management in Australian Cropping Systems—a training resource for farm advisers was released. Early in the period researchers confirmed that wild radish had joined ryegrass and wild oats as having resistance to a range of herbicides. Although it was aimed at Western Australia the publication became a national tool.

A rust outbreak in 2000 provided an opportunity to measure the value of spraying as a control technique.

Four global models of low rainfall, resulting from studies of climate change, were compared in terms of simulated monthly rainfall and maximum and minimum temperatures for eight selected locations in the grain belt. The simulated future yields showed a yield decline in most locations. Some yield increases were observed in some higher rainfall locations due to the combined effects of increased carbon dioxide and reduced waterlogging.

In 2000 it was reported that an El-Nino prediction index and a Southern Oscillation index had been developed to provide more accurate indications of the likelihood of major droughts and favourable seasons.

Information of the impact of a dry season was produced for all levels of government. A poor year in 2002 resulted in adverse circumstances assistance being administered.

**Grain Legumes and Pulses Program**

Work continued on a range of programs through the period. Highlights were:

Early spraying with a synthetic pyrethroid was shown to be successful in control of aphids and gave excellent control of cereal yellow dwarf virus disease, with a yield response of 1.5 tonnes per hectare of wheat and 2 tonnes per hectare of oats.

There was dramatic expansion in canola production from the 33 000 hectares sown in 1993 to 800 000 ha in 1999. Best practice was vigorously extended to the industry. A program was developed to produce specialty oil canola with high oleic and low linoleic acid. The department cooperated with international organisations in the development. The canola breeding program...
was passed on to the University of WA later in the period.

The pulse group was proactive in adopting quality assurance approaches as a basis for promotion of supply from WA to new markets, particularly India.

An outbreak of anthracnose in lupin crops in the northern grain growing areas resulted in 130 properties being placed in quarantine. Anthracnose resistance was identified through testing in New Zealand, resulting in early release of a resistant high yielding variety.

A joint venture between Cooperative Bulk Handling and George Weston Foods to build a processing facility provided opportunities for developing lupin products for the food industry.

The department developed prototype lupin milk and other dairy substitutes and was negotiating to find a partner to commercialise the products. They were considered superior to comparable soy products. No partner had been found to the end of the period.

The lupin breeding program produced a number of new varieties. Kalya a new high yielding anthracnose resistant variety of sweet lupin with a 5 to 15 per cent yield advantage over Gungurru was released during 1996. A new narrow-leafed lupin variety named Coromup was also released; it had higher protein than other available varieties and was targeted at the dehulling and protein market.

It was demonstrated that eating lupin-enriched bread increased the satiety and reduced energy intake in humans. This work, done in association with the new Western Australian Centre for Food and Genomic medicine, contributed to a significant medical publication which stimulated commercial interest in lupin flour from a major US food company.

Lupin seed gave outstanding results when whole seed was incorporated in fin fish diets. In 2000 the department was promoting the benefits of lupin and canola meal for aquaculture in Taiwan and China.

The first Australian release of an early flowering yellow lupin (Wodjil) was made. In 2000, early flowering *L. albus* was being built up. In 1997 a fully domesticated line of *L. atlanticus* was built up for testing. In 2003 these world first fully domesticated *Lupinus atlanticus* lines were tested in the field.

In 2002 the program was aided by the introduction of new technology to produce varieties with thinner hulls.

The first chickpea varieties were released in a joint program with New Zealand's Crop and Food Research Institute.

The development of Kaspar field peas, from Victoria, was a major advance. Kaspar is upright and easy to harvest. The release of two field peas for higher rainfall production areas had been positive for the industry but Kaspar was now expected to dominate as it outperformed Dunwa, which was released in 2002. Material resistant to black spot was identified and attempts were being made to have it introduced into the genome.

Two new lentil varieties were commercialised.

There was an increased focus on the need for lime in some soils which had developed increased acid levels, particularly for growing some pulses and oilseeds.

The genetic modification of lupins to transfer pesticide resistance into breeding lines was carried out in partnership with CLIMA. CLIMA had become the world’s leading centre for molecular biology of legumes. Partnerships were also entered into with other organisations to achieve access to specific skills or materials.

Some 300 tonnes of Cadiz serradella seed were produced during 1997/98. It was the most widely sown pasture seed in the 350 to 700 mm rainfall zone.

In 2000 there was interest in attracting investment in a biodiesel industry.

In 2000, new early triazine-tolerant, blackleg-tolerant canolas were showing high potential. WA lines had higher yields and higher oil and protein content than others tested. Another line had 65 per cent oleic and 24 per
cent linoleic oils. Fungicide treatment of seed was shown to be effective in controlling blackleg. In 2002 modelling of canola to forecast blackleg spore showers was developed.

Widely spaced rows and shielded sprays gave a 98 per cent control of ryegrass in lupins, with major advantages for the following wheat crop.

The first chickpeas were exported from south-western WA.

The department continued to be active with information, investigation and advice activities under this program.

**Horticulture Program**

The department serviced the fast-growing horticultural industries, which had a gross value of production of around $500 million. One-third of this amount was derived from exports. Vegetables contributed nearly half of the gross value of production, fruit 26 per cent, floriculture industries 22 per cent and wine 5 per cent. It was believed that exports would continue to grow strongly in the next decade.

Some main developments have been:

- the selection of a new fresh market potato, Nadine, after more than five years of testing. Nadine made strong inroads into the market with even, attractive tubers, free from blemish, and good resistance to disease. It also yielded better than Delaware, producing 10 per cent more premium grade tubers and up to 25 per cent more total yield
- unveiling of a new and improved cream-skinned fresh market potato variety called White Star during 2007/08. White Star should provide agronomic and profit gains for growers, and retail testing indicated 43 per cent of customers rated its appearance as excellent
- carrot exports increased with 53 000 tonnes exported in 2000/01
- increased mango production and new varieties were being developed
- wine grapes were planted at Welstead, Many Peaks and Bremer Bay at a density of 2222 vines per hectare
- application of new techniques to the management of Japanese grape varieties gave a berry size which was 50 per cent larger than in previous seasons. This was attractive and should open access to the Chinese market
- a superior strawberry variety developed in Victoria was being tested and commercialised in 2002
- export of crisping potatoes to Malaysia reached 6000 tonnes a year. The department was discussing these with Indonesian importers
- research on fertiliser leaching to the groundwater continued, with advice to growers being an important component
- a system allowing sea freight for mangoes from Kununurra to Asia was successfully developed and adopted by industry
- the possibilities for exporting lettuce to South-East Asia and the Middle East and seed potatoes to Vietnam were investigated. Cavity spot in export carrots was solved through better management packages.

The establishment of the Centre for Australian Plants was a new venture for floriculture. It brought together agencies and institutions for the domestic and international flower, foliage, pot plant and amenity plant markets.

Two new varieties of Geraldton wax—Jurien Bay and Esperance—were released. The department began a biotechnology program in floriculture with native species. The initial focus was on the mechanisms controlling flower colour. A world-first innovative plant tissue culturing system was developed to propagate plants which had proved hard to propagate, such as smokebush and the Qualup bell. Eleven varieties were released. Apple exports continued to grow with a new vigour, driven by new varieties such as Pink
Lady™, Sundowner™ and Lady Williams, which were all developed here. A quality assurance program for the industry was developed, with the involvement of the apple producers and packers. The export value of Pink Lady™ and Sundowner™ apples had grown to $7 million in 1997/98. In 2007/08 the department also released the first non-browning apple, called Enchanted™. Five further apple selections were granted provisional PVR registration.

The viticulture industry had a problem with obtaining good quality propagation material that was true to type and had known disease status. Agriculture WA helped to establish the Western Australian Vine Improvement Association to address this problem. The association established a source of stocks in all regions and quality management procedures to collect, treat, allocate and distribute 300 000 propagation units during the year. A high quality source was also established on Manjimup Research Station. Knowledge of vine fertiliser requirements was greatly improved by the department’s work and a manual, Fertilisers for Wine Grapes, was developed.

During 2007/08 the department concluded a world-first scientific study which proved that smoke affected the taste of wine grapes and subsequently the wine made from those grapes. This work was done as a result of burns and bushfires in growing areas. The study was of great interest to the Californian and South American wine industries.

Irrigation practices on wine grapes were revolutionised with the demonstration and adoption of regulated deficit irrigation practices. This involved stressing the vine during the growth phases and applying adequate water during berry development. Downy mildew had occurred for the first time on vines and the department was heavily involved in efforts to stop it from establishing in WA.

Over 60 new varieties of wine grapes were imported from the eastern states. This was aimed at ensuring WA had access to the best planting material available.

In 2002 a 10-year research and development project to establish table grapes in the north was successful when Carnarvon produced $6 million worth of grapes, with exports worth $750 000.

Banana production expanded, with 60 per cent of produce coming from Carnarvon and 40 per cent from Kununurra. Techniques had been developed for manipulating the timing of fruiting. Irrigation trials optimised soil moisture contents in the Ord. Appropriate plant density was also clarified.

An examination of the opportunities for the citrus industry indicated there was a significant opportunity for increased production.

There was also interest in identifying markets for organically-grown products. Work on the use of cold treatment to satisfy Japanese quarantine requirements for imported red-fleshed grapefruit was successful and new protocols for imported citrus were accepted by Japan.

Cotton production and management guidelines for the use of GM cotton on the Ord River Irrigation Area were developed.

The vegetablesWA website was developed in a partnership between the department, the Swan Catchment Council and the Premier’s Water Foundation as a medium for providing growers with access to information and an interactive on-line support for irrigation management.

In 2001 the department developed an export cauliflower plan which was adopted by industry. Research reduced the cost of production by 50 per cent, which offset rising costs. It also developed a fertiliser regime which excluded fowl manure, which had been banned for eight months of the year.

A major project was in place to address the requirements for production of horticultural crops on the Gnangara Mound. The aims were to reduce irrigation water use and minimise nutrient leaching. A good practice guide focusing on nutrient and water management for the Swan Coastal Plain was published by vegetablesWA in association
with the department. The publication aimed to improve grower profitability and reduce impacts on the environment.

The department was also developing innovative practices for reducing nutrient losses to groundwater associated with the irrigation of leafy and heading vegetables. Research indicated that vegetable yields can be tripled by a strategic application of mineral fertilisers, with reduced water application.

Strawberry production increased and there were significant exports, with a focus on improved quality, nutrition and handling.

**Food – an expanding program**

The development of a Food Program began in 2002 when an officer with a background in the food industry was recruited. This development was driven by a conviction that there was a real opportunity to provide greater value to the agricultural industries through work beyond the farm gate than through some on-farm work. However, the department did not officially become the Department of Agriculture and Food until 2006.

From 2002 to 2006 there had been considerable conflict with other departments on whether the Department of Agriculture had a role in the food industry. During this period the department developed its capacity to contribute, as is reflected in some of the issues worked on before 2006.

In 2008 considerable work continued in determining the best way to move forward in partnership with industry. A Food Industry Development Plan was developed and submitted to Cabinet immediately before the change of government. It had the support of other departments but was not considered due to the decision to call the 2008 election early. Some food-related issues addressed by the department during the period were:

- It helped reduce the burden of the food regulatory environment, providing input to the national debate on topics such as fortification of foods and origin labelling. It coordinated 60 Western Australian companies in showing at major international trade fairs.

- The Safe Food to Quality system (SFQ 2000) was expanded and more than 600 Australian agribusinesses were certified under the system.

- Work was done to eliminate the 'boar taint' from large pig carcases.

- Feeding trials indicated that feeding protected sulphur amino acids improved the quality of meat and the profitability of prime lamb production.

- Investigations into markets for manufactured products from the dairy industry were started.

- The dairy industry agreed to a system of quality assurance for dairy production and a quality assurance system for farm production, which was tested on about 45 pilot farms.

- The department's R&D (research and development) capacity was enhanced by the initiation of an alliance with Food Science Australia and establishment of Food-Net solutions.

- The creation and implementation of the *Buy West, Eat Best* program which encouraged the presence of local products in supermarkets.
Launch of the Buy West, Eat Best campaign. As part of its focus on market opportunities the department assisted with this campaign.

Disease Control/Biosecurity Program

Endemic disease and pest control has historically been an important part of the department’s activities. The Biosecurity Program is associated with barrier, quarantine and export standards, surveillance and preparedness, plant pest and disease eradication and control, animal disease eradication and control, vertebrate pests, resource protection and product support.

A significant issue was the requirement of the Uruguay Round that countries belonging to the General Agreement on Tariffs and Trade should show that quarantine provisions are not used as unreasonable barriers to trade.

An office of the Chief Veterinary Officer was established to service the needs of internal and external customers in relation to issues of animal health identification and disease control.

In 2003/04 the department took on a greater role in animal welfare, particularly in improving welfare for livestock.

The management of chemical residues continued, although it had been 10 years since the original market problem occurred.

Detector dogs and the Rapi-scan X-ray machine, coupled with road checkpoints, were important in the quarantine program.

Like other programs, quarantine and pest and disease control has continued. It brought a number of important results including:

- biological control of ARGT was successfully demonstrated in 1995/96 in field plots, using a fungus, *Dilophospora alopecuris*
- an effective response to the anthracnose disease outbreak in lupins
- successful implementation of WA’s component of the National Brucellosis and Tuberculosis Eradication Campaign
- continued implementation of the footrot eradication campaign
- the eradication of apple scab and identification of a new outbreak
- the introduction of Paterson’s curse control agents into the field
- progress with biological control of mesquite
- control of bee diseases
- the effective management of the animal disease diagnostic service
- the recognition of the Albany footrot laboratory as the Australian national reference laboratory. The number of properties under quarantine for virulent footrot increased from 48 to 58 during 1998/99, largely on abattoir surveillance. The industry agreed that sheep producers would provide the majority of funding and manage the footrot control program.
• emergency response capacity was strengthened through planning and training and the contribution of the department to crises such as the Esperance fires and floods, Moora floods and cyclone damage in the Gascoyne-Murchison regions

• effectively dealing with outbreaks of mildew in grapes, chalk brood in bees, sugarcane smut and a mice plague, which resulted in commendation of the department's performance

• development of a wheat industry protection action plan to minimise the risk of damage from exotic pests and weeds, diseases and pesticide residues

• drafting an industry protection and action plan with the wine grape, table grape and dried fruits industry

• accreditation of the Western Australian Animal Health Laboratory by the National Association of Testing Authorities (NATA) and continued provision of effective diagnostic capacity for a wide range of animal diseases

• participation in a national surveillance program for transmissible spongiform encephalopathy (TSE) which began in 1998. Coupled with the ban on feeding of mammalian protein to ruminants, this maintained Australia's access to markets which require TSE freedom

• agreement to cost-sharing arrangements which were developed for national pest and disease incursions. The department supported the development of the Australian Plant Health Council to lead the planning and responses to the increasing range of serious plant pests and health challenges facing Australia's plant industries

• continued provision of international quarantine and export services across WA under an arrangement with the Australian Quarantine and Inspection Service

• interstate quarantine inspections at permanent checkpoints at the State border at Kununurra and Eucla and through a mobile checkpoint. Almost 85 000 vehicles were checked, with 45 000 seizures, principally of fruit and vegetables, plants and honey

• operating detector dogs at the Perth Domestic Airport, at over 11 000 flights carrying over 1.2 million passengers. The Rapi-scan X-ray machine allowed scanning of an increased number of interstate and international parcels. This resulted in significant increases in the interceptions of seed consignments entering Western Australia from interstate

• imposing intrastate restrictions on the movement of stone fruit and citrus into the Ord River Irrigation Area to protect the area's freedom from Mediterranean fruit fly

• strengthening of the program in 1998 through funding of $3.5 million to boost interstate quarantine, to enable better protection for agriculture through activities such as regional surveillance coordination, extra quarantine detector dogs and a Rapi-scan X-ray technology at Australia Post's parcel post centre, plus a number of regulatory activities, including an improved risk assessment, removal of neglected orchards and development of a Mediterranean fruit fly eradication strategy
• continued association with CSIRO and others to develop integrated pest control for Paterson’s curse, cape tulip, blackberry, mesquite and parkinsonia

The department conducted extensive inspections for declared pests. Some issues addressed were:

• incursions of the European wasp and Khapra beetle were eliminated and other exotic pests were excluded
• starlings were successfully targeted and removed from South Coast areas west of Esperance
• surveys showed that the Kimberley area was free of important agricultural pests and animal and plant diseases
• a list of pests of greatest concern to Western Australia was compiled and relevant literature on their identification, control and eradication was accumulated
• the partnership adopted by the Agriculture Protection Board with the slogan ‘Protecting Agriculture is Everyone’s Business’ was launched
• arrangement made for 16 private companies to undertake the inspection of empty containers for contaminants before they were loaded with export goods
• amendments to the plant diseases regulations provided for interstate imports from firms with a certificate of assurance agreement based on auditable quality control
• eleven quarantine displays were mounted at agricultural and travel shows
• professional staff worked tirelessly to keep equine influenza out of Western Australia.

The rainbow lorikeet, an introduced pest that harms crops and native flora and fauna, was attacked by volunteers and organisations who removed more than 6500 wild birds from the Metropolitan Area.

In a world-first, detector dogs were employed to detect European house borer in suburban houses. This was regarded as an important scientific development. The program was staffed by two handlers and two dogs.

During 2007/08 the Australian plague locust control program covered 32 500 ha.

In 2007/08 the department was working with industry to enhance the State’s reputation as a preferred supplier of safe quality food. It was developing two major whole-of-government strategies, one for food and another for biosecurity, in conjunction with other agencies. It anticipated playing an increasing role in animal welfare. These initiatives were focused on community demand for greater evidence of plant and animal health status, including freedom from specific diseases, pests and chemical residues.

During 2007 the Biosecurity and Agriculture Management Act (BAM Act) was passed. This is an important piece of legislation which improves the ability of the State to manage, prevent and contain biosecurity risks, including pest plants and animals as well as diseases.

The Eucla checkpoint. Prevention of the introduction of pest species was an important part of the department’s work from its earliest days.
Chapter 5 – 1995 to 2008: a change of focus

The department enhanced the biosecurity team of inspectors and detector dogs and launched the new look Quarantine WA (QWA). During 2007/08 the Quarantine WA team checked around 14,500 vehicles entering WA via Eucla and Kununurra checkpoints and confiscated nearly 25,000 kg of quarantine risk material.

Rangeland Management Program
The overall thrust of the department's activity was the promotion of the concept of improved land management through the Land Conservation Development Committees and focusing on increased profitability through restructuring. However, during this period the Environmental Protection Authority issued a position paper entitled *Sustainability in the Rangelands of WA*. The department advised that it favoured an approach which included:

- a whole-of-government policy statement
- implementation of the National Strategy on Rangeland Management
- established environmental objectives standards
- specific delegation under the *EPA Act* to the Pastoral Board and the Commissioner for Soil Conservation.

Two significant contributions were made to the management of pastoral areas in the Kimberley. The first was the development of a business plan for the beef industry, based on changed herd management. Experimental work had shown that weaning of calves resulted in greater survival and a higher fecundity of females. The calves could be sent south for development and finishing or retained for sale at younger age as steers.

The department also demonstrated the value of irrigated Leucaena for fattening young stock from early weaning. The plan aimed at changing the turn-off from five-year-old steers to younger animals in order to increase the breeding herd and the gross income of the stations. This plan became the leading focus of the Kimberley beef industry development team for education and training at its September 1994 meeting. There was some adoption of the plan by the end of the period but this was relatively slow.

In association with the Kimberley Beef Research Committee and supported by Meat and Livestock Australia, the department developed a grazing land management package for the Kimberley Region aimed at maintaining and using pastures during highest value. A report on diet quality and performance of grazing cattle in northern WA was also submitted to Meat and Livestock Australia. The project reported on changes in body condition of breeder cattle grazed on pastures in the Pilbara and Kimberley over three years. A landcare teacher's resource kit was also developed for the Kimberley.

The department established close collaboration with indigenous pastoral lessees. Management support projects were established with five of the 14 indigenous-owned properties in the Kimberley.

The department developed an employment program with an Aboriginal employment group to develop contract teams to service the mustering, feral animal eradication and pastoral rangeland monitoring needs of the Gascoyne.

Management plans were developed in the southern pastoral areas and live cattle exports from these areas were promoted. Major rangeland surveys were completed in the Murchison and the north-eastern Goldfields.

Methods of achieving more even grazing across pastoral lands were investigated, including satellite imagery to provide information on which improved rangeland management could be based. An arrangement was also made in association with CSIRO to bolster the research effort in southern rangelands. This involved, among other initiatives, the use of GPS to trace cattle and sheep grazing movements.

Improved knowledge of landscape and rumen ecology was extended to the industry so that pastoralists would have a sounder
basis on which to redesign livestock production systems.

A $450 000 total grazing control project was funded at Winderie station in the Carnarvon area to examine the impact of goats on the environment and to measure their productivity, particularly for meat production. This demonstration was to be the basis for considering the feasibility of a goat meat industry in the southern pastoral areas.

In 2006/07 the department was developing a program for new opportunities for tropical and pastoral agriculture. This project identified opportunities for expanded agricultural and pastoral development in the west Kimberley. These included a re-examination of the opportunities for intensive agriculture south-east of Broome, based on the use of underground water supplies.

The Carnarvon artesian basin was successfully rehabilitated during the period by closing off bores, which resulted in rising pressures in the artesian field. The department completed a drilling program to prove the water resources of both the proposed Meda and Brickhouse horticultural precincts. The estimated total amount of water available for other uses as a result of closing the bores was 100 GL annually. A detailed examination was being made of possible uses for the saved artesian water. At the end of the period the project was still under consideration.

The department's publication Pastoral Stock Water Workbook was accepted as an important contribution to infrastructure development for the northern beef industry; it will be republished by Meat and Livestock Australia.

**New Industry Development Program**

Under the new industry development component a Centre for New Industry Development was established. In this context a number of industries were referred to as 'emerging'. These were cocoa, poppies, organic farming, olives, camels, green tea, pharmaceuticals in clover, bamboo, bush foods and rice. It was reported that both cotton and sugar were now regarded as developed industries in WA and would be considered under the Horticulture Program in future.

The aquaculture industry was also seen as developed and would now fall under the Sustainable Rural Development Program. The relative efficiency of the olive industry was assessed in association with the Department of Commerce and Trade. Some work was also done on the water requirements of olives.

Opportunities for a pistachio industry were examined in the wheatbelt.

The possibility of a grain-fed beef industry in the wheatbelt was considered.

There was continued interest in the development of pharmaceuticals from native flora.

Ord River rice potential was discussed with the national body.

**Trade and Development Program**

A range of initiatives was undertaken, including follow-up on markets for fishery and food products in Egypt and Jordan, assistance to the pig industry with exports to Singapore, help to cattle exporters in obtaining new markets, negotiating improved cool chain arrangements for fresh horticultural exports, participation in the Taiwan Food Show to consolidate market share, and hosting visits from importing countries to assist in identifying importers' needs and to display WA products.

In 2002 this program involved with promotion of Margaret River products in Singapore, developing a stronger relationship with Taiwan's agriculture and food industries and follow-up with the Middle East market development. A number of major market research reports were produced and Moore River olive growers were assisted with the production of a pre-feasibility report on establishment of a processing plant.

Contacts were made to clarify shelf life of vacuum-packed meat products and to
identify further opportunities for canola sales in Dubai and possibly Saudi Arabia. There was also interest in a Middle Eastern country investing in a milk processing plant.

In Japan, the department supported the approval of lupins as a human food, resulting in a soy/lupin sauce being prepared.

In the UK and Europe pig producers were encouraged to invest in WA. One producer established a piggery at Beverley.

In 2004 the department facilitated a $2.5 million investment by a Japanese company in a starch and gluten factory, as well as further development by the UK in pig production valued at $1 million. It supported 50 agrifood companies in a major international trade fair at Dubai. It also assisted with the establishment of a new State trade and investment office in South Korea. It won and managed a number of projects in Asia and the Middle East.

**Natural Resource Management Program**

Soil conservation had been a priority of the department since the 1940s when the original *Soil Conservation Act* was enacted. Soil conservation staff had received little community support for many years despite being committed to achieving important outcomes. Community interest and support only really surfaced in the early 1980s following the major 1983 drought in NSW and northern Victoria resulting in a major dust storm over Melbourne.

As the commitment to soil conservation and rangeland management became a demand for sustainable land use, the department provided leadership in the development and adoption of sustainable land management practices. This was initially achieved through promotion of the landcare movement from the early 1980s. This had involved the establishment and support of the Land Conservation and Development Committees (LCDCs). As the programs matured through the 1990s the focus shifted to whole catchments and/or sub-catchments. This resulted in the closing down of many LCDCs in the late 1990s and early 2000s.

In the mid-1980s the State and Commonwealth Governments agreed that development in rural Australia should be based on ecologically sustainable development principles which aimed to maximise economic and social benefits while preserving options for the future. Rural people had demonstrated that they were strongly committed to landcare principles and they expected to participate as communities in land use planning and management at catchment and local levels. A number of shires appointed community landcare coordinators. Some exceptional circumstances assistance was needed in some areas to allow natural resource management programs to continue. The South Coast needed this assistance in the early years due to unseasonably strong winds, exacerbating dry conditions.

Cropping, with the historical need for ploughing and in some places bare fallowing, was always the major source of soil degradation and often soil loss. Almost in parallel with the developing demand for sustainable land use, the cropping system moved into a new era. The advent of herbicides which could control weeds selectively and effectively resulted in farmers being able to control weeds without cultivation. This drove the move, initially, towards reduced tillage and then to minimum tillage. The final development of one-pass planting almost eliminated the exposure of the soil to wind and water erosion.

At the same time it allowed farmers to seed earlier to maximise the use of rainfall. The practice of continuous cropping developed, which meant that deeper-rooted plants were established, growing longer. These developments had a major effect on the amount of water escaping the root zone. Coupled with the onset of climate change they have, without doubt, reduced the rate of development of dryland salinity. How much reduction and over what period will only become apparent over time.
A 'Farming for the Future' initiative completed the identification and documentation of a generic baseline of agricultural management practices. This was to be used by the agricultural industries to assess, verify and improve sustainability. Using these criteria, assessments of the Geographe Bay and Ellenbrook catchments were completed. These included the collation of information on the adoption of management practices to reduce nutrient export. Considerable work was also done on studies and assessment of surface water structures as a basis for water conservation.

A Gascoyne/Murchison regional strategy was prepared, following extensive consultation and the development of a range of initiatives to deal with the decade-long downturn in economic conditions. The strategy included economic and structural adjustment, land use management, regional development including diversification of enterprises, environmental protection to achieve adequate representation of ecosystems in reserves, and improved social infrastructure.

Within this initiative a program for coherent property business management and planning was established by integrating a focus on farm business planning and implementation, and training in business skills by the Rural Adjustment Scheme with a sustainability rural program initiated by the Commonwealth Government. This and other initiatives dealt with both the environmental and financial sustainability of producers, with the program delivering funding and support to enhance the business skills and abilities of primary producers. There was also assistance to enhance the capacity and willingness of communities to be involved in community development in rural areas.

Under the general heading of 'Doing More with Agriculture', a range of programs within regions aimed at the development of leaders within the rural community and developing the capacity for them to manage social and economic change. This included building self-management of marketing. There was also a secondary objective of building the capacity in the private consulting finance and training sectors to deliver an expanded program over four years, while evaluating prospects for market-driven training in the long term.

In the period from 1995 to 2008 the Government issued or developed a number of plans and policies, including:

- a policy statement on managing rangelands
- a new drainage policy which aimed to minimise the environmental impact of saltland drainage and reduce conflict, through a catchment approach to drainage proposals
- a State policy on natural resource management and partnership with community groups
- a report on priorities to reduce greenhouse gas emissions in agriculture was jointly developed with other agencies
- a ‘Planning for Agricultural and Rural Land Use’ discussion paper was co-developed with the Western Australian Planning Commission and involved extensive community consultation.

The WA Government’s Salinity Action Plan was a major initiative. This plan aimed at controlling salinity and reducing its impact on agricultural land, water resources, natural diversity and built infrastructure. The plan included the Rural Towns Program which entailed planning, technical advice and direct funding of works to halt and reverse groundwater rise in those country towns which were most under threat from salinity. Sixteen towns were involved.

Other Salinity Action Plan activities included revegetation on farms, a water use calculator for estimating water use in farming systems, initiation of a best drainage practice project for the eastern wheatbelt, completion of a high water use farming system project, negotiations with the Commonwealth to modify the Rural Adjustment Scheme to permit cost sharing for critical works required for catchment management projects, and
development of standard methodology for local-scale catchment management. From 2003 to 2008 the department took a lead role in the coordination, management and delivery of the National Action Plan for Salinity and Water Quality and the Natural Heritage Trust (NHT2). This plan was the extension, in Western Australia, of the Natural Heritage Trust and the National Landcare Program. Some $400 million of Commonwealth and State funds were invested over the period in community partnerships to achieve natural resource management outcomes under the regional delivery model. This model was based on catchment-scale landscape and natural vegetation targets set by five groups. These were the Avon, South West, South Coast, Northern Agricultural and Swan Catchments. These groups carried out the planned programs.

Specific State plans under the State Salinity Strategy related to the Catchment Demonstration Initiative (CDI) and the Engineering Evaluation Initiative. These initiatives were designed to provide long-term economical solutions to salinity managements. Four catchments were selected for the CDI initiative, which included surface water management, greater use of deep-rooted species and establishment of large areas of salt-tolerant plants.

As part of the focus shift to catchments, the rapid catchment appraisal system was extended to a further 1.83 million hectares.

Examples of the benefit-cost for industry resource protection were also given on the basis of plant pest and disease and animal pest and disease eradication, vertebrate pest control, work on chemical residues and inspection of pastoral properties. All the selected examples were favourable to the department.

A formal process designed to improve decision-making in land use planning was developed and called AGPLAN. It was used to identify and protect areas of key agricultural significance, avoid land use conflicts, integrate catchment and land management and environmental repair requirements, and encourage economic development and diversification in an environmentally responsible manner. The department developed a benchmarking method for assessment of existing surface water management works on farms. This study was intended to guide future work on catchment water planning.

The annual statement by the Commissioner for Soil and Land Conservation dealt with the review of drainage regulations; changes in land clearing controls which tightened the arrangements and required landholders to provide more detailed information on land clearing proposed; details of land clearing assessments approved and not approved; the number of drainage notices and those which were received in accordance with published drainage guidelines; the number of soil conservation notices issued; and the condition of the resource base with particular reference to dryland salinity in the south and rangeland condition in the north.

The monitoring of the extent of salinity and the condition of rangeland were important processes in assessing whether sustainability was being achieved. Input to government policy on a range of issues was another important sustainability activity. Remnant vegetation protection was managed through an agreement that all relevant government authorities would rely on a single evaluation process, with the assessment made on nature conservation and land conservation criteria. Over the period since conservation covenants were introduced in 1986, almost 93 000 ha had been protected. In some cases farmers who wished to clear a significant proportion of their farms were prevented from doing so because of a high level of clearing elsewhere in their catchment. A pilot natural resource adjustment scheme was established under which disadvantaged landholders were eligible for compensation. The prime responsibility for approval or not of clearing was moved from the Department of
Agriculture to the Department of the Environment.

The department set up a series of 21 weather stations to provide additional information to that provided by the Bureau of Meteorology to measure changes in climate over the next decade. These will form a valuable input into the Centre for Ecohydrology which has been set up with the University of WA. The Centre for Ecohydrology was established as a joint initiative between the department and the university as part of the Agricultural Research WA (ARWA) Alliance.

One indicator of the impact of the program was that the number of tree seedlings planted trebled between 1996/97 and 1998/99. There was an increase in integrated farm forestry which the department actively supported. With acidification increasing, the Soil Conservation Service supported the Time to Lime campaign. There had been a decline in land clearing resulting from changes in government policy and the active implementation of this policy through the department. Farm plans and programs had been widely adopted. Surveys indicated that 19 per cent of farm plans included predominantly natural resource information, 30 to 32 per cent included information predominantly related to business planning and 42 per cent included a mix of natural resource and business information.

The department’s work on enhancing the capacity and willingness of communities to adopt ecologically sustainable development principles had been an important component of its activities. An Agricultural Land Use Planning Policy and Procedures manual was also drafted for use in providing input to land use planning processes.

Fulfilment of the aims of the Salinity Action Plan was driven by focus catchments for which the department had formal responsibility. At the time of reporting 54 focus catchments existed throughout the South West. Agricultural region planning tools known as AgET and MODFLOW were developed and validated and were ready for use with farmers to evaluate the impact of catchment plans on groundwater conditions and soil salinity.

The department developed a benchmarking method for assessment of existing surface water management works on farms. This was designed to guide future work on catchment water planning.

A key part of the Natural Resource Management Program was the continued work on cropping initiatives and practices. These included the role of nutrient and stubble management, herbicide resistant weeds, the changing nature of diseases and the advent of new plant and animal diseases. This work was primarily carried out in the regions and is summarised below.

**In the high rainfall areas:**

The change resulted in programs such as:

- treatment of 2600 ha with 30 000 tonnes of red mud to reduce phosphorus loss from sandy soil in the Peel-Harvey catchment area
- working with community groups in the Birrega catchment to develop innovative catchment-based management of drainage water in the rural area. The initiative was expected to improve water quality and ecological values of riparian areas through using revegetation as nutrient filters on 80 km of drains in the Peel-Harvey catchment
- Water Wise on Farm irrigation training and information program was delivered to six priority groups in the Harvey, Manjimup, Scott River and Carnarvon irrigation areas
- development of policy and guidelines under planning legislation of proposals to retain productive agricultural resources
- development of a code of practice for the management of horticultural land on the Swan Coastal Plain to minimise nutrient loss to the subsurface water resources
obtaining funding for the preparation of a database for determining the availability of suitable land and water resources for horticulture development in the South West

development of a management plan for the East Muchea catchment, reconciling the varying objectives of landholders for incorporation into the Chittering Shire’s local rural strategy

couragement of integrated tree production by farmers in the South West through leading a group of farmers to look at developments in eastern Australia and New Zealand, improving liaison with industry, formation of a farmer group in the Peel-Harvey catchment to implement the establishment of pines on unproductive leaching sands, and increasing the understanding of soil suitability for blue gums

the Blackwood Catchment Coordinating Group signed an agreement with the Sustainable Rural Development Program to obtain $40 000 per year for program support and $60 000 for administration. This led to the Blackwood Land Conservation District being established, setting a precedent for regional bodies to take advantage of the statutory functions available to the LCDCs while not duplicating the actions of shire-based LCD committees

development of a strategy for the management of the Leschenault catchment to maintain its long-term productivity while improving or maintaining the water quality of the inlet

development of a proposal to obtain information on high water use on properties as a basis for determining alternative approaches.

In the medium-low rainfall cropping/grazing areas:

consultation with farmers, consultants and other stakeholders in each of six operational areas in the development of program plans and setting priorities

establishment of 30 catchment management groups in the central wheatbelt representing 470 farmers

fostering better management of seasonal risk by introducing a software package, ‘Rainman’ which:

  – allows extraction of rainfall data from a large number of sites in Western Australia

  – provides information on the soil water stored before the beginning of the season

  – starts a research project investigating the recharge being contributed to the groundwater system by unproductive acid sands

establishment of the Avondale Landcare Centre, which attracted some 5000 visitors in 1994

demonstration through experiments at Corrigin that deep placement of nutrients stimulated crop growth and production in soils without physical subsoil constraints in seasons where rainfall is sufficient to wet deeper soil layers

establishment through a survey of the Avon River catchment that 50 per cent of the catchment soils had a pH profile that indicated the application of lime would be profitable. About 75 per cent of topsoil (0-10 cm) had a pH below 5.5, 40 per cent of subsoils (10-20 cm) had a pH less than 4.8 and 25 per cent of deeper subsoil (20-30 cm) a pH less than 4.5. To the date of reporting this survey had tested 3000 sites. Large liming demonstrations installed in 2006 showed little benefit because of the dry conditions

establishment of a web-based dataset in partnership with the Avon Catchment Council to allow community-collected groundwater data to be collated into a managed database for easy access
• mapping of the condition and extent of remnant vegetation, using Landsat images in association with CSIRO
• the beginning of mapping of the South Coast, including hydro-geological mapping
• development of six catchment plans involving 150 individual farm plans incorporating NRM practices on the South Coast, which resulted in more than 10 000 ha of perennials being planted.

A further strategy named *Southern Prospects* for managing natural resources and developing rural communities on the South Coast was launched by the Minister for Agriculture after widespread consultation. Funding of the strategy amounted to over $4 million from a range of sources. Projects were developed and funded for:

• small catchment support teams to provide technical advice and group support to small catchments on the South Coast
• screening 2500 native species for their revegetation, environmental and economic potential
• ensuring that pests and weeds on both public and private lands were controlled in an integrated and efficient manner
• evaluating promising components of high water use farming systems
• monitoring and rehabilitating water resources
• ground works for the Gardiner and Corackerup catchment
• vegetation management for the Fitzgerald biosphere
• a photographic and written record of the Kalgan River
• four Green Corps teams to implement works in critical parts.

Some pastoral area activity:
The program examined ways to improve the economic and environmental sustainability of irrigated agriculture on the Ord River Irrigation Area. It identified water management practices as requiring adjustment.

Agriculture WA was aware that the government had approved a detailed feasibility study for the development of large scale irrigated agriculture in the west Kimberley and some 64 000 ha of land had been identified for potential development. This was not continued but it remained a possibility for the future.

Western Australia was responsible for a national rangeland monitoring program and had established nearly 1100 rangeland management and sustainability sites.

**Special activities during 2007/08**

The department developed and launched the WA Government's new food marketing campaign *Buy West, Eat Best*, which provided consumers with an assurance that they are buying products produced in Western Australia.

The department developed and established the first commercial cereal breeding company known as InterGrain Pty Ltd. This was a partnership between the Department of Agriculture and the Grains Research and Development Corporation. The arrangement gave plant breeding research workers access to new germ plasm via collaborative initiatives with the Molecular Plant Breeding Cooperative Research Centre and the China–Western Australia agreement on barley. It absorbed the department's wheat and barley breeding staff.

During 2007 the *Biosecurity and Agriculture Management Act* was passed. This was an important piece of legislation which improved the ability of the State to manage, prevent and contain biosecurity risks, including pest plants and animals as well as diseases.

The department also enhanced the biosecurity team of inspectors and detector dogs and launched the new look Quarantine WA (QWA) initiative.
Reporting requirements

During the period the department was required to report on its work against a series of outputs. These performance indicators were set at the beginning of the year and ranged across the total activities of the department. Also it had to report against an efficiency indicator dealing with the average cost per unit of knowledge obtained. The data provided, which came from independent sources, showed that Western Australian agriculture had outperformed that of all other states in each area under consideration. The reporting requirements asked for a measure of the average cost per unit of knowledge gained. This was difficult to calculate and the calculations inherently included estimations. Since subjective estimates were involved, the whole process could be regarded as of questionable value on any objective basis.

The department was also required to report on the outcomes in the improved sustainable development of the industry. This program required the department to meet efficiency indicators. Efficiency indicators were also applied to the work of the Rural Adjustment and Finance Corporation.

The Agriculture Protection Program was also examined. The process addressed the department's objective to minimise the impact of pests and diseases on productivity and market access. The program was also required to meet effectiveness indicators. The services provided by the Agriculture Protection Board were also examined. These services were also subject to efficiency indicators.

Miscellaneous information in the key performance indicators

Between 1930 and 1981 wheat yields increased by 7 kg per hectare per year. The average yields across the State in the 1960s and 1970s varied with season around 1.05 tonnes per hectare. The rate of increase rose to 21 kg/ha/year between 1982 and 2006 for an average yield around 1.6 tonnes per hectare. Very poor seasons in 2000, 2002, 2006 and 2007 contributed to much greater yield variability.

In 2007/08, 42 per cent of the State's woolclip was classed as superfine (less than 19.5 micron diameter) compared with just 37.5 per cent in 2006/07.

An independent survey in 2006/07 found that:

- 94 per cent of agricultural establishments performed some form of natural resource management
- agricultural businesses invested an estimated $526 million on NRM
- on an individual farm basis $41 000 was spent on NRM
- increased productivity and farm sustainability were the most commonly reported reasons for improving NRM practices
- continuing difficulty due to seasonal conditions limited the capacity of farmers to adopt some NRM practices.

A concluding comment

Since the beginning of the current period (1995 to 2008) the full weight of the modern management reporting philosophies has been implemented by the WA Government. The modern reporting system is clearly costly. It is not a ‘free good'. Every person employed in the preparation or assessment of the information, much of which is subjective, is directly competitive with a person providing a service to the community, or a hospital bed. Across the service there would be hundreds if not thousands of people doing just that. There is a real need for an objective benefit-cost analysis to be made of the whole system.
Chapter 6

Animal health and production issues

The Department of Agriculture contributed to the animal industries through the development and/or introduction of new management approaches and identification of the causes, development of control measures, and in some cases eradication of major diseases. Much of this work was outstanding in national and international terms and provided the firm foundation for Western Australia’s livestock industries.

This chapter lists issues covering specific work on animal health problems caused by infection, nutrition or management and two industry-related issues. A major component of the work on management in the livestock industries does not lend itself readily to that treatment. The first pages deal with these issues under the heading of Animal Production.

Animal production

Production research really began with the focus on fat lamb production in the early 1930s, and expanded in the post-war period, shifting emphasis depending on the issues of the time. Similar work was carried out for the southern beef industry after 1960 as staff resources permitted. While research relevant to the sheep industry was also carried out at the University of WA and CSIRO, particularly after World War II, the Department of Agriculture was the only organisation servicing the cattle and other industries at farm level in WA.

Sheep and wool

Fat lambs

In the 1930s the focus was on developing both the fat lamb industry and legume-based pastures.

There was a need to demonstrate the logic of the use of crossbred ewes (usually Border Leicester rams over Merino ewes) with terminal sires (basically Dorset and Southdown). This work was done mainly at Avondale. It was very important as farmers in the medium rainfall areas turned to fat lambs as an alternative to cereals following the 1929 Depression. These farmers would have had little or no knowledge of the breeds and husbandry needed to produce high quality fat lambs. The work included general supplementary feeding and focused feeding (flushing) of ewes before mating. It was shown that feeding a grain supplement to ewes in the last four to six weeks of pregnancy improved the survival of the ewe and lamb.

In the post-war period the increase in wool prices shifted the economics of fat lamb production towards the use of Merino ewes as opposed to crossbred ewes. In later work it was shown that a high protein diet before and during mating increased ovulation and lambing percentage (see below under sheep fertility). At that time there was also some detailed work on the exact mechanism involved in this stimulation of ovulation. This effect appeared to favour later mating and spring lambing when feed quality was higher. However, as high protein lupin stubbles became available from phomopsis-resistant crops, this may not necessarily have been the case.

Post-war research

During the post-war period the general thrusts of the research and extension activities of the Division of Animal Production were in continued work on sheep nutrition and reproduction; the effects of worms on productivity; management of flystrike; time of
shearing and lambing; stocking rates; objective measurement of wool; objective selection for desirable characteristics in the breeding industry; use of hormones to increase fertility in ewes and growth rates in wethers; interaction between pastures and the grazing animal; selection for fleece rot resistance; prevention of acidosis or grain poisoning; the problem of dust and the behaviour and management of sheep in export feedlots and during shipping (see below); the impact of nutrition on wool growth in autumn; and the value of ammonia-treated grain to increase protein content.

A computer model was developed to help vital decisions such as how many sheep to run in a paddock, and how much phosphate fertiliser to apply. The model looked at prices and costs and calculated the point of optimum return based on wool production as influenced by the effects of fertiliser rate and stocking rate on pasture production.

Management for survival of lambs immediately after birth and of weaners through the first summer/autumn was always critical. It was shown that the body weight of ewes at mid-pregnancy was an important factor. This was important, as work showed that as many as one in five Merino lambs died in WA between lambing and weaning.

During the rapid expansion of cleared area and area of sown pasture in the late 1950s and the 1960s there was an acute shortage of sheep. There was a dramatic fall in sheep numbers after the collapse of wool prices in 1990, and a shortage of sheep returned from around 2006 and became more acute as the prices paid for wool and lambs increased. In the 1960s work to increase the number of lambs produced per ewe included using rams from the high fecundity Booroola strain. However this demonstrated the need to ensure that the lambs survived through the early days after birth. In general, the more intensive management needed to ensure a high survival rate has not been available on the large farms in the State.

In the 1960s housing was also tested. While it improved survival, it was not practical. Overall this work showed the importance of close management and good nutrition during the lambing cycle.

At all times of lambing, weaner nutrition is critical to maintain growth rates (and survival) through the first summer/autumn. A lot of work was carried out over the years using different techniques for preserving feed quality or different direct supplements. The use of early-mown pastures was one technique tested as a mating supplement and feed supplement for weaners. The use of phomopsis-resistant lupin stubbles was also tested and this higher protein feed was shown to be an excellent diet for weaners.

It was calculated that if half of the seven million weaners in farming areas were grazed on lupin stubble this would yield an extra $15 million for the industry. Good nutrition to achieve high growth rates was particularly important if the mating of weaner ewes was planned. On the domestic market lambs carried over for the high-priced late summer to early winter markets need special attention. Considerable work was done on lamb nutrition, including lot-feeding. The effect of weaning of lambs several weeks before slaughter on carcase weight and quality was examined.

Lambing times and nutrition

The industry has traditionally mated ewes in the early summer for late autumn lambing. In the State’s Mediterranean environment, with reliance on annual pastures, late autumn is often a time of limited feed supply and quality. For this reason the department recommended that the industry shift lambing from autumn to spring when feed supplies for the milking ewe and growing lamb are normally available and increasing. The increased feed supplies in early spring reduced the level of supplementary feeding required in late pregnancy and reduced the potential for pregnancy toxemia in the ewe. In earlier times this did not suit the export fat lamb industry which aimed at a window of
opportunity from September to November before the UK market was supplied by New Zealand. After the UK entered the Common Market in 1971 this market was largely lost. While the logic seemed right the adoption of spring lambing by the industry was limited.

**Objective measurement in breeding**

Work based in NSW showed that improvement in the genetic capacity of a breed could be best achieved by selection of breeding stock on the basis of measurement of key characteristics. In a wool industry focused on fleece weight and the micron thickness, measurement was clearly demonstrated as being superior to the traditional visual assessment used in the Merino stud industry. The department promoted this technology heavily to the industry, with limited initial success. However, over time the industry moved to objective measurement in its breeding programs.

**Stocking rates**

Following the demonstration by CSIRO at Glen Lossie Research Station that higher stocking rates were both possible and desirable, a lot of testing and demonstration of this change was carried out across the State. A report of work on the interaction between fertiliser and stocking rates is in Chapter 7. These demonstrations were important in lifting stocking rate in the industry and improving profitability. This work also demonstrated the importance of testing pasture species under grazing, resulting in the productivity of some different pasture species being tested. It showed, among other things, that a species which is showy in spring but has a low seed set and a sparse autumn germination did not do well under intensive grazing. Another example was the performance of medic species of similar visual appearance in a large-scale grazing project on a red clay loam. The new medic species being tested proved capable of carrying 60 per cent more sheep without penalties in wool or liveweight production than the established (control) medic Cyprus.

**Wool: ‘Sale by sample’**

Historically, the assessment of fleece quality by buyers and producers was visual. CSIRO developed equipment capable of assessing the fineness of the fibres in microns. Starting in the early 1970s fleece measurement became the standard practice in the industry and wool was sold on its clean wool weight and the micron measure. Initially instruments measured the average micron of the wool sample. Subsequently instrumentation to measure the distribution of the fibre thickness in a sample was developed. This character was shown by the department to be heritable. The department was heavily involved in promoting this change in a conservative industry.

**Time of shearing and wool quality**

In WA ‘tender’ wool had been a continuing quality problem, with 36 per cent of wool offered at some sales affected. This resulted from the practice of spring shearing so that the weaker, summer/autumn wool was in the middle of the fibre strand. In order to address this problem the department recommended and promoted autumn shearing, which resulted in the weak growth being at the ends of the fibre. The uptake by the industry was variable and there remained a problem for spinners in dealing with the weaker ends on the autumn-shorn fibre. The CSIRO wool research laboratory showed that tender wool could be processed as well as other wools if the settings on the card were set appropriately. In recent years, the department, in association with spinners in Europe, has demonstrated this technology commercially. It was proved that with adjustment to machines both types of wool could be spun into an excellent product. Nevertheless there remained a strong case for better feeding of sheep through the summer/autumn. In 1993 the Department of Agriculture joined the Cooperative Research Centre for Premium Quality Wool established to look for ways to strengthen wool fibre.
The live sheep trade

The live sheep trade has been an important and growing part of the market for the past 50 years. Initially the shippers sought heavy older wethers. A study tour by a departmental officer in the late 1960s found that the consumers in the target countries actually preferred younger animals. While this was initially resisted by the shippers, change occurred progressively. The study also found that the market preferred local fat-tailed sheep over the Merinos from Australia. This led to the department introducing the Awassi breed into WA. While there was resistance from the wool industry, which saw a potential problem of the introduction of black fibres into the wool, the breed was established and now contributes to the live sheep trade. There were problems of high death rates during shipping. The problem of the behaviour and management of sheep in export feedlots and during shipping is discussed separately below, with details of the import of the Awassi breed.

Other focused investigations

The management of sheep grazing saltbush pastures was studied. It was found that a 50:50 saltbush:dry feed diet gave far better production than saltbush or dry feed alone. Extensive work on the management and feeding of sheep in drought years was done, resulting in detailed advice being available to farmers during drought.

Experiments with sheep subjected to very cold conditions immediately after shearing showed that a plastic cover was sufficient to protect them from death, but if they were uncovered they could only maintain body temperature for about 10 hours.

It was demonstrated that while zinc was an essential element, toxicity could be developed as had occurred in the United States. Trials using stubbles for sheep feed showed that location, species and variety could all affect the digestibility and chemical composition of the straw. Researchers were also checking on the likely causes of lameness among young sheep fed cereal grain for long periods. It appeared that the problem was due to lack of calcium in the diet.

Research in 1986/87 showed that an additive, flavomycin, could increase wool growth by as much as 20 per cent without increasing fibre diameter. The additive could also increase liveweight gains by up to 30 per cent, according to the report. The department lodged a patent application for the use of this additive. Progress in commercial development of devices which slowly released the additive to grazing animals made use of this technology by wool producers technically feasible.

Flystrike

The primary blowfly (Lucillia cuprina) entered Australia in 1913 but was not detected in WA until 1934. Its wide distribution at that time indicated it had been in the State for some time. Its presence had a major impact on sheep management and breeding. In favourable conditions for the fly there were heavy losses in pastoral areas where flocks were scattered and intensive management was not possible.

In the agricultural areas early control relied largely on selecting plain-bodied sheep, crutching and strategic shearing to reduce or eliminate areas attractive to flies. Synthetic insecticides after World War II made control easier, aided by the promotion of the 'Mules' operation by the department after 1950.

This operation involved slicing off the loose skin and the associated wool from the breech, which was the major area of flystrike, leaving a bare area which was not attractive to flies. Later, the activities of animal rights groups overseas opposing this operation and stimulating a boycott of wool from mulesed sheep, caused the department to decide to operate internally without using mulesing and to focus on breeding sheep less susceptible to flystrike. The industry has been ambivalent on the use of mulesing in more recent times. In southern areas it is difficult to manage large flocks without using the operation.
Strategic extension
A major innovation in response to collapse of the wool market in 1990 was the development of a Wool Industry Strategic Extension Program. This was to extend the immediate and long-term implications of wool industry changes to growers. To support this program 33 Farmnotes were prepared and distributed to 190 advisers and private consultants from December 1990 to May 1991.

A computer model was developed to help with vital decisions such as how many sheep to run in a paddock, and how much phosphate fertiliser to apply. The model looked at prices and costs and calculated the point of optimum return based on wool production as influenced by the effect fertiliser rate and stocking rates have on pasture production.

Animal Breeding and Research Institute
At the new Animal Breeding and Research Institute the main studies were a comparison between Merino strains and, in a cooperative project with Merino breeders, breeding higher fertility Merinos. As a result 450 potentially high-producing sheep were transferred to the institute as foundation stock. The institute also carried out work on embryo collection and storage which advanced that process. A pilot reference scheme for stud Merino rams was also developed. This program systematically tested young rams from many studs against reference sires, which allowed researchers to accurately compare rams from different studs. The establishment of the sire referencing program was controversial but the results revealed important issues which the industry could not reject. Demand from other states resulted in valuable links with the WA scheme which identified rams of higher breeding value which might otherwise have escaped industry attention.

By 1984 the institute had five registered studs, Bred to Breed studs and Body Weight studs. Both types had a horned and not horned (polled) selection. The fifth stud was the base flock. These flocks provided semen back to the participating studs and the outcomes were followed.

Research was also undertaken to determine if there was a genetic basis for the production of tender wool in Western Australia. This indicated that fibre diameter distribution is a heritable characteristic. Work on ewe and weaner nutrition and immunisation to increase fertility was also undertaken.

Beef cattle
Early work with the beef industry in the south centred around feeding and health control to achieve a high reproduction level and the finishing of young stock for market. Feeding of heifers for growth to achieve early mating was also important. The available autumn pasture in the South West is determined by the length of the growing season. The cold conditions and shorter day length limits growth from mid-May through to June or early August and can result in limited high-quality pasture in years when the autumn break is late. Normally there is a flush of feed in spring. Ideally cows with calves at foot should have a good food supply available at the time of peak demand, when the calf is four to six months-old. This requires autumn calving. However, this could not be undertaken without considering the effect of autumn feed conditions on late pregnant breeders, the one-year-old replacement heifers, and yearling cattle being prepared for turnoff at 20 months of age.

These issues interacted with methods of fodder conservation and improved use of the spring flush. As a result, considerable work was carried out on finishing beef cattle in winter. This involved grain feeding where it was shown that urea could both provide a useful elemental supplementary source of nitrogen and could control the daily amount of grain supplement accepted by cattle from the self-feeder.
Increased fodder conservation in the spring and increased autumn feed were common issues for both beef and dairy cattle. Nitrogen fertilisers were extensively tested on both pastures and sown fodder crops. Work also covered areas such as the feed requirements of different cattle, diets, and degrees of fatness. In 2008, as part of the work of the CRC on Beef Production (centred on New England University) an experiment was being carried out to examine the energy cost of the mother in a beef production operation. Angus cattle were obtained which had been selected for high energy and low energy conversions or high and low feed efficiencies. It was shown that energy efficiency was an independently inherited character.

The challenge for the beef industry remained achieving reasonable on-farm prices, permitting the adoption of much of the technology from the dairy industry. Feed production systems could be the same but affordability was the problem.

In work with both dairy and beef cattle, baled and plastic-wrapped silage was shown to be superior to hay as a method of conserving high quality roughage. It was easy to store without deterioration if conserved properly. In common with the dairy industry there was a focus on reduction in the protein degradation of the higher protein content of lupins in the rumen.

Comparison of breeds and selection systems was undertaken in a long-term genetics and technology experiment at Wokalup Research Station. The results indicated that a well planned embryo-based selection system had the potential to double the rate of genetic progress in a breeding herd.

In the early 1980s the department tested the feasibility of developing a computerised auction system of selling as an alternative to auction in a market. This system was based on on-farm visual assessment of weight and quality. Having had independent assessment of the carcase weight and quality of an animal or a group of animals, the owner could then offer them for sale on the computer-based auction. If satisfied with the offered price he sold, if not he withdrew the animal(s).

In line with the policy of developing computerised models for complex estimates, a profit maximising beef cattle feeding model was developed in 1985.

Carcase classification
During the late 1970s and early 1980s there was a general thrust across Australia for the development of a carcase classification system for the beef industry. A system was established but research continued, seeking a system which gave a more accurate estimate of fat distribution through the carcase.

A carcase classification group was established to develop and promote the use of objective description for the marketing of livestock carcasses and meat. The officers monitored classification in abattoirs, trained abattoir personnel in the system and sponsored the introduction of market development by specification and branding for both the domestic and export trades. A survey in March 1981 showed that the classification was firmly established at the retail and wholesale levels of the industry. In 1986/87 a national industry body responsible for product description and quality assurance called Aus-Meat was established. It saw WA as having the most comprehensive and complete system for carcase classification of any state and requested the department hand over responsibility for monitoring various schemes. Two officers were seconded to Aus-Meat to assist with its early work.

Kimberley cattle fattening and management
As the industry contracted to the medium and higher rainfall areas following the recovery of wool prices in the early 1970s, greater attention was directed to finishing Kimberley cattle.

Early experiments with cattle brought south at six months, 18 months and 30 months of
age were disappointing. In general the cattle only achieved a fat score of 2 and after consuming a tonne of feed per head. However the quality of the beef improved over time and the results showed that Kimberley cattle would need closer management for longer periods, which would improve eating quality.

In 1985/86 further work was done on finishing Kimberley cattle. Fattening Brahman-cross cattle from the Kimberley was a means of increasing the productivity of Kimberley stations. Results showed that Kimberley cattle with a higher proportion of Brahman blood would fatten satisfactorily but at a slightly higher weight than southern steers. By 1990/91 the department was satisfied that a reliable system for finishing pastoral cattle in the south under both grazing and feedlot conditions was available. A full-scale extension program across all beef producing areas was conducted, resulting in a very large increase in the number of cattle brought south for finishing. In 1992 it was shown that finishing Kimberley steers was more profitable than finishing south-western steers.

A survey in the 1960s of the age of cattle slaughtered in Kimberley abattoirs found that 68 per cent were eight-tooth, 19 per cent six-tooth and 6.5 per cent four-teeth. Very few were killed at two-tooth or younger. This approach was doubtless due to a history of poor market access and the need to walk to the abattoir. It also showed a high percentage of dry cattle in the herd, which further reduced the percentage of breeders that could be run. By 1990/91 a long-term program on the Kimberley Research Station had shown that substantial gains in efficiency and profitability were possible through improved weaning practices. (See some additional detail in Chapter 7.) It was shown that weaning at both the start and end of the dry season increased branding percentages from around 45 to 85 per cent. In addition, cow mortalities were reduced from around 18 to 9 per cent. Breeding from Brahman bulls increased the growth and survival of calves. Application of this management practice had the potential to revolutionise the Kimberley industry.

Experimental work in the early 1980s showed that with infusion of Brahman blood and improved fencing for herd control, it was possible to manage the herd differently. If mating was controlled, calves weaned (at least in part of the herd), the weaners trucked south for fattening (or fattened on irrigated pastures where available), the percentage of cows could be increased.

While cattle tick still needed to be controlled, the eradication of pleuro-pneumonia and TB had removed constraints on transport. Weaning itself was an important management practice as it allowed cows to put on condition, resulting in higher fertility. Even weaning and turning off two-tooth or four-tooth steers provided big opportunities. This work was developed into a management strategy which in later years was adopted by a number of Kimberley cattle stations.

**Dairy cow nutrition**

A dairy pasture utilisation and production project was completed, with 86 per cent of surveyed producers rating the project as successful in helping to improve production. In common with the beef industry a large amount of work was carried out on the relationship between stocking rate, nutrition and fodder conservation in the dairy areas. This included the use of nitrogen for both early autumn feed and increased hay or silage yields. It was shown that, in many cases, higher stocking levels could be carried comfortably when large amounts of fodder were conserved. Even at relatively high stocking rates part of the conserved fodder was carried over, depending on season. In general, the stocking rates achieved were considerably higher than traditional stocking rates in the area. This had a potential to result in a major increase in net farm income and viability. This work was expanded and tested in a large grazing trial at the Vasse Research...
Station in 2008. This experiment was testing the production from dairy cattle at five stocking rates and five rates of nitrogen fertilisation of the pasture. The rates of nitrogen were 0, 0.5, 1.0, 1.5 and 2.0 kg/ha/day applied as urea. The five stocking rates were 1.25, 1.5, 1.75, 2.0 and 2.25 cows/ha. Interestingly, the paddocks were no longer responsive to phosphorus and were topdressed with adequate potassium. The cows required selenium and may have required cobalt. In wet years there was need for additional sulphur in the latter part of the season. On-farm the nitrogen application and stocking was determined by the amount of ground cover. A leaf area index of 2.5 seemed about correct for maximum production. The production from the herd was very high. When the pasture dried off the animals were boxed and run on pasture irrigated with underground water. This could be the future for the dairy industry.

**Poultry industry**

The poultry industry was slow to establish in WA but during World War II had enjoyed a very good period of high demand. In the late 1940s a graduate poultry officer was appointed. He found that egg production per hen was low and undertook a production-research-demonstration program for both the laying and meat industry to bring it up to modern standards.

Breeds for both the laying industry and the meat industry needed to be sorted out, as were the feeding regimes. For the laying industry the most suitably-bred bird was selected and the environmental impact on its performance demonstrated. The major environmental issue was light, and in the early years techniques for light management developed. Initially, meat birds were also selected but as the industry became dominated by two major companies they adopted their own breeding stock.

**Feeding studies**

The emphasis in feed studies was on sources of protein and the balance between protein and energy. Of the items tested fishmeal appeared to increase growth rate more than other protein sources and this was confirmed in feeding trials. Rations with an energy to protein ratio of 45 to 1 were favoured. These experiments showed that riboflavin was not deficient in the normal diet.

A problem of the bruising of chickens during the early stages of processing was examined in 1984/85. This was caused within 12 hours of entering the processing chain and almost certainly during the catching and transporting process. Work was also undertaken on the use of a protected enzyme in increasing the efficiency of feed in broiler rations.

In trials on laying birds there was no comparable response to fishmeal. In contrast to the result from meat birds, experiments with layers showed riboflavin was deficient in the ration. With layers there was also an advantage of including green feed. Following this early work a full range of feeding trials was carried out.

With the later advent of lupins as a source of protein to replace the normal animal protein meals, particularly meat meal, experiments were carried out on the use of lupin meal. One special issue was the effect of lupin meal in increasing the moisture content of droppings. It was felt that if this could be overcome the use of lupins would be greatly increased.

Differences in the lupin meal from different varieties were tested as lupin meal became a major component of feed. The conclusion of this work in 1984/85 showed that lupin seed of either species was a suitable replacement for all or part of the meat meal in a layer ration. Another conclusion was that low nutritional density reduced egg production. Field peas were also tested as a protein source for layers. An algae which originated in the Pink Lakes near Esperance was also tested as a possible alternative yolk colour additive. A preliminary trial tested rapeseed meal from a new variety but it
appeared to slow growth rates on chicks from day-old to six weeks. Some serious disease problems also occurred, which are dealt with below.

Some disruption of the industry occurred when legislation to introduce quotas was implemented in 1971 to control over-production. Pressure for deregulation grew in NSW and controlled egg marketing was abandoned in that state in 1989, which meant deregulation in WA was inevitable.

**Pig industry**

Initially the work by the Intensive Industries Branch focused on diets which would achieve the low fat carcasses sought by the consumers. Lupin varieties and species were tested as alternative protein sources to meat meal. As they became available, particular interest was directed to work testing lupin kernel meal and other factors influencing carcase quality. A sire referencing system was established in the pig industry.

Separately the Animal Health Laboratories confirmed that the industry in WA was carrying a severe form of Atrophic rhinitis. This caused twisting of the snout and bleeding and could affect growth.

In 1984/85 the group continued providing a service to industry by testing pigs for growth rate and depth of fat and providing a selection index. Almost 9000 pigs were tested under this program.

An investigation of a dietary enzyme response was initiated. In this investigation, growing pigs were fed restricted diets, including a protected dietary enzyme. There was significantly improved feed efficiency and growth rate. Whether the growth rate change was due to increased energy or increased amino acid supply was examined.

Research reported in 1986/87 referred to the study of initiation of early puberty in young female pigs. It had been found that exposure of gilts to a mature boar stimulated puberty. An investigation was started to determine the underlying reasons for the boar effect.

A Pig Health Monitoring Scheme implemented in 1987 identified the major diseases present in the WA pig industry. Researchers were also examining the effect of different levels of nutrition on the speed with which sows returned to heat after weaning their piglets. They were aiming to determine the mechanism which caused better-fed sows to come into heat earlier.

**Apiculture**

WA was free of major bee diseases, and maintenance of strict quarantine was a vital service to the industry. Beekeepers were interested in having a subjective assessment of the cost of production by the Department of Agriculture. A subsequent survey indicated an average reduction in financial liquidity from 92 to 28 per cent in the industry over the past two years.

Investigational work by the Apiculture Section focused on pollen quality, fertilisation opportunities and flora regeneration.

Queen bee production was also a major activity. The queen bee unit was the largest in the world, due to the disease-free status of Western Australian bees. By 1984/85 the bee breeding program, which had been in progress for five years, had developed superior stock and distributing this to the industry.
Bees have a marked impact on the yield of canola.

The difference in quality between pollen sources was examined. In the later 1990s opportunities for arrangements to provide fertilisation services to agricultural industries began to emerge. Parts of the fruit industry were interested and the developing canola industry provided further opportunity.

**Animal Health: Infection, nutrition, management**

The animal-based industries and the use of horses for traction and transport were vital to the development of Western Australia in the early days of settlement. While the areas available for cropping were limited it was possible to run sheep on the extensive areas of shrub and grassland in the semi-arid pastoral areas and the Kimberley. In the south, care had to be taken with any use of the limited native pastures or scrub land due to poison plants.

**Inspection and regulation**

The sheep scab mite, *Psoroptes ovis*, entered the Colony early and its history provided evidence that a livestock disease could be controlled using a regulatory approach. The WA Government initially enacted a ‘Bill for the prevention and cure of scab in sheep’ in 1866. This was followed by the *Scab Act* which prohibited the movement of stock from infected areas without treatment. Sheep scab acts had been introduced in other states and had proved effective. Sheep scab was eradicated from WA by 1895.

Control of disease was generally restricted to the knowledge base brought from England. Most of the work of professionals was focused on inspection at the ports. A government veterinarian was employed before the establishment of the Bureau of Agriculture. This officer and his staff were incorporated into the Department of Agriculture in 1902. The senior veterinarian was then titled the Chief Inspector of Stock.

The normal work of the Stock Branch in the first 25 years was concerned with the inspection of imported animals, either from overseas or from interstate, particularly control of cattle imports to prevent bovine contagious pleuro-pneumonia being brought in from South Australia. There was also routine monitoring of the occurrence of endemic diseases and problems such as pleuro-pneumonia and cattle tick in the north, and tuberculosis (TB) of dairy cattle, lice and tick on sheep and problems of internal parasites, particularly of sheep, in the south. Contagious abortion (bovine brucellosis) became endemic and was reportedly being controlled by adoption of recommended practices. Action required later suggests this was an optimistic assessment.

In the general context of the development of the Colony, the 1903/04 report of the Chief Inspector of Stock is interesting. The bulk of the inspection work was at ports, with large numbers of stock imported. However, there had been an export of heifers from Wyndham to South Africa. In the south, the poultry industry was described as backward; impaction was the main source of death of dairy cattle, and although there had been only one reactor to the TB test, the Chief Veterinary Officer felt that the problem was widespread and he recommended compulsory testing of all dairy cows. He reported that influenza was a big killer of young pigs, and in that year lambing was ‘indifferent’ following a long dry summer.
In very early days cattle could be brought down from the north as there were no ticks until later, and pleuro-pneumonia was not recognised or seen as a problem. The hygiene at the abattoirs was obviously of concern and the chief inspector recommended that a central abattoir be constructed to improve meat inspection and the general hygiene associated with slaughter of livestock.

In 1904/05 the chief inspector reported that another 2000 heifers had been exported from Wyndham to South Africa. He also referred to tick-infested cattle being supplied to a Kalgoorlie abattoir. They were to be held ‘near Southern Cross at Hines Hill’. This suggests some ignorance of the geography of the State. Pleuro-pneumonia had been reported in some herds in the Metropolitan Area but had been eradicated. A swine fever outbreak was eradicated with losses to affected herds.

In 1909/10 it was reported that 7500 cattle were exported live from the Kimberley. In 1913 there had been a rapid growth in the live cattle trade to Java and Manila. It seems likely that the export was more frequent but was reported only spasmodically.

**Rinderpest**

An outbreak of rinderpest in 1923 was a serious problem but through firm action it was successfully dealt with. The disease was first reported from Beaconsfield. It was diagnosed on 20 November, and on 21 November the Chief Inspector of Stock ordered the destruction of all affected animals.

On the following day he ordered the destruction of all contact animals and all dairies in the area were quarantined. There was a lot of ‘common’ grazing ground around Beaconsfield, and control of cattle was not easy. There was also some hostility from dairy farmers who objected to their cows being shot. A further outbreak occurred in Bassendean on 26 November. As a result, the quarantine area was extended to a 30-mile radius from Fremantle. On 4 December a control board was formed, chaired by a pastoralist and including veterinarians from both the Commonwealth and State. The board took control and decided to slaughter all cattle, sheep, pigs and goats within a mile of an outbreak. A further extension from Bassendean was found on Rottnest Island on 27 December. The last case occurred on the mainland on 18 December. Rottnest Island was restocked on 11 February.

Western Australia was declared free on 26 March 1924 and all quarantine restrictions were lifted. This rapid eradication doubtless resulted from a willingness to take decisive action quickly. It was a credit to the limited veterinary staff of the State at that time. The disease has not recurred in WA.

This was the first occasion where the eradication of a livestock disease was the subject of cost sharing with the Commonwealth, although the Commonwealth share was not generous. It was later determined that the disease had entered Australia in stock brought by ship via Derby and Singapore and off-loaded at Fremantle.

**Swine plague and swine fever**

An extensive outbreak of swine plague was diagnosed along the Great Southern railway and branch lines in late 1927. A large part of that region was quarantined. The disease had been largely eradicated by the following April. Isolated infected properties remained and had to be dealt with individually. It was not mentioned again in reports and it is assumed it was eradicated.

Outbreaks of swine fever were reported periodically over the early years but were eradicated by quarantine and slaughter of affected herds. The last occurrence in 1942/43, was eradicated on a slaughter-out basis and involved the slaughter of 12 000 pigs.

The losses to individuals were substantial and resulted in a *Pig Industry Compensation Act* being passed in late 1942. A levy was charged on all sales of pigs and paid into a fund, to be used to compensate producers.
when their herds were affected by outbreaks of specified diseases.

Swill from an army camp was seen as the source of the infection which caused the outbreak in 1942/43. As a result, swill feeding was prohibited and remains prohibited today.

**Disease control and research**

*Bovine tuberculosis (TB)*

While bovine tuberculosis, caused by *Mycobacterium bovis*, was not a serious production-limiting disease for beef cattle, tuberculosis in the dairy herd was a major cause for concern because it is transmissible to humans, particularly children, through the consumption of contaminated, unpasteurised milk. Testing for TB was continuous from the early 1900s but reactors continued to be found at much the same rate, indicating that the disease level had changed little up to 1940/41.

In 1942/43 assistance was given to farmers to free their herds from both TB and contagious abortion (bovine brucellosis). The scheme, designed to accredit herds free of these diseases, was promoted but was not successful.

A trial on TB eradication at Harvey in that year showed that of 809 cows tested there were 5.5 per cent reactors. Later tests on many of the same herds showed the elimination of reactors had reduced the number of new reactors to 1.1 per cent. In 1946, the amended *Milk Act* replaced the *Dairy Cattle Compensation Act* and provided for the compulsory tuberculin testing of all cows owned by licensed dairymen supplying whole milk to the Metropolitan Area.

The Act also provided for all reactor cattle to be destroyed. Compensation was paid at a rate of up to $40 per head. During the first year, 12 590 cattle were tested and 2876 gave positive reactions and were destroyed. The 1948/49 results (see Table 3) are startling to a current reader.

The initial level of reactors in the Metropolitan herds had been 40.5 per cent. TB testing continued to 1965/66 but the reactor rate did not change much. Hence, while the prevalence of TB had declined to relatively low levels, eradication was not achieved.

In 1965/66, in the manufacturing milk sector, 22 165 cattle were tested with a prevalence of 0.4 per cent. In beef cattle, 42 904 were tested with a reactor rate of 0.14 per cent. Overall, testing showed a satisfactorily low level of disease in the South West. In 1967/68, 70 cattle of unknown origin were condemned at metropolitan abattoirs and 40 cases of generalised tuberculosis from 15 stations in the Kimberley were seen at abattoirs.

**Table 3 Tuberculin testing of dairy cows – 1948/49**

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of herds tested</th>
<th>No. of cattle tested</th>
<th>No. of reactors</th>
<th>Percentage of reactors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro Area herds retested</td>
<td>45</td>
<td>3 362</td>
<td>160</td>
<td>4.76</td>
</tr>
<tr>
<td>South West dairy areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herds tested for first time</td>
<td>161</td>
<td>10 773</td>
<td>1 918</td>
<td>17.80</td>
</tr>
<tr>
<td>Herds retested</td>
<td>148</td>
<td>9 343</td>
<td>345</td>
<td>3.70</td>
</tr>
<tr>
<td>Wanneroo – herds for first time</td>
<td>4</td>
<td>542</td>
<td>221</td>
<td>40.79</td>
</tr>
<tr>
<td>Bunbury – herds for first time</td>
<td>6</td>
<td>655</td>
<td>90</td>
<td>13.74</td>
</tr>
<tr>
<td>Geraldton – herds for first time</td>
<td>4</td>
<td>235</td>
<td>9</td>
<td>3.83</td>
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<tr>
<td>Other areas – herds for first time</td>
<td>10</td>
<td>883</td>
<td>176</td>
<td>22.00</td>
</tr>
<tr>
<td>Total for herds tested for the first time</td>
<td>230</td>
<td>16 450</td>
<td>2 474</td>
<td>15.03</td>
</tr>
</tbody>
</table>
Between 1958 and 1967 on-farm tuberculin testing had been conducted by private veterinarians with no supervision. This was found to be unsatisfactory, so district veterinary officers (DVOs) of the department took control of the testing program. A national bovine brucellosis and tuberculosis eradication campaign (BTEC) was introduced in 1970, resulting in many years of extensive testing by government and private veterinarians. Eradication was based on detection (using the tuberculin skin test for TB and serological tests for bovine brucellosis) and slaughter, with compensation paid to the owners of infected herds. Critically, tail-tagging was also instituted, to allow traceback to the farm of origin when infected cattle were detected at abattoirs.

TB eradication in the Kimberley. Fitting a radio collar developed by the department to a young animal so it would lead veterinarians to cattle hidden in the rough country.

This massive, nationwide, complex and very expensive campaign occupied animal health services for many years. It was operationally difficult and became logistically complex, especially in the north. A national eradication campaign of this magnitude had never before been attempted, but with the financial support of the cattle industry and State and Commonwealth Governments, it was very successful. The south of WA was declared provisionally free of TB in 1976. After that date, disease detection in the south was based primarily on abattoir surveillance. However, surveillance information was lacking on some herds and some tuberculin skin testing of ‘at-risk’ individual herds (mostly neighbours of infected herds) continued. Known infected herds were kept under quarantine and movement out of them was controlled. At 30 June 1976, 12 herds in the Kimberley and northern pastoral area were in this category. Tuberculosis eradication continued in the Kimberley and in 1982 restrictive controls were placed on store cattle moving into the southern provisionally-free area. After four years of the program in the Kimberley the prevalence was estimated, from abattoir samples, to be 0.02 per cent. In 1985/86 the program continued in pastoral areas. Cattle were tested on 29 pastoral stations and the disease was found on three stations in the Pilbara, where eradication procedures were put in place. Some isolated TB infection was also detected in southern areas and necessary action taken.

In 1986/87 the program focused on the fencing of pastoral properties known to be infected, and a year later was reported to be on track to achieve an ‘impending freedom’ status for the Kimberley by 1992. Throughout the TB eradication campaign, the department’s Animal Health Laboratories at South Perth had given specialised support by classifying the lesions detected at abattoirs and determining their cause. Because of doubt about the accuracy of the current tests the mycobacteriology laboratory, led by Dr Debbie Cousins, embarked on a research program. This improved the culture of Mycobacterium bovis and the precise identification of the organism using DNA techniques.
From 1986, the laboratory played a pivotal role in investigations into the cause of tuberculosis in sea lions and NZ fur seals at a Perth marine park. One of the marine park trainers subsequently developed tuberculosis following infection with the same organism. Then in 1990/91, sea lions and NZ fur seals died from infection with the same organism on the south coast of WA, raising the possibility of a spill-over of infection from infected cattle. Dr Cousins was able to show, after some years of research using DNA fingerprinting and other techniques, that the M. bovis-like strains in the seals were genetically more closely related to the human TB organism, M. tuberculosis. Hence, a transfer of infection from cattle was unlikely. Eventually, the organism responsible for tuberculosis in seals and sea lions was classified as a new species of Mycobacterium, named M. pinnipedii. Similar techniques were used to investigate the likely sources of infection when ‘breakdowns’ occurred in cattle herds around Australia, including a large outbreak in Victoria in 1991.

The laboratory became the National Reference Laboratory for Bovine Tuberculosis in July 1992, giving it an Australia-wide role in ensuring the correct identification of TB in samples collected at abattoirs as part of the National Granuloma Submission Program. During the many years of service to BTEC, the laboratory had forged a worldwide reputation for excellence and was made an International (OIE) Reference Laboratory for Tuberculosis in 1993, which led to many collaborative research and training programs.

In later stages of the campaign efforts were concentrated on the Kimberley and Pilbara, where infection rates were relatively high and eradication had proved difficult due to transmission of infection between adjacent cattle stations. Eventually, the WA Government acquired ownership of some problem stations and, with extra spending on fencing and watering, was able to retest and destock as required. The last reservoir of infection was in the Pilbara, Warrawagine Station, bordering the Great Sandy Desert. Abattoir traceback showed this station had a high TB infection level. After several unsuccessful attempts, the station was finally destocked (20 000 cattle were removed) between 1988 and 1990, and no new cases were detected in the Pilbara after 1991.

Many departmental DVOs were involved in the eradication of TB from the Kimberley and the Pilbara, and the program proved problematic for five Chief Veterinary Officers. On 31 December 1997, Australia was declared a ‘Free Area’ for bovine tuberculosis. The Tuberculosis Freedom Assurance Program (TFAP) was then instituted, based on laboratory confirmation of suspicious lesions detected in cattle at abattoirs. The program led to additional detections, the last cases being seen in WA in 1998 and nationally in 2002. TFAP was finally completed in 2006.

Bovine brucellosis (contagious abortion)

Contagious abortion, caused by infection with the bacterium, Brucella abortus, is a serious cattle disease that can cause abortion rates of up to 100 per cent, and is responsible for a relapsing disease called undulant fever in exposed humans. It had become endemic in WA after colonisation. Early reports stated that it was being controlled by adoption of recommended practices. However, when the department's veterinary pathologists produced a test in 1938/39 it was hoped it would be possible to free a herd of this problem. This did not occur.

In 1945/46 it was reported that contagious abortion had been present in almost epidemic proportions and it was hoped to be able to use the newly developed Strain 19 vaccine to vaccinate heifers in the following year. In 1947/48, vaccinations proceeded with good results. There was a steady demand for vaccination in the following years and large numbers of heifers were vaccinated annually. By 1957, the disease was 'largely controlled' by the use of Strain 19 vaccine. In 1961/62, 37 600 heifers were vaccinated.
By this time outbreaks were restricted to areas where animals had not been vaccinated or vaccinated irregularly. Vaccination had greatly reduced the prevalence of disease, to the point that by 1965 there was talk of a national eradication campaign based on test and slaughter of infected cattle. By June 1970, vaccination was restricted to calves between three and six months-old but 50 700 heifers were vaccinated in the previous year. A new vaccine became available for adult cows and 331 cows had been treated during the year. In the Kimberley, 7653 serum samples were tested without a specific reaction being obtained.

Later, in 1970, the national BTEC program was initiated, with campaign funds being available to pay compensation for slaughtered cattle. There was a complication in WA because the use of Strain 19 vaccine over the years meant that positive reactions had to be further tested to separate those due to active infection from those due to vaccination. During most of the 1970s the brucellosis eradication campaign saw massive numbers of animals bled for testing in the laboratory.

Part of the Animal Health Laboratories in South Perth was remodelled in 1973 to accommodate the large-scale testing required. When the program reached its peak in the late 1970s, field officers were submitting about 16 000 samples a week, where the rose bengal, complement fixation and the serum agglutination tests were conducted. The scientist in charge of the brucellosis laboratory later conducted research to help distinguish vaccinated and infected animals. As a consequence, the laboratory also used the indirect haemolysis test from 1980. The enzyme-linked immunoglobulin test was added in 1983. The laboratory conducted six million tests for brucellosis during the campaign (from 1971 to 1986).

By 30 June 1975, testing, slaughter and strict movement controls had reduced the number of restricted herds in WA to 307. A system of tail-tagging was instituted to allow verification of the status of animals being sold. The number of restricted herds was reduced to 239 by 31 May 1976, and there were 1141 herds certified as brucellosis-free in the South West. Field sampling and laboratory testing had indicated that the Kimberley area was free of the disease. An important decision taken by senior veterinarians in 1975 was to discontinue vaccination, based on the perception that the vaccine policy had sufficiently dampened the infection rate to permit eradication to proceed. Vaccinations fell from more than 65 000 in 1971/72 to about 2000 in 1976/77.

Until 1978, nearly all testing had been directed towards ‘at risk’ properties adjoining infected herds. Thereafter, the first round of testing of all herds in the south of the State began. In the first year 3000 herds were tested and only 14 were found to be infected. The first round of testing was completed in 1981 and the second round by June 1984.

Provisional brucellosis freedom was declared in 1986 (by which time $700 million, in 1986 dollars, had been spent on BTEC nationally). This was followed by a monitoring phase, involving bulk milk testing and collection of specimens from abattoirs, which lasted until 30 June 1990. Australia was able to declare freedom from bovine brucellosis in 1989, at a direct (total BTEC) cost of $840 million. This was an enormous achievement for the large numbers of government and industry people involved in the campaign. When the extra costs to producers (mustering and yarding improvements) were added, the national cost was estimated in 1992 to exceed $1 billion. Eradication was claimed on the basis of farm inspection and testing with abattoir traceback as a safety net.

Contagious bovine pleuro-pneumonia (CBPP)

The infectious bacterial disease CBPP was inadvertently introduced through Melbourne in 1858 and reached the Kimberley in 1897. As veterinary services developed,
restrictions were placed on the movement of cattle south from the Kimberley. Cattle were required to be free of both cattle tick and CBPP and shipped out of Broome or Derby, inside the tick areas.

Cattle from stations where there were no ticks and therefore no resistance to tick fever risked picking up tick and contracting the disease as they were driven to Broome or Derby. They could not be guaranteed free of CBPP and would not be acceptable to southern markets. Fortunately, in 1958 CSIRO scientists working on CBPP developed the complement fixation test (CFT) which subsequently was used to underpin a national CBPP eradication campaign. The campaign was based on station-by-station testing, slaughter of carriers detected by the CFT, and vaccination of remaining stock.

The national campaign for eradication of CBPP from the industry, started in 1961, began in the Kimberley in 1964. Departmental officers in mobile laboratories tested cattle on-site using the CFT. In 1965/66 about 90 per cent of the cattle branded in the east Kimberley were vaccinated. No evidence of the disease was found in the west Kimberley. The west Kimberley was declared a protected area into which cattle could not be moved except under permit. No cases of the disease were found in the Kimberley in 1969/70 despite extensive field blood testing. The last confirmed case came from Carlton Station in 1967.

The disease was considered to have been eradicated, and Australia declared freedom from CBPP in 1973.

**Research facilities**

Research became a significant role of the Animal Branch in the late 1920s. The appointment of the veterinary pathologist Dr Harold William (Bill) Bennetts in 1924/25 opened the door to study of the causes of some significant stock diseases. Moves to establish a veterinary laboratory were prompted in part by the 1923 rinderpest outbreak, when the absence of a local laboratory to verify the diagnosis was a distinct disadvantage.

Also in 1925 the department agreed to fund a study of the lifecycle of the buffalo fly, jointly with the Commonwealth. The aim was to provide a basis for attacking the pest which was causing considerable problems across northern Australia. No control measures were developed; the problem remained and was subject of a further intensive research program later.

Dr Bill Bennetts made a major contribution to disease control in WA and won an international reputation for his groundbreaking research.

Following his appointment, Bennetts worked with makeshift facilities at several locations, including those at the Avondale State Farm. However, it was not until 1947 that the specifically-designed Animal Health and Nutrition Laboratory was constructed at Hollywood, allowing Bennetts to work with satisfactory facilities until his retirement in 1959. A new Animal Health Laboratory was commissioned in 1960 with the opening of the department’s new premises in Jarrah Road (now Baron-Hay Court), South Perth.
Enterotoxaemia of sheep (braxy-like disease, Beverley disease)
The so-called ‘braxy-like’ disease caused substantial losses for stock owners on the Great Southern railway line. Poor transport and communications and lack of facilities made this a difficult problem because the animals decayed quickly after death. To overcome this problem, a field laboratory was established at Beverley, but this was only partially successful and by 1927 Bennetts decided to live and work on the affected farms. This gained the respect and trust of the farming community and allowed study of the disease at close quarters. Bennetts was seconded to CSIR in 1927/28 to enable him to work full-time on the disease.

During 1928/29 it was shown that the disease was caused by the toxins produced by a massive increase in the population of an intestinal bacterium, believed to be *Bacillus welchii*. Subsequently, Bennetts named the causative organism *Bacillus ovitoxicus* (now known as *Clostridium perfringens* Type D). In 1929/30 the department decided to set up a laboratory at the Avondale Research Station to investigate the factors predisposing sheep to the problem and to try to develop a vaccine. CSIR contributed £500 ($1000) for laboratory equipment. Beverley farmers contributed £200 ($400) towards the building and the department funded the rest.

A vaccine was produced in 1930 based on specific (Type D) WA strains isolated by Bennetts. The vaccine proved successful. The problem was now understood and a prophylactic was available. Later work established the need for annual vaccination in areas prone to the problem.

The 1931 report records that the research on the ‘braxy-like’ disease had been successfully completed. Bennetts was credited internationally with the discovery of a new concept for disease development – diseases caused by the absorption of bacterial toxins. These studies and the success of an Australian vaccine galvanised much overseas research into similar conditions caused by clostridial organisms. Today's farmers vaccinate their sheep annually against enterotoxaemia or ‘pulpy kidney disease’, as the problem has become known over the years.

Botulism (toxic paralysis)
In the 1920s the southern areas of Western Australia were largely free from contagious diseases of livestock. However, there was concern about the high incidence of botulism or toxic paralysis among sheep which developed a depraved appetite and ate carrion from large numbers of rabbit carcasses caused by the onset of dry conditions and shortage of feed in the wheatbelt. A laboratory was set up at Meckering to study the problem.

South African work with cattle had identified phosphorus deficiency as a primary cause of depraved appetite leading to consumption of carrion. In 1933 the department advised farmers to use phosphorus licks but further work showed that the sheep were not suffering from phosphorus deficiency and the phosphorus licks were of no value. Work testing various supplementary feeding regimes showed that high protein diets gave control, indicating that protein deficiency was the likely cause of the deprived appetite. However, economically viable protein supplementation regimes were only partially successful. Water sources could be contaminated but could be easily ‘purified’ by treatment with lime. By 1928, Bennetts demonstrated that toxic paralysis was caused by the ingestion of a toxin produced by *Clostridium botulinum*, a bacterium growing in the carcases of rabbits and other animals.

The final solution came through a vaccine prepared with the help of Dr LB Bull of CSIR, which was shown by Bennetts to protect sheep from the toxin (botulinum) under field conditions. The achievement of higher protein summer feeds by the introduction of a legume and the control of rabbits were management options which became
progressively available and reduced the prevalence. However, the risk of botulism was ever-present during the summer, when carrion eating was often unavoidable. Vaccination is now a routine form of protection wherever ruminants are grazed, worldwide.

**Mastitis**

Mastitis has always been an endemic disease of dairy cattle. In the early 1960s, a major survey of its incidence in the dairy herds of Western Australia was undertaken. For the survey, mastitis was defined as an inflammation of the udder, producing evidence in the milk. The survey showed that two in every five cows were affected. While the incidence ranged widely between herds, no herd was completely free.

Staphylococcal organisms were found in 32 per cent of cows and streptococcal organisms in 4 per cent. In 25 per cent of the herds examined, staphylococci alone caused the infection. In 3 per cent of the herds streptococci alone caused the problem. In the remaining herds both organisms were present. Some herds contained staphlococci from human sources that were very resistant to antibiotics. The bovine strains did not show this resistance. Wastage in the State herd due to mastitis and low milk production was about 20 per cent. The conclusion was that, because of mastitis and antibiotic resistance, the milking herd was replaced every four to five years, which meant that most cows did not reach their genetic potential. For these reasons mastitis was very expensive for the industry. Typing of the staphylococci obtained from the survey showed several herds carried a type that was very invasive to humans and a considerable number belonged to a group commonly associated with outbreaks of human food poisoning.

The continuing nature of this problem was demonstrated by the Dairy Industry Authority introducing compulsory testing of milk, and a price penalty for high inflammatory cell counts in April 1987. This followed testing by the department’s Bunbury laboratory, which showed a significant proportion of milk with cell counts over 50,000 cells per millilitre. Field officers were advised of those farms with a cell count of more than 50,000/mL and advice was provided to the farmers concerned. It was found that 20 to 30 per cent of all high cell counts were associated with mastitis organisms. This program resulted in a significant reduction in the problem.

On-farm management practices were developed to control the problem. Back flushing of the milking cups coupled with the development of a rapid test to identify affected animals reduced the spread of the disease. The treatment of dry cows was also an important part of the program.

The management practice of back-flushing and treatment of cows as they dried off was developed and heavily promoted by departmental veterinarians. A major program involving a large number of herds kept under continual observation over the milking period proved the effectiveness of these techniques and provided the vehicle for convincing industry of their value. By 2008, the processors who had taken over the role of the Dairy Industry Authority imposed price penalties for high milk cell counts, and cows with mastitis were immediately withdrawn from the herd. This has resulted in mastitis now being successfully controlled in the dairy industry.

**Liver fluke**

In 1987 liver fluke was detected in one animal at an abattoir. This was of concern because it was known that the snail host necessary for completion of the lifecycle of the fluke was already in WA. Through traceback to the farm of origin, officers identified other infected animals on the original property and neighbours’ properties. Control measures were implemented and in 1989 eradication was claimed on the basis of farm inspection and testing, with abattoir traceback as a safety net.
Footrot in sheep

There are two forms of footrot in sheep:

- 'Virulent footrot' in which the destruction of the affected hoof is progressive, produces lameness, severe production loss and sometimes death
- 'Benign footrot' in which a similar lesion is mild and transient and affected sheep quickly recover.

Both forms are highly contagious but only the virulent form has economic and animal welfare significance. Both forms were widespread in the South West Land Division in the 1940s, causing considerable production loss. Moves by the Department of Agriculture to eradicate footrot began in 1947, when it was discovered that quarantining the farm and culling affected animals before the hot dry summer would usually result in whole-farm eradication, provided infected sheep were not introduced in the meantime.

By 1953 a full-scale campaign to eradicate footrot, based on these principles, was underway. Properties in quarantine were only permitted to sell sheep for immediate slaughter. During the year ended June 1955, 92 properties had been freed but 130 remained under quarantine. In 1958, only 61 properties remained in quarantine as opposed to 97 in 1957. By 1960/61, 20 properties were cleared and only 16 were left in quarantine. However, in 1965/66 the program took a step backwards with an outbreak in the South West during the early summer. The seemingly uncontrolled spread of footrot continued until 1974 when the decision was taken to exclude benign footrot from the eradication program.

Research was conducted at the newly-created Albany Regional Animal Health Laboratory to develop a test to distinguish benign from virulent footrot. This was successful with the discovery, by microbiologist Dr L Depiazzi, of the degrading proteinase test in 1978. This allowed more accurate prediction in the field, which supported the decision to quarantine farms for virulent footrot.

The eradication program was continued into the 1980s, during which time the number of farms in quarantine for virulent footrot fell to almost zero. However, an influx of sheep from the drought-stricken eastern states in the early 1980s was followed by the discovery of a large number of infected farms. In December 1985 all live export holding yards were declared quarantine areas, which gave farmers an outlet for healthy sheep from their quarantined properties. Success was considered possible with the footrot eradication program in the mid-1980s. However, in 1988/89 the program was set back by a major outbreak in the high rainfall areas from Boyup Brook to Augusta; the number of properties under quarantine doubled to 113, which represented about 1 per cent of sheep farms in WA.

The Albany Regional Animal Health Laboratory continued to conduct research into virulent footrot, demonstrating the strong interaction between the strain of the transmissible agent (Dichelobacter nodosus) and the environment. These studies helped to explain the regional distribution of virulent footrot in WA, and highlighted the importance of limiting spread between farms in the different rainfall zones of the South West.

In 1997 the Albany laboratory was recognised as the Australian National Reference Laboratory for ovine footrot. The degrading proteinase test and its derivatives proved to be the definitive test for virulent strains across Australia and put the WA eradication program on a sound basis. The number of properties under quarantine for virulent footrot increased from 48 to 58 during 1998/99, largely due to increased surveillance conducted at abattoirs.

In 2003, sheep industry representatives agreed to provide majority funding and to be involved in managing the eradication program which, until that time, had been supported entirely by State funds. However,
a subsequent decision was taken to abandon the objective of eradication and to focus on control. Under this plan, the farmer, having reported the presence of the virulent form on his property, had his property placed in quarantine and was given advice on how to manage the problem. It was left to the farmer to decide if he was going to aim for control or eradication from his property.

In 1999, a benefit-cost study using the Value Chain Model showed that attempts to eradicate virulent footrot in the previous 20 years had had substantial positive benefits. The program was estimated to have saved the industry about $116 million, of which $70 million was direct benefit to sheep farmers and the remainder a spill-over effect for abattoirs, butchers and others. The control of virulent footrot was subsequently passed to the hands of sheep farmers, with supporting advisory and laboratory services being supplied by the department. The continued low prevalence of footrot-infected farms was seen to have continued economic benefits for the industry in WA.

**Red water in calves**

This disease had been experienced for many years but despite extensive investigations no solution was found, although *Clostridium welchii* was the suspected cause. During the mid-1950s the cause was identified as the organism *Leptospira pomona*. It was believed that pigs were a reservoir of the disease and that calves needed to be kept from contact with pigs. While today a vaccine is available, this disease was a source of considerable losses in the early days of the industry.

**Mycotic dermatitis (lumpy wool)**

The mechanism of infection by *Dermatophilus congolensis*, the causative agent of mycotic dermatitis in sheep was elucidated by CSIRO researcher D Roberts following his departure as a veterinary microbiologist at the department’s Animal Health and Nutrition Laboratory. Subsequent studies at the South Perth laboratory clarified the role of dipping fluids and management practices in the transmission of this disease. These findings resulted in development of effective control strategies which are still in use, although a vaccine was developed later.

**Caseous lymphadenitis (CLA, cheesy gland)**

CLA became an important disease of sheep in the early 1970s due to international trade restrictions placed on infected carcases. A research team at the Animal Health Laboratories, working in collaboration with CSIRO and the Commonwealth Serum Laboratory (CSL), developed a commercial vaccine (Glanvac) against the causative agent *Corynebacterium pseudotuberculosis*.

This vaccine is now widely used throughout the sheep industry and royalty income from sales provides revenue for the department to continue to support sheep disease research.

Epidemiological studies by the Animal Health Laboratory CLA team demonstrated the importance of shearing cuts and sheep dipping fluids in transmitting the disease so that the use of the vaccine in combination with strategic management practices has greatly reduced prevalence in Australian flocks.

**Internal parasites**

With the introduction of improved pastures in the South West came higher stocking rates and the inevitable problem of internal parasitism in cattle and sheep. In the early 1960s, Department of Agriculture veterinary pathologist Dr MR Gardiner developed a system for determining the significance of worm burdens based on faecal egg counts with total worm counts for different nematode species of sheep and cattle. The ‘points’ system developed was still in use around Australia in 2008. In the 1960s parasitism was considered a specific disease requiring diagnosis and treatment.

In the 1970s, research by department veterinarian Geoff de Chaneet concentrated on cattle nematodes. Over about 10 years, studies on the ecology and epidemiology of internal cattle parasites were conducted at
Wokalup and Bramley Research Stations. The results provided the basis for the control program recommended today. It was not until much later (after 2005) that drench resistance in cattle was recognised as a global problem, and new studies were conducted in WA.

The emphasis of parasitology research moved from cattle to sheep in the late 1970s. The 'summer drenching' program, developed in Victoria, was tested at Mount Barker Research Station, with confirmation in 1980 that it dramatically reduced the number of drenches needed for effective worm control. Drench resistance in sheep worms was first demonstrated in 1979. Within two years, resistance was being found on an increasing number of farms. This led to a drench resistance survey (the first of its kind in Australia) that ran from 1982 to 1984 and showed that resistance was present on most farms in WA. This led to the 'CRACK' campaign (each letter indicates an action recommended to combat drench resistance), a comprehensive extension program that changed the way stock owners managed the complex interaction between parasite control and chemical efficacy. Surveys in following years consistently found WA farmers to be well ahead of their eastern states counterparts in understanding this issue.

The 'bell-wether' role of WA in the development of drench resistance was confirmed with the first published report of *Ostertagia* resistance to ivermectin in 1992. Researchers in the department discovered that ivermectin resistance was most advanced in situations where very few drench treatments were routinely given. The concept now known as 'refugia' was developed. This identified the need to preserve populations of less-resistant worms to dilute resistant ones, so resistance levels remained low as the basis of sustainable (low drench resistance) worm control programs.

Using ecological research methods, the group was able to confirm that in our Mediterranean climate few worms survived on pasture over summer, so resistant survivors of summer drenching were the main source of future worm populations. Consequently, worms in summer-drenched sheep developed resistance more rapidly than those in undrenched sheep. In the early 2000s, a large-scale series of observations on more than 60 farms showed that summer drenching was not necessary in adult sheep, which led to a change to 'summer-autumn drenching' recommendations. The concept of monitoring parasite burdens in sheep using repeated faecal worm egg counts as the basis of drench decisions was successfully introduced.

Major research was also conducted on non-chemical (genetic) worm control, through the establishment by John Karlsson of the Rylington Merino worm-resistant flock in the late 1980s. Over 20 years of breeding for lower worm egg counts, these sheep developed the greatest level of worm resistance reported internationally, and were used for many research projects on genomic and other indicators of worm resistance in individual sheep.

In 2001, the department research worker managing this program, Brown Besier, was appointed program manager for parasitology in the Australian Sheep Industry Cooperative Research Centre. The significant funding provided by the CRC resulted in better nematode diagnostic tests, less-selective programs for drench resistance, and a national website for worm control information (WormBoss).

**Lice control in sheep**

For many years there was a requirement that lice be controlled on every farm and plunge and spray dips were universal. In particular, all sheep were required to be dipped off-shears. However the discovery of the transfer of dermatitis through the dips immediately after shearing caused modification of the requirements. Control was still essential and sheep could not be sold through a public stockyard if infested.
In 1987 a proposal was developed, and supported by industry with a financial contribution, to eradicate sheep lice. This proved to be impractical and the program reverted to control. A major reason for abandoning the eradication objective was the development of resistance by the lice to the chemicals being used.

**Squamous cell carcinoma**
Long-term exposure to sunlight of the bare skin resulting from excessive removal of skin during mulesing sometimes resulted in a cancer called squamous cell carcinoma. This was managed through an extensive information campaign to mulesing contractors explaining the dangers of such radical wool removal. The cause was identified by a research program funded by the Australian Meat Research Committee in the early 1980s.

**Urinary calculi**
The problem of urinary calculi (urolithiasis) in wethers and rams fed grains for prolonged periods was recognised when sheep became common in the wheatbelt. It was extensively investigated by department veterinarians and chemists. Untreated urolithiasis caused blockage of the urinary tract leading to rupture of the bladder. The disease was known colloquially as ‘water belly’. Most uroliths in grain-fed animals were shown to be composed of magnesium and calcium salts. Uroliths with other compositions, including silica, occurred less frequently.

Uroliths developed primarily because prolonged grain feeding caused a change in urine pH towards alkalinity. Combined with high urine specific gravity, crystals were formed and produced a blockage. Treatment for urolithiasis involved the relative acidification of the urine using ammonium chloride at 1 to 2 per cent of the dietary dry matter. Salt was then added to increase water consumption, diluting the urine. Although the problem is still encountered, most stock managers are aware of the risks and the treatments available.

**Infectious laryngotracheitis (ILT) of poultry**
In 1947/48 a serious outbreak of the viral disease ILT occurred in poultry. Investigation showed that it had been present in WA for some time and eradication was not an option. ILT (a herpes virus) grown on dried egg was made available to poultry producers as a vaccine in 1951/52. A vaccination program was implemented for the areas where the disease had occurred. Each area was then quarantined, which meant no poultry except day-old chickens could leave the Metropolitan Area. The disease is significant for the poultry industry to this day. It is a nationally notifiable disease and vaccination is widely practised.

**Pullorum disease**
In 1953/54 pullorum disease in poultry was reported. It was decided to aim at eradication and compulsory testing of all flocks sending eggs to hatcheries was introduced. All hatcheries had to be registered and were monitored for disease presence. Regular testing for pullorum disease in fowls continued after the original diagnosis. In one year 75 600 birds were tested, of which 4470 gave positive reactions. In 1969/70, 327 400 birds from 90 flocks on 14 breeding farms were tested. Thirty flocks proved to be infected; 2370 reactors were detected representing an overall infection level of 0.7 per cent. Deterioration occurred caused through franchised hatcheries obtaining all replacements from the eastern states. The disease was largely eradicated from commercial poultry farms but it occasionally causes mortalities in backyard flocks.

**Cobalt deficiency (Denmark wasting disease)**
Reports of wasting and deaths of calves at Denmark from an unknown cause were a serious concern, as the government was committed to developing a dairy industry in the district.
Investigation into the cause of the problem began shortly after Dr Eric Underwood returned to WA in 1930 from postgraduate studies in the UK. In 1933 it was reported that the investigation of Denmark wasting disease ‘which had been started in earlier years’ was continuing. Underwood and veterinarian JF Filmer were in charge. There had been some indication that iron may be involved. In 1934 the iron product (limonite) was analysed and the components tested on affected animals. This showed that iron itself was not involved but the active principle lay in the zinc group of elements. This group was further divided into those with and without nickel and the group without nickel was not effective in curing the condition. By 1935 it was shown that the disease was caused by a deficiency of cobalt. Cobalt had been a contaminant in the nickel separated from the original zinc group. The disease was cured by adding minute amounts of cobalt to the diet. Initially a very dilute solution of cobalt and nickel was prepared by the local chemist in Denmark and sold to farmers.

The Waite Institute in South Australia was asked to map the soils which appeared to be associated with the problem. The soil survey of some 15 500 acres was later made by the Plant Nutrition Branch of the department, with some assistance from the Waite Institute. It was shown that the acute problem was restricted to one soil type. Later it was shown that cobalt was low and at times deficient in many other parts of the South West.

Copper deficiency in sheep (enzootic neonatal ataxia, Gingin rickets)

A problem of lambs born without the full use of their hind legs, known as enzootic ataxia, had existed for some time at Gingin. The view in 1933 was that it was caused by the ingestion of some toxic principle by the mother during pregnancy. Feeding trials showed that phosphate and mineral licks were of no value. By mid-1937 the cause of the problem was identified as a deficiency of copper in the diet of the ewe. This was based on experiments conducted by Bennetts and analyses by the government chemist. It appeared that on some soil types the pregnant ewe could not obtain enough copper for the normal growth and development of the embryo, and the newborn lamb was affected by ataxia. The ewe was anaemic for the same reason. It was also noted that wool appearance and production was improved on treated sheep. While the virtual absence of the problem in the control flocks did not allow the effect of copper on ataxia of lambs to be fully investigated, the effect of copper treatment on the anaemia of the ewes and the improved wool growth and character were clear. An experiment to determine the frequency needed for copper dressings of pasture was established.

Surveys of copper status of farm animals showed that mild deficiency was widespread and that ‘stringy’ or ‘steely’ wool was a reliable indicator of copper deficiency in sheep. The identification of copper as an important trace element in WA stimulated investigations of its use by plants. This led to the opening up of the vast areas of light land. Bennetts was credited with the discovery of another new concept, that disease could be caused by deficiency of a dietary trace element. This discovery led to greatly improved animal and plant production in other places, notably the UK and South Africa.

Copper deficiency in cattle (falling disease)

In 1936/37 a problem known locally as ‘falling disease’ of cattle was identified in the Margaret River area. High producing cattle would fall down and die from no apparent cause. This often happened at milking time, sometimes in the bale, hence the name ‘falling disease’.

Investigation over a number of years showed that animals in the affected herds were anaemic. In the field the disease was usually associated with the presence of drooping-flowered clover. As there was no evidence
that the condition was infectious, the effect of various nutrients was tested. The animals treated with copper were healthier and not anaemic, and farmers were advised to give their cattle a lick containing copper. In 1945/46 an experiment on an affected farm indicated that copper deficiency caused progressive atrophy and fibrous tissue replacement of the myocardium, leading to heart failure under stress. The problem disappeared from the district once the use of copper fertiliser became widespread. It was found that drooping-flowered clover was very tolerant of low copper levels in the soil.

Copper and cobalt deficiency (coast disease)
Following South Australian work, the effect of copper and cobalt on animals affected by 'coast disease' in South West coastal areas was tested. As in South Australia, treatment with both copper and cobalt cured the problem. The affected areas were mapped as they were identified.

In 1958, in work with CSIRO to survey the copper and cobalt levels in pastures it appeared that sheep have a capacity to store copper and could suffer from toxicity. Following detailed studies by the department in 1961/62 a general 'ill-thrift' of sheep was attributed to marginal copper and cobalt levels. Coast disease was subsequently shown to be due to a dietary deficiency of cobalt, which is necessary for the production of vitamin B12 in the animal. Cobalt treatment of pastures and vitamin B12 supplementation of animals cures the condition.

Selenium and vitamin E deficiency
A survey also showed critically low concentrations of selenium in some pastures in high rainfall areas of the South West. Although pastures did not appear to suffer, a number of conditions were seen in grazing stock. Poor body weight and wool production and a degenerative myopathy ('white muscle disease') in lambs were documented. Mortality rates due to white muscle disease were high in some areas.

Field studies by department veterinarian Brian Gabbedy demonstrated a production response to treatment in susceptible areas. Selenium deficiency was thought to be associated with ill-thrift and often myopathy in sheep grazing cereal stubbles. Autumn ill-thrift in weaner sheep was later shown to be associated with seasonal protein malnutrition and depletion of vitamin E. While selenium protected sheep from white muscle disease, it was vitamin E that gave protection from autumn myopathy in both selenium-deficient and sufficient sheep.

Phosphorous deficiency of cattle
A problem of poor production and infertility in cows at Manjimup was investigated during the late 1940s. Studies of phosphorus levels showed cows on dry feed had low levels through summer. Experiments showed that up to the hay stage the phosphorus content of pasture was adequate for a four-gallon-a-day cow, even on areas topdressed with only one hundredweight of superphosphate per acre. After the hay stage even topdressing a pasture with 4 cwt of super per acre did not maintain the phosphorus at a level which would support a cow milking one gallon a day.

In 1947/48 an investigation of a serious infertility problem in cattle in the Margaret River area identified a serious phosphorus deficiency on the basis of low phosphorus blood levels. This also occurred late in the summer with little time to recover before the demands of milk production. It was found that milking cows needed direct phosphorus supplementation to raise their blood phosphorus to a 'normal' level.

A new research station was acquired at Bramley just north of Margaret River in 1948/49 to concentrate on this problem. In 1953/54 it was reported that the phosphorus-fed group produced more milk and butterfat than the controls. In 1955/56 the increased production of the control group, now receiving phosphorus as a result of reversing the feeding regime, confirmed the value of phosphorus in increasing milk production in...
the area. This result was maintained in the 1957 research program, further confirming the importance of phosphorus level for milk and butterfat production.

Deaths during transport of sheep during live export

In 1985 the Senate Select Committee on Animal Welfare, following an enquiry into the live sheep trade, indicated there were compelling reasons to terminate the trade, but allowed a continuation based on recommendations for improved husbandry and additional research. Department of Agriculture veterinarians then embarked on a program of research, led by Barry Richards and Richard Norris, that ran from 1985 to 1990.

Extensive studies were made of the causes of deaths among sheep exported live to the Middle East, and the results published in scientific journals. A synopsis was given in the Journal of Agriculture in 1990. The work showed that about 3 per cent of the sheep that left their farms did not reach their overseas destinations through rejection before export or death during shipping. Approximately 12 per cent of these were rejected in the assembly feedlot and 15 per cent on the wharf during loading. Of the remainder which did not reach their destination, 54 per cent died during the sea voyage and 14 per cent died during unloading at the destination port. An examination of the causes of death found that 47 per cent of those that died during transport at sea or unloading did so because they did not eat from the time they left the farm (the ‘shy feeder’ or inanition syndrome). A further 27 per cent died from salmonellosis, often preceded by inanition (six of every seven that died of salmonellosis were shy feeders).

The work also showed that sheep had low salmonella levels when they arrived at the feedlot, but progressive environmental contamination of the feedlot yards and sheds predisposed them to increasing infection. This work clearly identified salmonellosis and shy eaters as the major issues. Further work showed that the major factors predisposing to death during shipping were season, age, fatness and farm of origin. Deaths were higher in the second half of the calendar year, the death rate of adult wethers was three times that of hoggets, and fat sheep were more likely to die than lean sheep. Inexplicably, a small proportion of farms contributed most of the deaths, and the reasons are still unclear. By 2000, the annual industry mortality rate had fallen below 1 per cent due to the adoption of recommendations arising from the research.

Vitamin A and weaner sheep

In the late 1940s experiments on digestibility of cereal hay showed the greatest yield of digestible nutrients occurred at the late milk to early dough stage in wheat – two to three weeks after flowering.

This work also showed that only ‘greenish’ coloured cereal hay had sufficient carotene to be a source of vitamin A. Dry pastures and cereal grain were virtually devoid of vitamin A or carotene. Based on the knowledge that animals at birth have no vitamin A in their livers, there was an interest in the vitamin A content of the colostrum of ewes following a dry summer. It was found that the level was only one quarter of the
‘normal’ level produced on green feed. Experiments testing the effect of this on lamb health were planned as it was known that calves with low levels of vitamin A were predisposed to a variety of infections. In the early 1950s a trial was carried out in which weaner sheep were treated with a large dose of vitamin A during the summer. There was no response to the treatment.

**Sheep fertility**

A long-term problem of sheep production in Western Australia has been of the low level of fertility of Merino ewes. Investigations into this problem on 20 commercial properties began in 1970 and suggested that the problem was related to the ewes not producing enough eggs. It was found that for every 100 ewes served by rams an average of only 110 eggs were released. Higher protein diets with lupins were shown to increase the ovulation rate and fertility markedly. These experiments were conducted in 1974 and it was found that the ewes responded very quickly to lupin feeding. Feeding for only 14 days before joining with rams was as effective as 35 days. Once feeding ceased the ovulation rate and fertility quickly fell back to pre-feeding levels. The degree of increase depended on the nutrition of the ewes. The increase was higher where ewes were grazing on low-protein cereal stubbles as opposed to ewes grazing on subterranean clover-based pastures.

Two approaches were taken to genetically improve fertility in the Merino. One was the evaluation of the Booroola strain as a source of high fertility genes and the other was the mating of high fertility Merino ewes with rams that had been selected from ewes with a high fertility history. The progeny born within the high fertility flock were shown to be more fertile than those in an unselected flock. In 1989 it was reported that two products, Fecundin and Regulin, had been shown to increase lambing percentage by up to 40 and 25 per cent respectively. Fecundin was a vaccine which affected the hormone balance of the ewe and increased the proportion of ewes releasing more than one egg – hence more twins. Regulin improved the conception rate and also produced more twins.

Keeping lambs alive after birth was also a major issue. On-farm studies in 1988 showed that management of the ewe during pregnancy, particularly maintaining her weight in mid-pregnancy, had a major influence on lamb deaths. It became possible to develop management programs to significantly reduce lamb losses and increase the efficiency of sheep production.

**Phosphate nutrition of Kimberley cattle**

A trial began in 1974 to study the effects of stocking rate and phosphorus supplementation on animal and pasture performance, using pasture established on pindan during the wet season and black soil plains pasture during the dry. Half the animals received a phosphorus supplement and half received salt only. Those animals given a monosodium phosphate lick consumed the equivalent of 4 grams of phosphorus a day during the trial. After the dry season of 1976/77, the low stocking rate group had no deaths when cattle received phosphorus, compared with 45-50 per cent deaths in the group on salt only. At the higher stocking rate, phosphorus reduced the death rate from 46 to 6 per cent. This work was part of the overall re-examination of the management of cattle in the Kimberley.

**Grain poisoning (acidosis)**

In 1993/94 work on the use of a feed additive virginiamycin was shown to reduce the gram positive bacteria in the rumen of sheep. These bacteria produced lactic acid, which could cause grain poisoning. This work was done in partnership with the Wool Research and Development Corporation and Smith-Kline Beecham. Its use in Australia was of value to the feedlot industry. Normal management practice required grain to be mixed with hay to avoid the problem and substantial mixing costs could be saved.
Plant related diseases and poisons

Native poison plants

One special part of the department’s early work was the identification of naturally-occurring poison plants which had a devastating effect on the livestock industries. There are more than 180 poisonous plants endemic to Western Australia. It is therefore not surprising that from early colonisation, poisonous plants have had a profound influence on agriculture. An extreme example is that between 1833 and 1840, more than half of the Colony’s livestock (sheep, goats, cattle and horses) were poisoned.

Many of the early poisonings were caused by shrubby legumes in the genus Gastrolobium (the genera Gastrolobium and Oxylobium were combined into the single genus Gastrolobium in 1987). Unfortunately the European colonists believed all legumes must be nutritious and they saw native animals eating these plants without effect, so made little effort to stop their stock eating them. It is now known that 34 of the 47 Gastrolobium species in Western Australia are toxic.

The department worked to identify which plants were toxic, define the problem, develop prevention and management procedures and inform the rural community of the details. As a result in the last 80 years poisonings from native plants have become only occasional. The first publication on the subject was the Department of Agriculture Bulletin 32 written by A Morrison in 1909. Bulletin 69 was written by DA Herbert in 1921, and revised by WM Carne, CA Gardner and HW Bennetts and published as a second edition in 1926.

After his appointment in 1924/25 the veterinary pathologist Bennetts worked on the toxicity of the Gastrolobium and Oxylobium species which were the most common of the native poison plants. He carried out tests of some 17 native plant species, 11 of which belonged to the Oxylobium or Gastrolobium genera. He commented that the toxic principle of Oxylobium parviflorum was water soluble and he expected that to apply to the Gastrolobiums as well.

He published a definitive paper on the subject, co-authored by CA Gardner, the Government Botanist. The toxic principle was later shown to be sodium fluoroacetate (later manufactured as 1080 for rabbit control). In the 1965/66 report studies of prickly and crinkle leaf poisons were reported. It was shown that increased metabolic activity in the plant following rain produced the fluoroacetate which made them toxic. They were likely to remain toxic for up to two weeks after such an event.

Bennetts and Gardner collaborated over 30 years in studies which defined which plants were poisonous, the clinical signs and any gross pathology produced. This work was reported in 1956 in an authoritative book, The Toxic Plants of Western Australia. The Toxic Plants of Western Australia dealt mainly with native and introduced plants where poisoning followed unknowing or accidental exposure of livestock. Knowledge of these types of plant poisonings was further increased by the studies of MR Gardiner, published between 1960 and 1976, and the Government Botanist, TEH Aplin, who published 35 papers between 1964 and 1984. Aplin expanded the scope of poisonous plants to include poisonous garden plants and toxic cyanobacteria and oestrogenic compounds which caused the problems in livestock grazing pastures dominant in these clovers. (See under Clover disease.)

In 1906 the State Botanist recorded an investigation of cattle losses in the Ashburton district. These proved to be due to a shrub of the Indigofera genus which he named Indigofera boviperda. Analysis of material in Perth showed the plant contained a toxic alkaloid. With so much work of this type needed it was surprising to read that the position of botanist (together with the
assistant entomologist and bee expert) had been abolished by mid-1906.

An unusual poisoning case was reported when 25 cattle died after being forced to eat radish as their major food for about five weeks. Work was also proceeding on characterising the poison in the *Isotropis* spp. Bracken fern was known to cause numerous deaths among calves in the South West but apart from avoidance, little work was done.

In 1989 it was reported that unexplained sheep deaths in the eastern wheatbelt were found to be due to oxalate poisoning. The plant responsible has been identified as the slender ice plant and chemists found that it contained 18 per cent soluble oxalate in the dry state.

*Subterranean clover infertility (clover disease)*

In 1942/43 an investigation began into the cause of dystokia among lambing ewes. This was the first reference of the major problem which became known as subterranean clover infertility, or clover disease. Apparently a number of cases had been reported in the previous two years but the extent of the problem had not been appreciated.

On first analysis it was thought it may be due to large lambs and ‘fat, sluggish ewes’ grazing on luxurious subterranean clover pastures that were understocked for the seasonal conditions. Also, eversion of the uterus was observed among ewes that had lambed, and wethers developed what was called a ‘high tail’.

Identifying the cause and treatment of the problem became a major project. In 1943/44 a team made up of EJ Underwood, HW Bennetts and FL Shier was formed to attack the problem. Bennetts explained the clinical signs by showing that pregnant ewes developed cystic lesions in the uterus, lactation was induced in wethers and maiden ewes, and some wethers developed severe hyperplasia of bulbo-urethral glands of the urogenital tract (causing the tail to be raised). No solution was found and the disease occurred in increasing numbers of animals in 1944/45.

While the cause had not been identified, it was accepted by this time that it was due to a hormone imbalance. In 1945/46 Underwood and Bennetts showed that similar lesions were produced in mice and guinea pigs fed an extract of subterranean clover. They then reproduced the disease in sheep by prolonged feeding of the synthetic oestrogen, diethylstilboestrol. On this basis it was concluded that subterranean clover contained oestrogen or an oestrogen precursor.

The program was now being directed by a team made up of CSIRO, Department of Agriculture and University of WA personnel. The program sought to identify the substance and examine differences in the toxicity of subterranean clover cultivars from different soil types and locations. The type of fertiliser and the toxicity of mixed pastures (with a balanced mixture of grass and forbs) and subterranean clover were also examined.

In 1947/48 it was reported that the infertility problem in sheep could be managed in the field by additional cropping and a focus on balanced pastures. Investigations continued to elucidate the chemical involved and its effects on the animal.

Investigations were continued in 1948/49 aimed at isolating and identifying the phyto-oestrogenic substances, the impact of environment on their production, distribution through the plant and their long-term effects on the breeding capacity of the ewe. The isoflavones thought to cause clover disease were finally identified as genistein, biochanin A and formononetin, when advances in analytical techniques improved the capacity to identify them.

The effective dilution of phyto-oestrogen intake resulting from balanced pastures and improved sheep management greatly improved the situation. While occasional problems were reported, clover-related infertility was no longer considered a
significant field problem by the end of the 1940s. The problem was not raised again until 1954/55 when incidents on areas where subterranean clover pasture had been recently established were reported. In 1958 attempts were made to isolate isoflavones from other subterranean clover cultivars without any real success.

In the early 1960s an examination of the effect of different subterranean clover cultivars was made by CSIRO using a ‘milking wether’ bioassay. This work showed that there were marked differences between cultivars and that the popular Yarloop cultivar contained high levels of the oestrogenically active substance. By this stage it was known that Dwalganup did not produce the classical disease if it was present as a component in mixed pastures.

In 1965/66 increased problems on pastures dominated by the Yarloop, Dwalganup or Dinninup cultivars were reported. These reports continued from the recently developed areas over the remainder of the 1960s.

Advances in analytical techniques, including thin layer chromatography, were now available for more rapid identification of the nature and level of isoflavones. Using these techniques it was shown that formononetin was the potent isoflavone in all cultivars of subterranean clover. Unlike genistein and biochanin A, which were converted into non-toxic compounds in the rumen, formononetin was converted into a more oestrogenic compound, equol.

Some cultivars had low or very low levels of formononetin, and these were selected for a breeding program at the University of WA. Subterranean clover cultivars with a range of maturities and low formononetin levels were identified and commercialised. The first of these became available in the late 1960s and they were extensively sown over the following years. Traditional forms of clover disease were then greatly reduced and lambing percentages improved.

However, surveys in the 1970s showed that although clinical clover disease had virtually disappeared, the fertility of sheep grazing subclover pastures was still unacceptably low. The department estimated that poor conception rates were costing the State about one million lambs a year. Subsequent extensive studies conducted by CSIRO veterinarian Norm Adams in collaboration with departmental officers John Lightfoot and Keith Croker, demonstrated that long-term low intake of phyto-oestrogens caused anatomical changes to the cervix of ewes, making them infertile.

Later studies showed that successive generations of sheep exposed to low level phyto-oestrogen intake were eventually naturally selected for a form of genetic resistance. By 2008 it was clear that the clover disease story was not complete and that further work would be required to allow sheep to reach their full reproductive potential.

Lupins and lupinosis

Lupins were the cause of two major toxicities in Western Australia. The sandplain lupin (*Lupinus cosentinii*) was accidentally introduced into Western Australia late in the 19th century and soon became naturalised. In the 1920s the sandplain lupin and the introduced New Zealand blue lupin (*Lupinus angustifolius*) became widely grown to improve poor sandy soils and for stock fodder. Both of these lupins contained high concentrations of quinolizidine alkaloids, which under certain conditions could poison animals, causing a transient neurological disease named lupine poisoning. Farmers soon became aware of how this disease could be avoided.

The second major toxicity caused by lupins was the liver disease lupinosis, which became a serious livestock disease in Western Australia.

The first outbreak of lupinosis occurred in 1948, and outbreaks became annual events for the next 45 years normally following summer rain on dry stubble. Chief Veterinary Pathologist Dr MR Gardiner studied the disease extensively between 1960 and 1975.
He established that a fungus growing on dead lupin plants produced toxins that caused the disease. South African researchers identified the fungus in 1970, and named it *Phomopsis leptostromiformis*. In the 1990s a series of studies by WA Department of Agriculture plant pathologists established that the real cause of lupinosis was *Phomopsis* sp. with the teleomorph of this fungus being named *Diaporthe toxica*.

In the 1950s UWA plant breeder Dr AJ Millington initiated a breeding program, later taken over by Dr JS (John) Gladstones, to develop low alkaloid lupins as a crop plant. The first low alkaloid variety of *Lupinus angustifolius*, the narrow-leafed lupin, was released in 1967 and the second in 1970. These were followed by improved cultivars over the next decade (see Chapter 7 for details).

The area sown to lupins increased dramatically and was accompanied by an increase in the number and severity of outbreaks of lupinosis. The disease became a major limitation to expansion of the use of lupins. The worst recorded year was 1977/78.

Sheep suffering from lupinosis. Lupinosis was a major disease affecting the safe use of high protein lupin stubbles.

Lupinosis in sheep grazing low alkaloid commercial lupin stubbles had significant epidemiological differences to the disease in sheep grazing the bitter sandplain lupins.

Veterinary pathologist Dr JG Allen undertook the investigation of lupinosis and authored or co-authored 113 articles on the subject between 1975 and 2008.

During the 1970s and 1980s, extensive studies of the fungus by plant pathologist PMcR Wood, and biochemist DS Petterson in collaboration with CSIRO, identified the toxins produced by the fungus (linear peptides named phomopsins) and described many of their physiological effects. Allen also established that the causative fungus could infect the seed, raising concerns about the safety of the harvested grain and increasing the impetus to find a solution to this disease. At one time the role of copper, which was high in the livers of affected sheep, and the possibility that zinc may help overcome the problem were examined with various management approaches.

Gladstones turned his attention to breeding lupin varieties resistant to infection by the phomopsis fungus, starting in the late 1970s and bringing together a team that included plant breeders Dr J Hamblin and Dr WA Cowling, with Allen and Wood. In 1989 the first three phomopsis-resistant lupins were released. As the area sown to phomopsis-resistant lupins increased, the prevalence of lupinosis decreased. Today the disease is seen infrequently, and usually only in a mild form.

**Annual ryegrass toxicity (ARGT)**

The sowing of annual ryegrass throughout the South West during the early 20th century resulted in a higher quality and greater quantity of feed available to grazing livestock, and greatly increased the carrying capacity of pastures. Annual ryegrass became relied upon by the livestock industries, while ecological and habitat characteristics of the plant meant it became a highly successful weed in cereal crops. In 1968, a new neurological disease occurred in the Gnowangerup area in sheep grazing annual ryegrass pasture. An identical disease had occurred sporadically in South Australia since 1955. The disease was named annual ryegrass toxicity (ARGT).
From this small beginning, the number of outbreaks each year increased dramatically. Between 1968 and 1988, the number of new holdings reporting the disease doubled every three years, and between 1986 and 1991, 307 to 782 holdings reported outbreaks each year. By 1992 ARGT had been reported on more than 1400 holdings, and during the 1990s it was estimated that an average of 20 000 to 30 000 sheep and 230 cattle died each year. In some years there were considerably more deaths, with 80 000 to 90 000 sheep deaths reported in each of 1991 and 2000.

Department of Agriculture research into this disease has been extensive since the early 1970s.

Veterinary pathologist Dr PH Berry studied field epidemiology and pathology of the disease, plant pathologist Dr BA Stynes, together with other scientists in South Australia, studied the complex inter-relationships between the ryegrass plant, the toxigenic bacterium *Rathayibacter toxicus* (previously *Clavibacter toxicus* and *Corynebacterium rathayi*) and the nematode *Anguina funesta* that caused pastures to become toxic. Biochemist Dr P Vogel and CSIRO collaborators isolated and identified the toxins, named corynetoxins. Nematologist Dr IT Riley identified a fungus, *Dilophospora alopecuri*, that could potentially disrupt the life cycles of the bacterium and the nematode and developed it into a commercial biological control agent called twist fungus.

Microbiologist Dr Sue Sutherland developed an ELISA for the detection of the toxic bacterium that has been extensively used to ensure the export of non-toxic hay, and veterinary pathologist Dr Jeremy Allen conducted a national survey with South Australian colleagues that demonstrated widespread contamination of harvested grains with the toxic bacterial galls, thus identifying a significant risk that needed to be managed by the grains industry.

ARGT remains a significant disease of livestock today. Pasture and livestock management procedures have been developed to reduce the risk of disease, and the twist fungus has been spread over several hundred thousand hectares, but these measures have not been totally effective and the disease continues to occur and spread. The development of herbicide resistance in ryegrass has made control of the grass more difficult. A very effective, nematode-resistant ryegrass named Safeguard has been developed, but there are difficulties in getting it appropriately established and many farmers are reluctant to plant it because it has unknown potential to be another weed. CSIRO developed a vaccine that was very effective in preventing the disease in laboratory experiments but could not get funding to develop this into a commercial vaccine. Research to find an effective solution to this toxicity continues.

Pyrrolizidine alkaloid poisoning (Kimberley horse disease, walkabout disease)

Department of Agriculture reports through the 1940s noted that Kimberley horse disease remained a problem needing further investigation. In 1949/50 work was carried out in consultation with other states where the problem occurred.

The disease was initially examined on the basis that it was related to Birdsville horse disease, which occurred in Queensland. This was known to be caused by ingestion of a plant containing an hepato-toxin (indospicine). However, in 1952, observations indicated that a different plant toxin, pyrrolizidine alkaloid, was involved. In 1953/54, a joint investigation by the Northern Territory, WA and CSIRO confirmed that one cause of Kimberley horse disease was ingestion of the plant *Crotalaria retusa*. Subsequent investigation suggested that two other closely related species of Crotalaria could also contribute to the problem. In 1961/62 poisoning of cattle by *Crotalaria crispata* rather than *C. retusa* was identified in the Kimberley.
Other broadscale toxicities
Several other broadscale toxicities of lesser significance than those highlighted above have been encountered. These include perennial ryegrass staggers, phalaris staggers, phalaris sudden death syndrome, facial eczema, kikuyu poisoning, tagasaste staggers, tagasaste-associated leucodystrophy in neonatal calves, interstitial pneumonia and severe gastro-enteritis caused by reshooting canola, black soil blindness, sorghum toxicoses and photosensitisation in livestock grazing perennial and new legume pastures.

For all of these, department scientists have studied the diseases to identify the causes and developed prevention strategies that have been communicated to the farming community. In 2008 no less than three projects were underway to better understand and prevent livestock problems that might arise with three new pasture species. These are biserrula, an annual legume; tedera, a perennial pasture legume; and perennial panic grasses. All three cause, or have potential to cause, photosensitisation in grazing livestock.

Other new plant toxicoses continue to be diagnosed. The veterinary pathologists in the Animal Health Laboratories reported the occurrence of 25 new plant-associated diseases between 1991 and 2001. It is clear poisonous plants will continue to be important in Western Australian agriculture.

General activities
Awassi fat-tail sheep
Export of live sheep to the Middle East became a major industry through the 1960s and 1970s. Large older Merino wethers were exported almost exclusively until the early 1970s when a study showed a preference for younger animals and more particularly for the local Awassi fat-tail sheep, which were not available from Australia.

In the early 1980s the department decided to import this breed of sheep. Careful quarantine was essential to avoid the import of the disease scrapie into Australia. With part funding by the Australian Meat Research Committee (AMRC) an import protocol was developed to avoid this. This required the collection of embryos from sheep on a Mediterranean island and implanting these into ewes in Australia, to be followed by a long period of strict quarantine for the resultant progeny.

Awassi sheep were introduced after a meticulous quarantine program to provide Middle Eastern markets with the sheep they preferred.

When the AMRC withdrew its support an Australian-Kuwaiti company took over control of the quarantine and the associated development of the breed in Australia. The company also controlled subsequent marketing of the adults. Quarantine finished in 1991 and by 2005, around 100 000 sheep per annum were exported to selected markets in the Middle East. Fat-tailed sheep were highly desired in Middle-Eastern markets and buyers were prepared to pay a substantial premium. The Awassi is also a dairy breed but a proposal to foster a sheep dairy industry in collaboration with the University of WA was never realised.

A possible goat industry
Increased interest was reported in 1987 in the development of a goat industry as the basis of producing cashmere. While the national average production of cashmere from feral goats was around 60 grams a year and efforts to increase production by improved nutrition had been largely unsuccessful, there seemed a possibility of
some improvement with breeding. Captured goats from islands offshore from Carnarvon produced two to four times the amount of cashmere obtained from mainland goats. Breeding experiments were undertaken and production measured from the progeny of these island goats.

Goats also had a special advantage in that they ate saffron thistle. Around Geraldton about 200 000 ha of land was infested with this weed, which sheep do not graze readily. Even at low stocking rates, goats were reported to have grazed 96 per cent of thistles in a paddock. While all this was positive at the time, a collapse in the price for cashmere caused the work to be abandoned. A trial with goats in the pastoral areas failed for the same reason.
Chapter 7

Important plant and soil research and development issues

Over the decades the focus of plant research has shifted, depending on industry needs and the opportunities provided by new knowledge. In the early years agriculture was relatively simple, with the basic activities and principles of crop production following those established over the millennia. However, there was an urgent need to understand the unusual soils in Western Australia and to develop crop plants which could mature and produce seed in climatic conditions different to those encountered in the United Kingdom.

Against this background this chapter summarises some of the main advances the Department of Agriculture was associated with. It does not claim to be complete, nor does it deal with the myriad small projects dealing with on-farm problems which were part of the department’s everyday work. The subjects dealt with are generally but not necessarily in order of their importance.

The introduction of the first generation of machines for cultivation, sowing and harvesting of crops brought major changes to the farming industries. Further major changes followed with the introduction of tractors, motorised transport, more sophisticated machinery, better roads and railways and the capacity to handle materials in bulk, which became the basis of modern agriculture.

Improved tractor tyres and the associated increased power and the development of synthetic chemicals for the control of pests, diseases and weeds in the second half of the 20th century provided further opportunities and challenges for research workers.

Finally in the late 20th century broadscale chemical herbicides eliminated the need for cultivation for weed control. This, coupled with the availability of new machines and equipment, provided the basis for new cropping systems. This required new and modified crops and introduced an entirely new framework for production, with new challenges and opportunities.

A wide range of issues

The range of issues covered by the Department of Agriculture is partly reflected in the following extracts of items listed for reporting against objectives, developed by the central agencies in 1990:

Under the objective of the development of new industries issues were, the development of emu farming as a commercial entity, the establishment of kangaroo meat as a food for human consumption, and the segregation of wheat grain suitable for noodle production.

Under the objective of developing new technology, highlights were the release of lupin varieties resistant to Phomopsis, the introduction of field peas into the cereal farming system, the development of a chickpea industry on the Ord, the start of a major research program into the management and production of Western Australian wildflowers, the identification of the basis for the spread of cucumber mosaic virus in lupins, the integrated management needed to combat herbicide-resistant weeds, examination of reduced phosphorus in pig diets as a method of reducing phosphorus leaching to the groundwater, development of...
a high fashion sheepskin industry, the distribution of mites which were predators on redlegged earth mite and lucerne flea, a new diagnostic technique for tuberculosis, the importance of summer feeding for improving wool staple strength, release of new varieties of cereals, a method of distributing insecticide into bunches of cut flowers, and the biological control of dock.

Under the objective of getting information to the user, the issues selected from work in 1988/89 were: improving the national sheep flock through a program for selection and recording of the production of rams, development of a cropping technique for the south coast, the introduction of a program providing an integrated package of the latest management strategies available to dairy farmers, cooperation with a chemical company in developing pest control for field peas, the expansion of regional radio education programs, the monitoring of pig health, the use of a computer program as a guide to feeding of sheep grazed on annual pastures or stubbles, the promotion of the transfer of weaners from the east Kimberley cattle industry to the south, and the promotion of a plan for more scientific breeding of cattle.

Under the heading protecting our industry from pests and diseases the issues listed were: eradication of Queensland fruit fly, action to eradicate apple scab, the sheep lice eradication campaign, development of an export protocol for export of melons from the Ord to New Zealand, control of a TB outbreak in the provisionally-free area south of Perth, control of an outbreak of footrot, a new quarantine strategy for the Kimberley, support for the live sheep export trade and the discovery and eradication of an important parasite of deer.

Under the heading conservation of land, vegetation and water the issues listed were: use of explosives to loosen ground on dam sites in the goldfields to aid the conservation of water, computer technology to give managers better use of the rangelands on a sustainable basis, improving the profitability of cattle raising through the demonstration of productive potential through changes in the sex and age structure of the herd, provision of advice to pastoralists in the Murchison land conservation area, provision of advice to producers on sandy soil to achieve better water and fertiliser utilisation, management in the Peel Estate and the Peel-Harvey area, identification of the sources of phosphorus which leach into Albany harbour, provision of advice to market gardeners on the use of water and fertiliser to limit leaching and consequent groundwater contamination.

In soil conservation, the protection of small areas of remnant vegetation, the development and support of the land conservation district committees, promotion of the landcare concept at school level, educating children in rural and remote schools on the why and how of restoring degraded areas, the use of space technology to identify issues such as waterlogging and salinity in agricultural areas, and the use of Caesium 137 as a tool for tracking the degree of water erosion taking place in an area.

**Plant breeding**

Plant breeding has always been a major function of the department and one of its great success stories. Before 1940, breeding to develop cereals adapted to the climate and soils was the major scientific activity in the plant field. It was initiated in the earliest days of the Bureau/Department of Agriculture with wheat crossbreds tested at Hamel in 1898. However, it only really gathered pace after the arrival of GL Sutton as Commissioner for the Wheatbelt in 1911 who brought a considerable amount of crossbred material with him.

By 1935 there was growing concern about the bread-making quality of WA flour. The Wheat Quality Laboratory was developed in the department to monitor this characteristic. The laboratory tested the flour quality of all advanced crossbred wheats from the breeding program in the 1960s, 1970s and 1980s. The role of this laboratory increased
as the different requirements of expanding markets were identified and the breeding program was directed to match those requirements.

By 1957/58 the focus of the breeding at Merredin was on wheat and six-row barley; at Wongan Hills it was on oats and two-row barley; and at Avondale on linseed in a hope of reviving that industry. Merredin was also working on the pasture legume, barrel medic, selecting the most promising types and bulkling them up. By 1970/71 plant breeding was centred at the Wongan Hills Research Station. Merredin and Mt Barker Research Stations remained as testing sub-centres for evaluating introductions and later generation crossbred material.

In the early 1980s the aims of the breeding programs were reviewed. It was agreed that they should continue to concentrate on disease resistance as well as yield improvement. There was a continued challenge to maintain resistance to the evolving threat of new stem rust strains in wheat. Oat breeders were also seeking field tolerance of stem rust. Lupin breeders were making headway in their search for varieties with better seed retention, higher yield and resistance to infection by the *Phomopsis* fungus.

However, breeding was to become more complex. Breeders needed to consider the tolerance of new varieties to herbicides. Market demand for wheat with particular qualities increased the complexity of the task. Then the new farming system which developed in the late 1970s and early 1980s needed different wheat varieties. Until this change the challenge was to have early maturing varieties to match the short growing season where fallow was omitted and weed control was achieved through cultivation after the opening rains. When chemical weed control permitted earlier sowing and gave a longer growing season, later maturing varieties were needed. The development of climate change produced further complications, with increased risk of frost damage to flowering crops and more uncertain rainfall.

The subterranean clover breeding program, which was started by the University of WA in the early 1950s, was carried out cooperatively by the department and the university from 1967, with the breeding at the department. It became the basis for the national subterranean clover improvement program.

In 1993 a Cooperative Research Centre (CRC) was developed called the Centre for Legumes in Mediterranean Agriculture (CLIMA). This was a cooperative arrangement between the Commonwealth, the Department of Agriculture, the University of WA, CSIRO and industry. However, despite CLIMA's success it was not given further funding after 1998.

Lupin breeding, which had also been started at the university in the 1950s, became a cooperative program with the department in 1967 and was located at the department. It largely remained with the department but with close cooperation with CLIMA.

After the CLIMA bid for further funding failed, the partners (including the department) were successful in obtaining funding to $4 million. This allowed work to continue until 2007. The organisation is now a centre within and funded by the university.

The variety of soils and range of climates in WA required the widespread testing of potential new crop varieties before release. Initially the testing was done on the three experimental farms and then on the seven farms established up to the 1930s. Eight stations were available by the 1950s. While this was generally adequate before the extensive development of light land, it was not sufficient by the 1960s.

In 1965/66 the program was substantially increased to cater for the greater range of variation in climate and diversity of soil types being cropped. A network of sites, largely on farmers' properties, was developed to cater for this variation. The size of this program was reflected in 1983 when 200 crop varieties were tested in a total of 540 experiments on research stations and farmers' properties. More than 100 of the varieties were in the final stage of testing.
Cone seeder (top) and Hege harvester (bottom). Mechanisation revolutionised crop variety testing in various regions.

In the early 1970s the management of plant breeding was computerised and mechanised so that far greater quantities of crossbreed material could be managed and much of the tedium removed. Field observations were recorded on data loggers for immediate and error-free transfer to computer storage, and seed packets and plot labels were printed automatically. Further development of computer-based equipment and new storage and handling facilities (opened 2007) revolutionised the management. This has allowed much more rapid advances across a wider range of species.

In brief, the plant breeding program has been a great success story. A high percentage of the State’s cereal crops are sown to WA-bred varieties. The department’s cereal breeding has become the centre for the national wheat and barley breeding program. In the joint program the narrow-leaved lupin has been developed into an integral part of the new cropping system and the pasture legume program has become a centrepiece in the national legume breeding program. The rapeseed program was a world leader through the 1980s and still enjoys international status but is now primarily with the University of WA. The program has been broadened to cover pulses other than lupins. The following account of the Department of Agriculture’s plant breeding record is not intended to be exhaustive but is indicative of its extent and quality.

**Wheat**

In the very early days the material brought from England would have been selected on the basis of some plants performing better than others. Certainly there is a record of crossbreds being at Hamel in 1898.

The plant material Sutton brought with him and used in the early wheat breeding program was the foundation of the ‘modern’ breeding effort of the time. It benefited from Farrer’s work in New South Wales. Sutton recognised that it was unlikely that one variety of wheat would suit the whole wheatbelt and considered that a number would be required. Appreciating that it was desirable for breeding to be done near or in the conditions under which a new variety would be used, all variety trials and crossbreeding were transferred to the Chapman and Merredin Experiment Farms.

In 1918, Nabawa, was one of eight cereal varieties listed as released.

In 1930 two new wheat varieties were released at the Merredin field day. One was Bencubbin, described as a mid-season variety which had resistance to flag smut. It became one of the most popular varieties planted in Australia, but finally succumbed to rust in 1948.

While flag smut was controlled by breeding there was continued concern with ball smut. The department successfully treated seed with mercury compounds and this treatment became widely used in the wheat industry.
Contractors travelled through the wheatbelt grading and treating seed (known as pickling). The graders were manufactured by the Hannaford Company and were a feature of the wheatbelt through summer and early autumn. They were replaced by more sophisticated centralised treatment and grading facilities after the early 1970s.

A rust garden established at the Merredin Experiment Farm created a humid environment which favoured the development of rust. Following a serious outbreak of stem rust in 1934 it was decided to test all varieties in this facility every spring. The genetic base was periodically increased by introductions, particularly from Sydney University. Although interstate and international varieties were also introduced, in 1939 61 per cent of wheat was sown to WA-bred varieties. Bencubbin was sown on 37 per cent of the area, and was also the leading variety in New South Wales.

During the 1940s and 1950s a number of varieties were released but did not become dominant. Kondut, Wongoondy, Dowerin, Darkan and Moora all appear in the records. Varieties introduced from the eastern states were also planted widely. Gabo, Insignia and Halberd were some of these and later the NSW-bred variety Gamenya became important after a new strain of rust eliminated Gabo.

The main aims of wheat breeding were the development of both yield and rust resistance. In 1964 some 13 400 crossbreds were planted in test rows at Avondale, Esperance Downs, Merredin and Wongan Hills Research Stations. In addition, 180 fixed varieties were planted at Wongan Hills and 260 planted at Avondale. About 5400 crossbreds were planted at Esperance for testing for rust resistance under field conditions.

The genetic base was widened further by the introduction of semi-dwarf varieties from Mexico, as well as the variety Chile, which was crossed with commercial varieties to raise flour quality. Rust-resistant lines were again introduced from Sydney University and introductions from overseas brought into the system. These included material for male sterile and fertility restorer lines of winter wheat from America.

In 1968/69 the wheat program was redirected to look for resistance to species of *Septoria*, which had been recognised as causing a significant yield loss. During 1970/71, 7500 wheats were screened for resistance to *Septoria nodorum* and *Septoria tritici* and sources of resistance to *S. tritici* were located among the early maturing varieties.

The release of varieties for particular markets and/or areas with specific qualities also started. In 1969/70 the variety Bokal was named and seed was released for sowing in 1970. Bokal was selected for higher rainfall areas. It also yielded at least as well as Insignia throughout the wheatbelt. It had a bread-making quality similar to Gamenya, which was the standard at the time, and it was better than Darkan.

In 1974 the department released Madden, which was resistant to all known races of rust. Although it yielded slightly less than Gamenya in trials, it outperformed the current rust resistant variety Eagle by 15 to 25 per cent and had better grain quality. In 1978 a new wheat variety, Tincurrin, suited to the soft wheat markets of South-East Asia, was released as suitable for the south coast.
In 1979 Miling was released. It was an early mid-season hard wheat of short to medium height, with some resistance to leaf blotch septoria, resistance to flag smut but susceptible to rust. It was expected to be used substantially on the West Midlands sandplain and the areas to the east. It had outyielded Gamenya and had a better baking quality.

By 1980, breeding was further focused on developing resistance to *Septoria tritici*. While this had started some years before, by 1980 there appeared to be lines with resistance which needed further testing before release.

Five new wheats were released in 1982. This was a reflection of the increased capacity established some years earlier.

In 1985 further varieties were released. One was Cranbrook, released as an Australian Standard White variety. It was resistant to both stem and stripe rust and bred particularly for the south coastal areas.

In 1986 the variety Kulin was released and performed very well. It was suitable for the Australian Standard White category. Kulin was short-strawed, high yielding, stem rust and flag smut resistant and partly resistant to stripe rust. It was suitable for the central lower rainfall areas and south central medium rainfall areas. Field experience in 1986 showed Kulin to be 5 to 7 per cent higher yielding than the top yielding variety Aroona.

In 1990 two further wheat varieties were released. In addition a screening technique for selecting wheats for noodle quality enabled their segregation from the general wheat deliveries.

Varieties of wheat and barley tolerant to a herbicide for brome grass control were identified. With further development it was considered that control of this weed in cereals might be possible. However, it seemed likely that brome grass could be controlled more easily through herbicides in the legume phase of the rotation.

Cadoux was released in 1992 as a high yielding wheat suitable for white salt noodle production. It was developed in close consultation with Japanese flour mills. In 1998 its continued high performance was noted.

In 1993 two new wheat varieties were released. Amery was a high yielding, early maturing, hard grained, Australian Standard White variety for general use in the medium and lower rainfall areas. It would replace Kulin and Bodallin which had been downgraded to general purpose for 1995. Another variety, Stretton, was released as insurance against future introductions of stripe rust to which it was resistant. It was also high yielding and suitable for the 325 to 450 mm rainfall area.

Extensive sowings of Arrino and Calingiri were reported in 1998. These were released in 1997 for the salted noodle trade. Two new wheats were released, Camm for the Australian Premium White segregation, and Ajana for the Australian Standard White segregation. In 1998 two varieties, Westonia and Brookton, suitable for the Australian Premium White segregation, were released, together with Arrino and Calingiri, suitable for the White Salted Noodle market, and Nyabing, suitable for blending with noodles. In 2000, 45 per cent of WA wheat plantings were of the 12 varieties released after 1996 and almost 67 per cent of the plantings were of WA-bred varieties.

During the next seven years a further 10 new wheat varieties were released:

- Dataline - a soft wheat with good resistance to stem and leaf rust and slightly later maturity than the currently-grown soft wheats
- Tammin - a very high yielding wheat with potential for white salt noodles
- Cascade - a good quality hard grain ASW wheat with excellent flour yield and dough properties, and good disease resistance
- Kalannie - a very short season variety with excellent quality for the Australian Hard category

In 2000, 45 per cent of WA wheat plantings were of the 12 varieties released after 1996 and almost 67 per cent of the plantings were of WA-bred varieties.
• Carnamah - a mid-season variety adapted to the high and medium rainfall areas, with resistance to the three rusts, *Septoria nodorum* and yellow leaf spot – Australian Hard quality
• Cunderdin – an early mid-season variety widely adapted across the State – Australian Premium White
• Perenjori – a mid-season variety adapted to medium and lower rainfall areas – Australian Premium White
• Binnu – a variety with wide adaptation to much of the central and northern wheatbelt, with improved yield, improved disease resistance and excellent quality for noodle manufacture
• Magenta and Yandanooka were two other new wheat varieties.

In 2007 the department combined with the Grains Research Development Corporation to form a semi-commercial breeding company named InterGrain. This was half-owned by each of the partners. Its focus is the breeding of wheat and barley. It took over the Department of Agriculture's cereal breeding program and is the home of the National Cereal Breeding Programs. It has a small independent board chaired by a prominent farmer. It rents space and facilities at Wongan Hills Research Station. In 2010 it was expected to take over the department’s wheat breeding staff. This arrangement will allow the company to earn royalties from successful varieties such as Wyalkatchem. There are now only two other major wheat breeding institutions in Australia—one in South Australia and one in Queensland.

**Oats**

In 1918 the production of two earlier maturing oat varieties, Burt's Early and Lachlan, was reported. There were no further reports of new oats until 1953/54, when two new varieties, Ballidu and Dale, were performing well and there was a demand for pedigreed seed of these varieties. The aim of the oats program then was to produce varieties with a high yield, high bushel weight and processing quality suitable for export. In 1954/55 a new variety was released called Avon. Avon became the dominant variety in the medium rainfall areas for the next decade. In 1956 a sister line of Avon was released under the name of Kent. It was also successful.

In the 1960s the genetic base for oat breeding was widened with the introduction of advanced crossbreds from New South Wales and varieties from the United States of America and Cyprus. The overseas introductions were grown under quarantine. In 1965 Irwin was released to farmers, followed by West in 1975. This had outyielded the recommended varieties over the previous five years by at least 8 per cent. The cross which led to this new variety was made in 1965, reflecting the long lead time involved.

In 1978 the variety, Moore, was released for areas receiving more than 450 mm of rainfall. Mortlock was released in the early 1980s; it was well accepted and performed well. In 1985 Winjardie was released for the West Midlands, and Murray for the medium and lower rainfall regions. Both were expected to outperform Mortlock in their specific areas.

In 1992 Yilgarn was released. This was an early maturing, tall oat suitable for both grain and hay production for the export market. In 1998 a feed oat, Needilup, was released. In 1999 two more varieties were released. These were Hotham, a high yielding feed variety and Vasse, a hay variety for the high rainfall areas.

Three further oat varieties were released up to 2008:
• Pallinup – a high yielding oat with potentially high quality for milling
• Coomallo – an excellent milling quality oat with a good yield potential in medium rainfall areas
• Toodyay – which had improved milling quality and higher yield potential than Coomallo across the State.
The national oat breeding program is now located in South Australia and oat breeding was reduced in WA by the end of 2008.

**Two-row barley**
The initial aim of the two-row barley program was to find a barley which would outperform Prior, which was used almost exclusively in the malting industry. In 1965/66 a crossbred named Dampier was released and accepted by the malting industry. In 1982 Stirling was released, initially as a feed barley while its malting characteristics were assessed by industry. Stirling proved to be very acceptable for malting and rapidly became the major variety planted in WA. By 1988, Stirling occupied some 75 per cent of the area planted to two-row barley.

In 1998 two new two-row barley varieties, Fitzgerald and Gairdner, were released as feed barleys pending assessment for malting. Gairdner and Unicorn malting barley were adopted by the malting and farming industries. The success of the program was reflected in the availability of two more two-row varieties in 2008. These were Baudin and Hamlin which were high yielding and had very acceptable malting quality. Powdery mildew remained a problem for the industry.

Barley breeding made major advances in the early to mid-1990s and the areas planted expanded more than even canola up to 2008. This related largely to finding cultivars which suited brewers in Australia and overseas, resulting in prices which made it competitive with wheat.

The double haploid technology and marker assisted selection which were introduced into the barley program were also taken up by the wheat breeders. They markedly increased the capacity of the programs. Barley breeding has followed wheat into InterGrain.

**Six-row barley**
In the 1960s the six-row barley genetic base was increased by the introduction of material from South Australia, Israel, the United States, Cyprus and Japan. At that time the program was at an early stage. A new six-row barley variety, O’Connor, was well accepted by farmers and continued to perform well. A new feed barley, Forrest, had been released for the 1981 season, initially for southern high and medium rainfall areas. In 1987/88 the variety Moondyne was released. This had a late spring maturity and was developed for the long season conditions of the south coast. The Moondyne and O’Connor varieties occupied about 10 per cent of plantings in WA. In 1994 Mundah, in 1996 Molloy, and in 1998 Doolup feed barleys were released. Doolup was particularly suited to the medium and high rainfall areas where high levels of boron were a problem.

**Linseed**
Rust resistance and higher oil yield were the aims of the linseed program which was in place from the late 1940s to mid-1960s. In 1964 a high yielding selection of linseed from an existing variety, Kameniza, which was satisfactory in other respects, was named Gibson and released; it became the leading commercial variety in the State. At the end of 1965 the program was terminated because of limited demand.

Seed of Gibson was distributed to farmers for planting of restricted acreages. Testing of available varieties continued after the breeding program ended. This testing program showed that two un-named crossbreds, A7 and A21, performed very well.

**Flax**
The collapse of Belgium during World War II resulted in a sharp increase in the price of flax and the establishment of a small industry in the Boyup Brook district. A breeding program was established to meet the needs of that area and particularly to achieve rust resistance. In 1942/43 selections were made of plants which appeared rust resistant in the field. In 1945/46 a rust-resistant flax variety
named WADA was ready for release and two other crossbred flax varieties were showing promise at Avondale. Another variety, Boyup, was released at that time. In 1948/49 a rust strain attacked WADA. By 1955 both the new varieties had become susceptible to the Ottawa 770B strain of rust and breeding work focused on potentially resistant selections. However, the industry failed due to economic circumstances. In the early 1960s there was some interest in the production of high quality fibre in WA. While the trial work was successful, the industry did not develop and the flax breeding program was closed in 1964.

**Lupins**

Lupins had been used in Western Australia as dry stockfeed (largely the sandplain lupin) and as a green manure crop in orchards and vineyards (mainly the narrow-leafed or New Zealand blue lupin). The development of the narrow-leafed lupin (*Lupinus angustifolius*) as a crop started at the University of WA in the 1950s. It was transferred to the Department of Agriculture in the mid-1960s but remained as a joint enterprise. Over the next 30 years the lupin was developed into an important crop plant through astute plant breeding, led by Dr JS Gladstones. It provided the essential legume component to the ‘new agriculture’ system. The conversion of this lupin to a crop plant in such a short time is a credit to the breeders involved. After CLIMA was established in 1993 the program’s informal cooperation with the partners became more formalised.

In 1948 a toxicity problem was first described among sheep grazed on the dry stubble and unharvested seed of lupins. This problem, named lupinosis, caused serious stock losses. It was finally identified as being due to a toxin produced by the fungus *Phomopsis*. Although extensive work was done on the problem the major advances resulted from the breeding of varieties of lupin resistant to infection by the fungus. Details of these investigations are in Chapter 6.

The initial releases of potential crop plants from the breeding program were the varieties Uniwhite and Uniharvest. They had limitations as crop plants. The third variety Unicrop was released in 1973. Standard yield trials up to 1975 demonstrated that it was superior to Uniwhite and Uniharvest. But this was only beginning and yield increases continued to be achieved.

In the 1979 season Illyarrie was released. It was produced in collaboration with the USDA at Tifton in Georgia. It had a similar maturity to Unicrop and the greater vegetative vigour and the green colour of Marri. It was resistant to the disease grey leaf spot and had a better yield than other varieties. Yandee was released for commercial sowing in 1980. It appeared to be higher yielding in central and southern districts in statewide trials in 1979. Danja, released in 1986, outyielded Yandee by 14 per cent. The progress in developing a crop plant resulted in the yield being doubled between 1960 and 1985, with further increases in the pipeline.

In 1987/88 the first variety with resistance to *Phomopsis*, Gungurru, was released. It also had a higher protein and lower alkaloid content than previous lupin varieties. In 1989 another variety, Yorrel, was released. Both the new varieties were phomopsis-resistant. In addition to providing extended periods of grazing compared with what could be achieved on the stubbles of the old varieties, these new varieties gave higher seed yields
in many parts of the State. In 1992 Merit was released. It was slightly higher yielding, more uniform and more resistant to *Phomopsis*.

The first lupin variety with significant resistance to brown leaf spot was named Myalli and released to seed producers in 1995. It was adapted to the northern and lower rainfall regions and because of its consistent low alkaloid content was expected to replace Yorrel as the favoured variety for human consumption. A variety named Coromup was released later, with higher protein than the other available varieties and was targeted at the dehulling and protein market.

An outbreak of anthracnose in the northern agricultural areas caused great concern in the industry. Material was identified in New Zealand (where the disease was endemic) which had anthracnose resistance and this material was introduced into the breeding program. Potentially resistant varieties were tested in New Zealand. A new breed line with excellent anthracnose resistance was selected for rapid seed increase and early release to growers. The first release of resistant material was named Kalja which was also higher yielding than Gungurru. This was followed by the release of another high yielding anthracnose-resistant narrow-leafed lupin in August 1998. It was named Taljil.

CLIMA became the world's leading centre for molecular biology of legumes. A partnership was entered into with CLIMA to genetically modify the narrow-leafed lupin to transfer pesticide resistance into the breeding lines. This project was successful but due to political interference was not commercialised. In collaboration with CLIMA and others it was also proposed to use gene transfer to introduce resistance to bean yellow mosaic virus and possibly other problems into the program. Partnerships were also entered into with other organisations to achieve access to specific skills or materials.

In 1998 the release of two new narrow-leafed lupin varieties was reported. They were Belara, which had high *Phomopsis* resistance and Tallarack which was the first restricted branching lupin.

There had also been interest within the program in other lupin species as crop plants. Work had started on the development of crop varieties of the sandplain lupin (*Lupinus cosentinii*) which was suitable for deep sandy soil. The aim was to breed a line combining sweetness, earlier flowering, white flowers and seeds and non-shattering pods. One such line was bulked up for field testing and possible release in 1977. A combined genetic source of both soft-seededness (to ensure reliable germination) and sweetness was still being sought.

Meantime, work on devising a method of seed scarification had given promising early results. In 1979 a soft-seeded characteristic of a selection from the sweet white-seeded non-shattering breeding line, CBE 49 was identified. Evaluation of its hard-seeded parent CBE 49 was continuing. CBE 49 was subsequently registered as Eregulla for possible use in continuous cropping in the northern sandplain. In field tests Eregulla, with its very low level of alkaloid, became very susceptible to aphids and had to be changed if it was to be a successful commercial crop plant. However, the suggestion of having a small addition of alkaloid to achieve aphid resistance was rejected by the breeder and the program was dropped. No further reference to work on this lupin was found.

There was also interest in the European yellow lupin (*Lupinus luteus*). The varieties available were later maturing and suited to the higher rainfall areas. An early variety was produced in 1998 and named Wodgil because it had been shown to grow on the wodgil soils of the eastern wheatbelt. Despite the suitability for heavier soil types the yellow lupin failed, largely through aphid problems associated with its low alkaloid content. This problem remained to be solved.

Another species of particular interest for loams and heavier soils was an earlier flowering Mediterranean white lupin. In 1980
two earlier flowering Russian cultivars of *Lupinus albus*, which outyielded the then 'standard' lupin in nearly all districts were identified as potential crop plants. Seed was increased with a view to possible release if the yield trend was continued. Another cultivar of *Lupinus albus*, named Hamburg, was included in general testing in 1980. Kiev Mutant, a Russian variety of the Mediterranean white lupin, was released in 1982. Three lines of albus lupins were tested in variety trials across the State in 1990. Overall, the material seemed very promising but it turned out to have 0.1 per cent alkaloid content, which was well above the standard of 0.02 per cent and the material was put aside for possible future development.

In 1990 a research program was also started to develop an entirely new lupin for heavier soils and possibly in cold climates. A lupin collected from the highlands of southern Morocco in 1973 was considered to be the best candidate and the world's first fully domesticated *Lupinus atlanticus* line was sown for testing in the field. Work was also proceeding on the development of both an agronomically suitable variety of the high protein yellow lupin grown in Europe and a low alkaloid, high oil variety of the Pearl lupin native to South Africa. Key traits important for the domestication of both species were being identified before incorporation into the breeding program. However, this work was not persisted with largely through lack of resources. Further work may be undertaken at a future stage but this was not part of the 2008 program.

By 2008 the focus had reverted to the narrow-leaved lupin. A high yielding variety, called Mandelup, with improved content of the sulphur-containing amino acid lysine and resistance to the pesticide Gard, was available. The field pea was still considered the only viable legume for heavy soils at 2008.

**Rapeseed**

Rapeseed (*Brassica napus*) was first grown as a broadscale crop in WA in 1970 but in 1971 crops sown on the south coast were seriously affected by the rootrot disease, blackleg. The rapeseed also had problems of the oil containing a significant amount of erucic acid and the meal remaining after the oil was pressed out of the seed contained toxic glucosinolates. The erucic acid limited the oil's use in human food and the glucosinolates limited the use of the meal for stockfeed.

Initially the breeding program aimed at developing resistance to the blackleg fungus. As it developed, its objectives were increased to include lines containing higher oil levels, low erucic acid and low levels of toxic glucosinolates.

By 1977 material was available which had a low erucic acid content and good resistance to blackleg. These crosses were regarded as having early enough maturity to be suitable for a considerable part of the south coast. The program was continued, aiming to develop earlier maturity and greater resistance. A low content of glucosinolates was also introduced to improve the quality of seed meal. A parallel breeding program was being carried out with turnip rape. The aim was to produce varieties with sufficient early maturity to extend rapeseed growing into the wheatbelt proper by crossing with very early varieties obtained from India. Oilseed rape is closely related to turnip rape (*Brassica rapa*). Being part of the Brassica family it was also related to the weeds wild mustard and radish.

In 1978 a new rapeseed variety which was low in erucic acid and resistant to blackleg was released. It was named Westway and produced from a cross between a French and Canadian variety. It was also earlier maturing and suitable for later planting or lower rainfall conditions.

In 1980 two new rapeseed varieties, Wesbell and Wesroona, were released and were expected to increase sowings. In 1987/88 a gene for complete blackleg resistance was imported from the wild mustard plant (*Brassica juncea*). This was combined with the field resistance already present and the
crossbreds inherited a high level of black leg resistance in the field. Progress was also made in developing improved oil qualities and improved resistance to shattering.

The advances in blackleg resistance, together with the development of shattering-resistant types of rapeseed, further highlighted the success of the program. It was recognised as leading the world in several lines of breeding and had attracted much overseas interest with the genetic material in great demand from breeding programs around the world. Unfortunately in those years there was little interest in the crop in WA. As a result, the breeder took up a position at Cornell University in the USA and took the breeding material with him. Cornell had close working arrangements with Canada and the breeding material became a key part of the modern rapeseed – canola.

In 1992 an early maturing canola variety, Narandra, was released, giving the growers in the medium rainfall area a new cropping option. From 1992 to 1999 the area of rapeseed (canola) sown in WA increased from 11 000 to 800 000 ha. The release was well timed to take advantage of the expanding WA oilseeds industry.

In 1998 it was reported that 'Specialty Oil' lines of canola with a high oleic and low linoleic acid were under development. Successful production of a variety was expected to increase the market share for canola. This program was carried out in collaboration with the Georgia and Cornell Universities and was reported as being close to releasing some material.

Today, the canola breeding program is at the University of WA and privately funded by the Canola Breeders of WA.

An interesting side to canola is that availability of honey bees for pollination has a marked impact on yield.

**Pulses**

As exports of pulses increased, a breeding program developed. In 1998 two WA-bred chickpea varieties were developed. They were named Sona and Heera, both of which were of high quality and yield. The Cassab and Cumra varieties of red lentils were also released in that year along with two field peas, King for the northern medium rainfall areas and Magnet, which was the first semi-leafless variety.

Molecular markers were introduced to the program through CLIMA. Achievements from the program were:

- release of the first chickpea variety in a joint program with New Zealand’s Crop and Food Research Institute
- release in 2000 of two field pea varieties, Cooke and Helena, which were expected to increase production
- identification of material resistant to black spot of field peas for introduction into the field pea breeding program which was continuing in cooperation with CLIMA and international organisations.

The program resulted in an increased focus on the need for lime in some soils which had become increasingly acid, particularly for growing some pulses and oilseeds.

In later years the field pea variety Kaspar, which was bred in Victoria, became available. It had reduced leaves and increased tendrils such that it stood up to be harvested. It became very popular and the area sown in WA increased.

The area of locally-bred material fell. The chickpea work continued in close cooperation with Indian researchers who carried out the original crosses and took the crossbreds through the early generations. At F4 or F5, 400 to 500 selected crosses were made available and selections were made from these.

An organisation called Pulse Breeding Australia has been formed within the Grains Research and Development Corporation and decided that the national programs for pulses, in which they included lupins, would be located at different centres. As indicated above, the national field pea program was located in Horsham, the national chickpea program was in Tamworth, the national faba
bean breeding program in Adelaide and the national lupin breeding program remains in Perth.

Work was continuing in the department in collaboration with CLIMA aiming to enhance the field pea germ plasm to produce black spot resistant genetic material. If successful, it was to be made available to Horsham.

**Pasture legume breeding**

Western Australian soils are inherently infertile and deficient in nitrogen and it was important to obtain suitable legumes as the basis of a sustainable agriculture. In the 1920s it was found that a mid-season flowering subterranean clover, later called Mt Barker, was a suitable legume for the higher rainfall South West. Other naturally-occurring strains were tested through the 1930s and 1940s and an early flowering variety named Dwalganup, after the farm on which it was found, was commercialised. It was used widely through the Great Southern and inner wheatbelt areas. None of the other known strains were commercialised at that time.

A breeding program was started by the University of WA in the early 1950s to find a clover for the eastern wheatbelt. This became a joint project with the Department of Agriculture in 1967. Early maturity was the initial focus and a naturally occurring variety, earlier than Dwalganup, was named Geraldton and released to farmers. It became the basic subterranean clover for the wheatbelt.

The demonstration that varieties of subterranean clover varied in their isoflavone content shifted the focus to developing a suite of subterranean clovers with low isoflavone content. This work was simplified by the development of a simple field test for isoflavone levels in the early 1960s.

During 1967 three low isoflavone subclover varieties were released to farmers. Two of these, Daliak and Seaton Park, had been selected from naturally occurring populations, and Uniwager had been produced from the breeding program. While Daliak and Seaton Park were reasonably successful, Uniwager never became a significant commercial variety.

In 1977 Nungarin subterranean clover was released for sowing in the wheatbelt. Nungarin had a low isoflavone content, was earlier maturing than Geraldton, and had a high level of hard-seededness. For these reasons it was believed to be suitable for the eastern wheatbelt and was planted widely before the focus shifted to continuous cropping.

Subterranean clover and the annual medics continued to be the two main pasture legume species in the program through to the late 1980s, when the program was reviewed.

In 1978 another new subterranean clover, Esperance, which was resistant to clover scorch disease, was released. It was suited to the southern agricultural areas.

Subterranean clover strain evaluation plots.

The focus of the subclover program was the breeding of a range of cultivars of varying maturity, with high productivity, reasonable hard seed level and low isoflavone content. Seed of four new varieties was built up after they had performed well in trials. These offered a broad range of maturities, low oestrogen levels, and clover scorch tolerance. Another 120 lines were under test. In 1985 the four new cultivars named Dalkeith, Green Range, Karridale and Junee were released.

There was also interest in other species for situations where subterranean clover was not suitable. Seed was increased of 22 lines.
of a serradella (*Ornithopus compressus*) selected for improved performance on deep sandy soils. Cultivars of early maturing yellow serradella were tested for the low rainfall districts. A new variety, Madeira, was released to seed producers in 1988. This program was particularly focused on early maturity and hard seed for deeper sandy soils.

The medics were initially seen as being suited to and largely restricted to the heavier more alkaline soils of the wheatbelt. The isolation of Rhizobia for medics suited to slightly acid soils extended the range of soils on which medics could be grown. Varieties of *Medicago polymorpha* had shown promise of having a big impact on pasture improvement on some hardsetting soils. Some early maturing medics appeared to have some potential for the rangeland. As part of the program, medics collected originally in North Africa and the Middle East were tested in the Goldfields, Murchison and Gascoyne regions.

A new variety of medic named Santiago was released in 1988. This was collected in Chile in 1962 and had been extensively tested in lower rainfall areas. Zodiac, the first cultivar of *Medicago murex*, was released in 1988. It was a mid-season variety suitable for areas receiving more than 450 mm of rainfall. Being deep-rooted, it remained green for two or three weeks longer than other species of similar maturity.

In collaboration with the University of WA and CSIRO several lines of work which gave promise of producing useful pasture legumes were undertaken. These included the introduction of the Mediterranean collection which contained a large number of subterranean clovers of all three subspecies. One subspecies, *Yanninicium*, was of particular interest because it was the same subspecies to which Yarloop belonged. A replacement for Yarloop was needed and found in that family.

The relative productivity of the newly recommended low oestrogen strains of subclover under grazing was examined. These strains were established in the wheaatbelt and higher rainfall areas, including Mt Barker and Lancelin. This was in keeping with the policy of testing pasture plants under grazing. Grazing trials with two medics and the subclover variety Dalkeith showed that the medics produced more wool over the summer and autumn than the subclover.

In 1990 the plant breeding program reported the registration of two further subterranean clover varieties for release. In 1992/93 the creation of CLIMA improved the research support for the legume breeding program and progressively widened its genetic base.

From the early 1990s to the end of this review there was a virtual explosion in the range of pasture species tested, released and adopted to varying degrees by the farming community. These developments were reviewed in 2007 in a publication under the names of 27 authors. Fifty-eight new annual and short-lived perennial pasture legumes were listed as having adaptation to both the existing and new farming systems. While the yellow-flowered serradella (*Ornithopus compressus*) had been used for deep sandy soils for some years, its use had been restricted by high seed costs associated in part with its hard-seededness. The release of Cadiz French serradella (*Ornithopus sativus*) created new interest with easier harvesting and lower hard-seededness. Sowings of up to 100 000 ha were reported as possible in 1998, with a prediction that 500 000 ha could be sown by the year 2000. The seed had originally been collected in the wild in South Africa in 1989. It had the potential to significantly increase sheep production in areas where deep sandy soils were common. Unfortunately it had little hard seed and was susceptible to false breaks. New cultivars have overcome this problem. Two varieties of yellow-flowered serradella, Santorini and Charano, with better seed characteristics, were released during the period.

Three new subclover cultivars from Sardinia were released in 1993—Denmark, Goulburn and Leura. Goulburn was expected to have a role in WA.
The first cultivar of *Medicago sphaerocarpus* (sphere medic) was released to seed producers in 1993, with subsequent distribution to farmers in 1994. It provided a pasture legume option for moderately acidic loams and sandy loams in the medium rainfall wheatbelt where cropping was frequent.

Resistance to attack from redlegged earth mite was given high priority in the development of commercial cultivars of subclover. While there has been little tolerance of the pest in commercial varieties, an early-maturing introduction from Spain showed good tolerance and was immediately introduced into the crossbreeding programs.

Overall, the success of the widening of the pasture legume base in the state was the result of work across southern Australia at a number of institutions, with the department playing a prominent part. The work was based on identification of the need for species with deeper root systems, resistance to false breaks, a range of hard-seededness, tolerance of pests and diseases, acid-tolerant root symbiosis and ease of harvesting to provide low seed costs. Mixtures of these legumes have provided for more robust pastures suited to different farming systems and the varied year-on-year conditions of farming. The size of the overall program was shown in a review prepared for the journal *Field Crop Research* in 2007.

**Fertilisers and plant nutrition**

**Superphosphate**

*The early days*

The most significant change in the development of agriculture in Western Australia occurred with the increased use of soluble phosphorus fertilisers which began in 1904/05. The increase followed experiments and farmer experience that showed that land which had previously been considered useless could be highly productive with the use of a fertiliser containing soluble phosphate which was readily available to plants. Superphosphate provided both available phosphate and sulphur, which was later shown also to be important.

In 1904/05, 2850 tons of artificial fertilisers were imported, with a value of a little less than £50 000 ($100 000). In the following year, 18 560 tons were imported. The quantity of fertiliser imported continued to increase and reached 30 000 tons by 1910.

The Victorian company Cumming Smith started manufacture of superphosphate in WA in 1911. Superphosphate was first manufactured in Victoria in 1876. The reason why it was not imported earlier is not clear. Certainly there was reference to it in the early issues of the *Journal of Agriculture* in 1894. Perhaps it was seen as being too expensive or the rates used in these early years may not have been adequate. Alternatively, this may reflect the lack of professionals in the bureau/department in the early days.

Nevertheless, the clearing and farming of soils previously seen as useless drove a dramatic increase in the cropped area. Since fertiliser responses were less common in the fruit industry the direct relationship does not hold there. The change is shown by Table 4.

A 1925 report refers to impressive results from superphosphate topdressing trials on pasture. There were also experiments reported from the Northcliffe plain and the Cranbrook district. By 1928 the practice of topdressing pastures based on subterranean clover was almost universally adopted for the developing dairy farms in the South West.

In 1922/23 a fertiliser trial on apple trees at Bridgetown showed a response to superphosphate but not to bone dust. This was important, as growers were in the habit of using bone dust, which they believed to be better than superphosphate.
During the 1930s a substantial amount of pasture research involving different species, fodder crops, fertiliser trials and trials with the use of lime was carried out in the South West. These trials established the basic information on which the dairy industry developed and on which subsequent research was carried out. In both the high and medium rainfall areas the fertiliser companies combined with the department to carry out trials aimed at increasing production through topdressing of pastures and fodder crops.

The wartime shortage
Throughout the 1940s phosphate fertiliser was in short supply due to enemy action during World War II and the focus was on achieving the best results with minimum applications. The total quantity of fertiliser imported into WA in 1938/39 was 4.5 million tons, including 4.16 million tons of rock phosphate. In 1940/41 the total was 2.53 million tons, of which 2.41 million tons was rock phosphate.

Experiments investigated minimum requirements of super for pastures and cereals in view of the shortage. Long-term experiments at Merredin were the basis for recommending farmers use only 40 pounds of super per acre (45.5 kg/ha) for their cereal crops. This was expected to be reduced to 30 pounds per acre (34 kg/ha) in 1943/44 due to shortage. Work on pasture species and fertiliser requirements was continued through this period.

Experiments were also carried out to test ‘Adams phosphate’ made by treating phosphate rock with 75 per cent of the normal sulphuric acid. This product was developed by AB Adams at Muresk. This became more relevant after the war when a sulphur shortage was feared. Adams was one of the early graduates in agriculture from the University of WA.

Post-war development issues
After World War II there was a need for further work on phosphate use, for a number of reasons. First, the explosion in the development of the sandy-surfaced ‘light lands’, some of which had a high level of ironstone gravel requiring heavier rates of superphosphate for successful development. Second, there was a need to revisit established areas to measure the residual value of previous dressings. Finally, and more urgently, there were concerns about the possible shortage of sulphur for superphosphate manufacture.
Chapter 7 – Important plant and soil research

Uneven spinner topdressing showing big response to superphosphate.

A possible sulphur shortage
A potential shortage of sulphur based on uncertainty about supplies from the United States was the focus for research in the early 1950s. The experimental work included reassessment of the value of Adams phosphate and assessment of the value of very finely ground rock phosphate. The finely ground rock phosphate did not give very good results with wheat or pasture but seemed to be used better by oats. A major practical problem was that it did not flow freely through the drilling or topdressing equipment, and it was not persevered with. In contrast to its performance on normal soils it was superior to superphosphate on some acid peaty sands because it did not leach to the same degree as the more soluble superphosphate. On many soils, particularly the peaty sands, sulphur was also required. In the mid-1950s a decision was taken to use sulphur extracted from iron pyrites mined in the goldfields and the issue was solved.

In some trials calcined rock phosphate was also tested at the request of the British Phosphate Commission. The material provided was found to be an inferior source of phosphorus for wheat or subterranean clover on phosphate-deficient soils.

The new land areas
Through the 1950s and early 1960s extensive work was carried out on both new land and developed areas. The work concentrated on determining the most economic level for development and assessing the residual value of previous dressings. The outcome in both cases depended on the soils involved, the level of other nutrients, the method of application and the rainfall. An incidental observation of this work was that subclover with good phosphorus nutrition showed less effects of drought in lower rainfall years. In a dry winter some phosphate topdressed onto the surface in these areas probably did not reach the root zone.

In the South West good growth of subterranean clover planted on the virgin gravelly-surfaced soils of the forest country was only achieved where superphosphate was topdressed at high rates. On some gravelly-surfaced soils, particularly where Karri forest had grown, higher phosphate dressings were required, even where the land had been farmed for some time. In trial work maximum yields of subclover pasture were only obtained with dressings of up to 4 cwt of superphosphate per acre (509 kg/ha) on recently cleared ironstone gravelly-surfaced soil which had not been previously topdressed. Where finely ground rock phosphate was used 16 cwt per acre (2036 kg/ha) was required to give equal growth.

In the 1960s, experiments with pastures were carried out on the time and frequency of topdressing superphosphate. It was found that autumn topdressing was the most efficient and that on most previously topdressed land there was very little disadvantage in using twice the normal rate every second year. However, on ironstone gravelly soils at Margaret River and Manjimup the omission of superphosphate in any year greatly reduced pasture growth on established areas over the early years.
Superphosphate was essential for crop production on recently cleared areas even on heavier soil types.

Superphosphate was particularly needed on recently cleared sandplain soils.

**Sulphur deficiency**

Superphosphate supplies both phosphorus and sulphur to the plant. As phosphorus builds up in the soil, sulphur can become the most important nutrient supplied, particularly on sandy soils.

In a series of farm trials during 1965/66 testing the need for phosphorus and sulphur, the development of sulphur deficiency in the absence of superphosphate was identified in a large number of situations. As commercial phosphorus fertilisers which did not contain sulphur became available, this was important. These experiments were carried out in both the low rainfall and high rainfall areas and identified two areas where sulphur deficiency was unexpectedly widespread. These were the Avon and Chapman Valleys.

Using radioactive phosphate, it was possible to demonstrate differences in the phosphate loss from soils. Losses from deep sandy soils were found to be very high whereas the losses from soils with gravel or some clay in the profile were much lower. From soils such as the red brown loamy sand in the Swan Valley the losses were negligible. It was known from other work that there were high phosphate losses from soils such as the Plantagenet peaty sand at Denmark, which had a pH of 5.0 or less.

**Superphosphate on grazed pasture**

A grazing trial on subterranean clover and volunteer grass west of Mt Barker found a complex relationship between the effect of stocking rate and the level of superphosphate applied, on pasture composition. This in turn affected the performance of the grazing animals. The results cast doubt on the interpretation of the results of fertiliser trials on pasture where the productivity of the grazing animal was not measured.

The 1962 trial compared wool production from combinations of stocking rates per hectare (15, 12.5, 10) and superphosphate rates per hectare (127, 254, 380 kg). The highest wool production per head was obtained from treatments which favoured a high clover content in the pasture. A high grass content resulting from insufficient grazing pressure due to either, resulted in both lower wool production and lower body weights through summer. For example a combination of 10 wethers and 380 kg resulted in grass dominant pasture and inferior animal performance in the summer. By comparison, 15 wethers were carried continuously where 380 kg were applied annually, maintaining a better balanced pasture and giving the highest wool production per hectare throughout the trial, which ran until the late 1960s.
Relative importance of phosphorus and sulphur in superphosphate

The advent of low sulphur fertilisers required the relative importance of the two nutrients to be examined. Early experiments with low-sulphur fertilisers showed that sulphur deficiency could occur quite widely.

Trials in the higher rainfall areas to determine the relative importance of the two nutrients found that on the poorest sands and on sand with clay or gravel below 18 inches there was a requirement for higher levels of phosphorus and sulphur regardless of past history. In addition, there were very large responses to spring application of sulphur which could be greater than when superphosphate was applied in the autumn alone. This was doubtless due to the leaching of sulphur out of the root zone by the heavy winter rain.

On grey sands with shallower depths to gravel, and grey and yellow sand over clay, responses to sulphur were obtained, including some responses to spring-applied sulphur. Only on a few better class soils was there no response to spring application of sulphur. Despite this work the researchers were unable to identify exactly where this problem would occur.

In the lower rainfall areas responses to spring application of sulphur were not obtained.

On better class soils responses were obtained in the medium rainfall areas up to 114 kg/ha of superphosphate and in the higher rainfall areas up to the level of about 228 kg/ha of superphosphate, which normally provided the level of both sulphur and phosphate needed.

The relative importance of phosphorus and sulphur on mature pastures was tested under variable stocking rates at Kojonup. It was found that some of the responses were to sulphur rather than phosphorus and that phosphorus responses only occurred at high sulphur levels. At the lower stocking rate there appeared to be some benefit in wool growth from the additional sulphur in added superphosphate. This requirement for wool growth was tested further in a trial at Woogenellup, where there was no apparent increase in wool quantity on the sulphur-treated areas in the 1970 shearing, but the fibre diameter was increased and the crimp was reduced.

Phosphorus leaching and eutrophication

Work in the Harvey, Serpentine and Murray River catchments showed that phosphorus entering the estuaries could be reduced by 30 to 40 per cent through modifying superphosphate applications and replacing ordinary superphosphate with the new ‘coastal’ superphosphate. Coastal super was a granulated mixture of super and phosphate rock. The work on estuarine pollution was continuing in 1985. One finding was that on soils with an acid pH, no iron oxide and no clay, rock phosphate was likely to give a useful growth response.

As a precautionary measure alternative water-soluble phosphate sources were examined against the possibility that the existing supplies of phosphate rock may not continue to be available.

Similar eutrofication problems were encountered in the Albany harbour in later work.

Phosphorus level in seed

In 1988 it was found that the seed of wheat, medic and lupins with high phosphorus content produced plants which grew and yielded much better than those with seed from plants with low phosphorus. Around 1960 Russian and English research had suggested that such a relationship could exist.

Deep placement of superphosphate

In 1988/89 the approach of placing phosphate fertiliser in narrow bands below the seed was shown to be more effective than the conventional banding of seed and fertiliser together. Wheat yield was increased 14 per cent when fertiliser was buried 4 cm below the seed. A lupin crop sown the
following year with no additional fertiliser produced double the yield of a crop sown using conventional seed and fertiliser placed together at planting. The results were probably due to the deeper placed phosphate remaining moist longer and staying available to the roots for a longer continuous period.

The 1992 report refers to new information that phosphorus fertiliser should be placed below and separate from seed in order to improve utilisation. This had given spectacular results with lupins.

Miscellaneous
Aluminium toxicity was found on about 10 per cent of the yellow sandplains of the wheatbelt, due to low pH. In association with the University of WA a reliable test was developed for aluminium, which would identify these soils and avoid the losses involved in cropping or attempts at pasture establishment on them.

Estimating phosphorus needs
A program to develop soil analysis as a fertiliser guide was started in the mid-1960s. In 1966 the program included 28 field trials planted to wheat, which were soil-sampled. These samples were analysed with a range of methods aimed at estimating the yield potential from the soil analysis. The analytical results were compared with the actual yields. The tentative conclusion reached was that correlations were as good as reported from similar work in the eastern states. However, the confidence limits of prediction based on these data seemed to be too wide to allow practical recommendations for farmers.

District advisers' recommendations based on the strong correlation between the actual requirements and the history of past super applications were strongly correlated with the most profitable rate to use. These recommendations were better than the soil predictions when each was used separately. In brief, an examination of the use of soil analysis to forecast phosphate need showed that while the soil tests were reasonably accurate, they were no better than an examination of the superphosphate history and the advisers' predictions. There were also major problems in sampling due to variation within relatively small areas, which made sampling on a paddock scale very difficult.

In 1970 a survey was carried out of the results of commercial soil testing for phosphorus. The survey showed that 43 per cent of the recommendations would have been higher than would have been made by the department using soil type and fertiliser history, 17 per cent would have been lower and the remainder would have been about the same. As about 10 per cent of farmers were unable to supply any fertiliser history, soil testing would be valuable in these cases. When questioned, a high proportion of the farmers who had had their soils tested commercially had not actually followed the soil testing recommendations.

Efforts to develop more efficient means of recommending fertilisers coincided in 1974/75 with an increase in the price of superphosphate from $15 to more than $50 per tonne. This led to a review of existing technical data on crop and pasture responses to phosphorus in Western Australia and to work to gather new information. The CSIRO and the Department of Agriculture cooperated to develop a model for predicting phosphate responses and economic application rates. By mid-1975 they had produced a computerised program or model which provided for inclusion of the phosphate history of the area, the farmer's individual environmental management and economic situation, as well as his estimate of the likely yield or carrying capacity resulting from the applied fertiliser. On the basis of these inputs the model was able to calculate the optimum superphosphate rate in any situation. It was also possible to calculate the economic consequences of changed fertiliser strategies and economic conditions for farms on a statewide basis. Further research was used to improve the precision and scope of the model, called ‘Decide’.
In 1987/88 it was reported that the Decide model had been improved. It was now possible for specific paddock features to be taken into account and allowance made for possible seasonal effects in the choice of a fertiliser strategy.

A strategic fertiliser model to deal with recommendations for nitrogen and phosphorous fertilisers applied to crops and pastures, and a tactical nitrogen application model to deal with use in cereal cropping and take account of the influence of season, soil type and history were also available.

**Phosphorus in orchards and vineyards**

The history of phosphorus applications to fruit trees has been one of varied and unexplained lack of response. The issues seem to be availability of material topdressed on the surface, unknown history of previous fertiliser applications and situations where fertiliser, particularly phosphorus, was not the limiting factor. It is known that early orchardists used rock phosphate in large quantities. In the latter case the limiting factor may have been root pathogens, shortage of moisture, or lack of other nutrients.

In early work on fruit trees and vines, superphosphate gave a response when applied in the planting hole with young apples but there was no response to nitrogen. There had been no response to phosphate and nitrogen dressings to grapevines. This was probably due to historical application of rock phosphate and the natural fertility of many of the soils used in early orchard plantings. Moisture shortage may also have been a limiting factor.

In 1943/44 long-term research was being continued into the effects of nitrogen, phosphorus and potassium dressings on tree growth in the main fruit growing districts, but from 1944/45 the experimental fertiliser trial work was only continued at Kendenup and Bridgetown. The work continued despite barely any growth responses being evident. Observations at Bridgetown indicated that moisture was the limiting factor, particularly on lightly pruned trees.

In 1985/86 fertiliser trials at Margaret River and Frankland River confirmed remarkable yield responses to both superphosphate and nitrogen on vineyards. An extension program was undertaken to encourage vigneron to start fertiliser programs using up to 2.5 tonnes of superphosphate and 300 kilograms of ammonium nitrate per hectare to correct fertiliser deficiency. The increase in yield reflected the inadequate levels of previous application.

**Trace elements**

Next to superphosphate, the identification and treatment of trace element deficiencies has been the most important plant nutrition discovery in the development of WA agriculture. Before the identification of copper and zinc deficiency, agriculture was restricted to less than half the area now farmed.

**Copper deficiency**

The trace element saga was triggered by the discovery of copper deficiency of sheep at Gingin in 1938. This was followed by evidence of plant and animal responses in Margaret River. As a result, numerous experiments using trace elements alone and in combination were established across the agricultural areas, aimed at testing for responses and also developing soil and plant diagnostic information based on both symptoms and chemical analysis. In 1940/41 most of the work was on the South Coast and in the South West. Resources in the department were limited and these were areas where high levels of production were possible.

Responses to copper were initially reported from Albany and from Dandaragan. In all cases these responses allowed the development of soils to proceed where they had previously been regarded as useless. The 1940/41 report lists experiments at Lake Sadie in the south, in the south coastal districts, at Margaret River, Narrogin and
Trials were also conducted on fruit trees to determine any effect of trace elements across a range of conditions including the so-called pruning dieback. In 1941/42 more extensive studies of copper nutrition confirmed the effect of copper in overcoming the problem of wither tip in apple trees. This work also showed a very poor uptake of copper from heavy soils at Bridgetown. Addition of eight pounds of copper sulphate per tree showed no increase in the copper content of leaves. The copper was applied in the experiments by spray. It was concluded that all apple growing areas would have some soils which would be copper deficient. Plum trees at Bedfordale showed good responses to copper sprays applied as bluestone (copper sulphate). A response was seen on some sultana vines at Baker's Hill.

An extensive program testing for appropriate rates of fertiliser including trace elements was carried out on a range of species and in a number of locations. The work was partly in response to the shortage of macronutrients and partly an investigation to determine the nature and extent of responses to micronutrients, particularly copper and manganese. This work showed very widespread responses of cereals to copper. There were also responses on grapevines at Gingin. A response to boron was obtained on swedes at Bullsbrook. The observation was made that copper deficiency was more serious in dry years as a result of poorer root growth of copper-deficient plants. The outcome of this work was the very widespread use of super containing copper. In 1942/43 and beyond the work on copper use continued to show responses.

Copper-zinc interaction
A 1953 report expressed concern that in some instances zinc addition may reduce the effectiveness of copper dressings on wheat crops and suggested that zinc should not be applied without copper to wheat on light land. It was also suggested that zinc addition may reduce the response to copper in some situations. Some farmers had reported that copper plus zinc super reduced the yield of wheat compared with plain super but these reports could not be confirmed experimentally. The antagonism between copper and zinc observed from time to time was seen with subterranean clover in a trial at Baker's Hill in 1971.

Trace element deficiencies, particularly copper and zinc, were important and extensive in the Esperance district. Esperance Research Station was established in 1949 and the relationship between copper and zinc was investigated. The residual value of both was shown to be high.

A large number of experiments across the State comparing copper/zinc mixtures resulted in different mixtures being recommended to the fertiliser companies in 1967. This was due to the finding that applications of zinc oxide at greater than 1.5 pounds per acre tended in most cases to have a depressing effect on wheat yield. These mixtures contained lower levels of zinc but one mixture did not contain molybdenum and contained a lower level of copper. There were areas which were not fully catered for by these mixtures. By 1970 it had been recognised that molybdenum deficiency extended over a large part of the eastern wheatbelt and other mixtures were needed.

The residual value of copper dressings
Experiments on light land at Merredin Research Station and on black calcareous sand at Dongara indicated no reduction in the effectiveness of copper dressings applied three to 10 years earlier. Other work showed that a copper dressing would last for at least a decade.

In later years trials comparing the copper needed for plant growth with the copper needed for the grazing animal were carried out. One trial was at Bramley Research Station and another at a property at North...
Bannister. Past results from Bramley suggested that the level of copper needed to be higher for maximum pasture production than for animal health. However, when animals were put on an area which had received 2.5 pounds of copper sulphate per acre four years previously they failed to recover, indicating that after four years the level of copper in the herbage had declined to a point where it was not sufficient for animal health. Analyses showed that the animals did not achieve a satisfactory level of copper.

The trial at North Bannister was also affected by cobalt deficiency in the sheep. Marked copper deficiency occurred and it was found that 95 per cent of the copper ingested by the animals was excreted in the faeces and that the copper in the faeces could be available to plants. It was therefore likely that copper returned to an area in this form, coupled with the hundred parts per million supplied in the superphosphate, could provide a maintenance dressing. On this trial copper deficiency developed quite markedly on the clover in the pasture and differences were easily discernible between the rates of application.

An opportunity was taken at Esperance Research Station to test the residual value of copper 20 years after application. In the original experiment wheat yields were low and there was a marked response to copper. In 1970 the untreated area was still copper deficient and the original treated plots gave a high yield.

A major trial at Newdegate Research Station on the residual value of copper showed that in the first three years a control area averaged only 23 per cent of that receiving 10 pounds of copper sulphate per acre. Five pounds of copper sulphate per acre gave 65 per cent of the maximum yield. Comparison of the Esperance and Newdegate experiences showed the importance of soil type and possibly that the positioning of the copper application was also important.

Rates of application of copper and zinc
A large number trials looking at rates of application and the interaction between copper and zinc were carried out over the 16 years between 1948 and 1964. In general it was found that copper at the rate of 2.5 pounds per acre of copper sulphate would overcome copper deficiency on sandy soil, 5 pounds per acre on gravelly soil, and on a few sites it was necessary to apply 7.5 pounds per acre. The greatest need for zinc was found on soils at Lancelin, Esperance and Quindanning. On sandy soil at Lancelin maximum yields of wheat and oats were not obtained with less than 12 pounds per acre of bluestone and 4 pounds per acre of zinc oxide. However, somewhat smaller amounts gave near-maximum yields. At Esperance on a sandy soil with ironstone gravel 5 pounds of bluestone and 0.75 pound of zinc oxide was sufficient for wheat and 5 pounds of bluestone and 0.5 pound of zinc oxide gave maximum yield of oats. Rates at other sites of 2.5 pounds of bluestone combined with 1.5 pounds of zinc oxide gave maximum yields.

At Bramley Research Station an important trial using subterranean clover pastures and sheep was extended beyond three years. One dressing of bluestone at 2.5 pounds per acre supplied enough copper for plant growth and animal health for three years on a representative soil. The control (no copper treatment) failed to maintain the clover in the pasture and sheep showed distinct symptoms of copper deficiency.

Research to define more precisely the minimum dressing of trace elements which could be used for the successful growth of cereals and pastures was continued in 1966. In the medium rainfall areas 14 new trials were planted on soils which had either a sandy or gravelly surface or were intermediate between these two conditions. Over all sites the requirements for bluestone were between 2.5 and 5 pounds per acre depending on the location. For zinc the requirement was between nil and 0.75 pound.
per acre. These experiments did not include any assessment of the residual value. A similar approach to identifying more precisely the trace element requirements of different soil types was taken in the higher rainfall areas. No simple criteria were found for identifying the need for copper or zinc. Soils with apparently similar general appearance and character were found to have quite different trace element requirements. This suggested that the geology of the area may be more important than the soil-forming processes that followed.

The effectiveness of fertiliser copper thoroughly mixed with the soil was shown to decline in glasshouse experiments, in contrast to results from the field.

**Testing for copper status**

Initially with cereals, the copper level in young leaf tissue was used to identify deficiency. In the 1950s *Aspergillus niger* was shown to be useful as a biological assay tool for copper deficiency. However, in some cases where it had indicated copper deficiency there was no field response to copper application. In 1964/65 soil analysis which used EDTA was developed and gave very good correlations between cereal yield and extractable copper. Later it was decided that, on the limited results available, more reliability could be placed on root copper levels than on plant tissue analysis. A root copper level of 18 to 22 ppm for wheat appeared to be a critical level for maximum yield. Wheat tops would then contain 1.6 to 2.6 ppm. In 1969/70 it was reported that ribonuclease activity was being investigated as a method of identifying zinc deficiency, and nitrate reductase activity in the case of molybdenum. Two other enzymes were of interest for the diagnosis of copper deficiency.

The 1978/79 report detailed a test which enabled the determination of copper status of cereals with far greater certainty than was previously possible. If used correctly this new test for copper could increase the income of farmers through identifying patches of copper-deficient crop scattered within large areas of copper-adequate soil or by identifying marginal deficiency in areas which may never have been treated. It was also found that in particles greater than 3 mm diameter of superphosphate the incorporated copper was ineffective as a copper fertiliser in the year of application.

**Sources of copper**

Sources of copper other than copper sulphate were investigated for possible use in deficient areas. Work in the glasshouse showed that on some soils copper sulphide was inferior to other sources although it was greatly improved if finely ground. The carbonate ores were equal to bluestone as sources of copper.

In 1968/69 investigations into various sources of copper showed that insoluble copper materials were not as suitable as copper sulphate for wheat. The sources of copper other than copper sulphate were comparatively more satisfactory for clover than for wheat. In 1948/49 experiments showed that copper carbonate ores and zinc oxide are as effective as the sulphate salts.

**Zinc as a separate issue**

There was a marked response to applications of zinc on flax in 1946/47. This work was triggered by a large response to superphosphate in the previous year which appeared too great to be due to anything other than a contaminant.

In 1942/43 there was evidence of zinc deficiency on some calcareous soils. The low zinc status of a range of soils had been indicated in widespread sampling of subterranean clover leaves and petioles which was primarily concerned with the level of copper. Leaf samples were also collected from experiments to provide leaf levels as a basis for diagnosis of copper deficiency. The trials, which included zinc and copper applications to wheat, oats and barley, were sown to develop a better idea of the nature
of the response patterns to these elements of the different cereal varieties.

Work on pastures showed that zinc could be important for subterranean clover even where copper was not. Since copper could have an effect on seed production and not any obvious effect on foliage growth, a marginal deficiency was more difficult to identify.

Trials reported in 1953 showed that zinc deficiency was widespread on pasture. This was almost certainly due to the lower zinc content of the superphosphate which was then being largely made from phosphate rock from Christmas Island. By 1954/55 copper fertiliser mixes were being used over a million acres and zinc over three-quarters of a million acres.

There was evidence of a response to zinc on fruit trees when it was applied as a dormant zinc spray. In this work zinc deficiency was controlled with a dormant spray of 2 per cent zinc sulphate. But in 1954 experiments with zinc applied as a spray or soil dressing to fruit trees showing symptoms similar to zinc deficiency, had mixed results.

The experimental results of the early 1950s made it clear that the impurity of zinc in the rock phosphate obtained from Nauru Island had masked zinc deficiency for many years. For a period during and after the war the rock phosphate came only from Christmas Island and this resulted in zinc deficiency across much of the sandy and gravelly soils of WA. In the 1960s the source of rock phosphate was about 50 per cent from Nauru. This rock contained 700 to 800 ppm of zinc while Christmas Island rock contains only 300 to 400 ppm. However the Christmas Island rock contained 120 ppm of copper compared to Nauru rock, which contained only 20 to 40 ppm.

Experiments to identify the true residual value of zinc did not give clear results. This would have been partly because the superphosphate used after the mid-1950s contained at least 400 ppm of zinc.

A synthetic superphosphate which had no trace element contaminant gave yields of about 80 per cent of the maximum at some locations but at Lancelin gave no yield at all and at Esperance produced 15 per cent of the yield obtained with added bluestone and zinc oxide. The experiments also showed that lucerne was more severely affected by copper deficiency than Harbinger medic, Woogenellup subclover or Kondinin rose clover. Serradella showed little or no effect from a shortage of trace elements. There were also variations between the susceptibility of different strains of subclover.

In 1964/65 it was reported that Muscat grapevines sprayed with zinc chelate at Toodyay gave a significant response. Spray applications made in late spring resulted in much better set, heavier yield and improved maturity of fruit. Swabbing pruning cuts with zinc sulphate did not give the same response.

Five long-term experiments to determine the effective life of a zinc application were established. Zinc deficiency had cut wheat yield to less than half on four sites planted with imported di-ammonium phosphate without additional zinc. These results typified crop failures which have resulted from the use of phosphate sources not containing zinc in some form.

Manganese

Extensive work was done on manganese. While it was not as important as copper or zinc, the responses to both soil and spray applications were variable. While soil applications may give higher yields the patchy nature of the problem made them less economic than spray applications to affected plants.

Manganese gave responses on certain marly swamps on the South Coast and on some soils at Kukerin. Manganese deficiency also occurred on some soils in all fruit growing areas.

In 1943/44 an examination of soils where trees responded to manganese showed little evidence of shortage of the mineral. The
conclusion was that the deficiency related more to soil condition and moisture status than to an inherent soil deficiency.

Experiments showed that spraying leaves early in the year with trace elements was more successful than soil application. However, the residual value of spray was limited. Also there was a response to manganese placed in holes at depth; this lasted over some years. At Kendenup there was evidence of an effect of manganese on tree health.

Results on fruit trees continued to be variable and intermittent. In 1948/49 further investigations of manganese deficiency suggested there was some residual value of the manganese dressing. Some responses to sprayed nutrients were obtained on citrus where symptoms of manganese or magnesium deficiency were present, coupled with a low level of nutrient in the leaves. No responses were obtained in either case from soil dressings. In this experiment symptoms reappeared after two years, indicating a need to respray the plants.

Manganese deficiency of oats was found on ironstone gravel over clay at Bremer Bay. The spring yield was doubled by a dressing of 40 pounds per acre of manganese sulphate.

Manganese deficiency of cereals was generally likely to occur in patches. Spray applications could be effective, and eliminated the need for soil dressings to a whole paddock, but did not have any residual effect and needed to be applied annually. In 1956 experiments with manganese as a soil dressing showed that the residual effects were low, with no residual effect three or four years later, from dressings of 20 or 40 pounds per acre.

Some residual effect was shown with dressings of 60 and 80 pounds per acre but dressings of this order were not economically viable. For this reason spray applications at rates of 2 and 4 pounds per acre were tested on crops. The sprays gave some response but were not as good as soil dressings. Residual effects of some soil applications were seen three years later, indicating variability with soil type.

In 1972 and 1973 the problem of split-seededness in lupin was shown to be due to a manganese deficiency.

Molybdenum

In 1945/46 molybdenum deficiency was shown to cause whiptail in cauliflowers. In 1952 molybdenum deficiency of subterranean clover was identified in the Donnybrook area and was thought to be restricted to that district. In 1953 it was demonstrated that molybdenite ore was as effective as sodium molybdate in controlling the deficiency. In 1954 molybdenum deficiency was shown to extend to all the soils developed over granite in the dissected country from Donnybrook to Nannup.

Later, molybdenum deficiency was shown to be even more widespread. It was shown to occur through the western districts of the Great Southern in 1961/62. Responses to molybdenum were also obtained on ironstone gravelly soils in the Mt Barker district and were reported on similar soils at Albany and Denmark, and as far eastwards as Esperance.

There was a response on barrel medic and Harbinger medic at Badgingarra Research Station.

The overall position with molybdenum on wheatbelt soils remained undefined in mid-1964. This progressively changed over the remaining years of the 1960s and early 1970s. There was a response to molybdenum in one trial with wheat and one with oats in the north-eastern wheatbelt. This response resulted in molybdenum deficiency in the eastern wheatbelt receiving a lot of attention in 1964 and 1965. Responses were obtained across a very large area of the eastern wheatbelt and in 1964/65 there were 70 trials on molybdenum nutrition of pastures in progress. At Merredin Research Station in 1968/69 a medic pasture responded to 6 ounces of molybdenum oxide per acre.
whereas a dressing of 2 ounces gave no effect.

It was found that where soils had a pH of 6 or higher no molybdenum deficiency occurred but where the pH fell to between 5 and 6 pasture legumes responded to molybdenum. Very large areas were affected.

**Cobalt**

While cobalt was not found to be essential for plants in the field it was essential for animal health on some soils (see Chapter 6). Experiments showed that the residual value of cobalt varied substantially with soil type and application of between 2 and 10 ounces of cobalt sulphate was required to bring the cobalt level of a deficient area up to the level required for animal health.

Soils with a high clay or sesquioxide content, where the pasture was grass dominant and where the growing season was longer, required higher amounts of cobalt and the residual value of the cobalt was lower. This was exacerbated if the cobalt was applied before germination. On most soils the standard application of 6 ounces of cobalt sulphate per acre lasted about three years on moderately deficient sandy soil. On loamy and gravelly soils cobalt was only effective for one year and in some cases might not be sufficient for the whole year. Cobalt oxide was found to be only 10 to 50 per cent as effective as cobalt sulphate in the year of application but showed good residual value in the following year. The problem of cobalt deficiency of sheep and cattle was overcome in later years by inserting a slowly soluble form of cobalt into the rumen.

**Potassium**

A problem of ‘clover stalling’ in pastures of the South West had caused concern from the mid-1930s. Work showed that potassium deficiency was a major cause of this problem. This was demonstrated in 1954 when big responses were obtained to dressings of 200 pounds per acre (227 kg/ha). Subsequent work was directed to finding maintenance amounts.

Some experiments carried out with potassium fertiliser showed that it could be needed on deep sandy soils in lower rainfall areas even through the development years. But it was found to be preferable to use deeper-rooted species in these soils. On potassium deficient sandy soil in higher rainfall areas better responses were obtained to spring applications than autumn topdressing in some trials.

Experimental work on deep waterlogged sands showed a need to tailor application of fertiliser whether it was superphosphate (providing phosphorus and sulphur) or potassium. Later applications in the season were often important for sulphur and for potassium. The residual value of potassium in the years after the initial application was shown to depend on soil type and management.

Unfortunately the potassium resources of most sandy-surfaced soils are limited. As a result continued removal in crop or hay reduces the supply available for future crops or pasture. After between 30 and 50 years of use many of the sandy-surfaced light land soils of the medium rainfall cropping areas are depleted and potassium is now used widely and regularly. Issues of placement to avoid toxicities are important.

**Nitrogen**

Very little nitrogen fertiliser was used in broadscale agriculture before the 1960s. It was used extensively on horticultural crops, mainly on vegetables. Increasing amounts have been used in broadscale cropping since the 1960s. This use was initially associated with cropping of recently cleared land, particularly for second crops on new sandplain. Its use increased in the move to multiple cropping following a period of legume-based pasture and it was shown to be necessary in the practice of continuous cropping without a legume phase.
Wheat on recently cleared sandplain. The plot on the left received 127 kg/ha of sulphate of ammonia. Both plots had the same basic fertiliser.

Nitrogen is now used widely to maximise yield in the minimum tillage cropping system, where higher yields can be obtained. These opportunities result largely from the longer growing season, particularly in the medium and higher rainfall zones with the earlier seeding allowed by the use of herbicides for weed control. Nitrogen use on pastures in the high rainfall areas was also tested in the early years without much impact but is now used as part of an integrated management system on pastures.

Determination of the rates, forms and timing of applications to both crops and pastures has been and continues to be a major research program for the department.

A range of experiments on new land in 1954 showed that the average increase in yield from nitrogen addition did not pay for itself. In 1962/63 investigations of the effect of nitrogen application to pasture in the high rainfall dairy areas suggested an ability to increase the carrying capacity of dairy farms. This depended on the effective utilisation of the increased growth of pasture. In autumn this needed careful grazing management, and in spring required sufficient conserved fodder, utilised effectively in the following autumn and winter. Nitrogen use could lead to an overall better utilisation and management of the spring flush. To maximise the benefit for hay/silage cutting it appeared that around eight weeks was needed between closing up a paddock and actual cutting.

It is most valuable in years with a late start, as it increases autumn and winter feed. When there was an early start, pasture levels were usually adequate and nitrogen application was unlikely to give benefits. The eight-week gap between closing a paddock and cutting for hay was confirmed in further trials. Nitrogen application to a paddock to be cut for hay was shown to result in the protein level remaining high for eight to 10 weeks after closing. The need for nitrogen addition to maximise the fodder conserved would again depend on the season. Successful use of the added feed depended on adequate stocking rates. Despite the results of this work it was not used widely in the dairy industry.

In 1961/62 some 30 trials were carried out from Binnu to Esperance to determine crop responses to nitrogen fertiliser, largely on sandy and gravelly-surfaced soils. In 1962/63 a large number of trials on the value of nitrogen fertilisers on cereals were conducted on both new land and previously developed land. Considerable improvements in grain yield were achieved in many of these trials and recommendations were made. Times of application, the use on successive crops and areas where stubble had been ploughed in or had been burned were investigated. Also experiments were carried out on the use of nitrogen on linseed crops. In 1963 good responses were achieved with quite high rates in the medium rainfall zone on gravelly country. Results on sandy country were less reliable. Surprisingly there was no difference between autumn and spring applications. Both nitrogen and phosphate were shown to be essential and interdependent for new land.

Work on the use of nitrogen fertilisers on cereal grain crops continued in 1964. As before a favourable climate resulted in good responses and profitable results. In continuous cropping trials over six or more years, yields without nitrogen fertiliser were still high for the sixth crop but all yields were
improved by nitrogen fertiliser. Anhydrous ammonia gave profitable yield increases when applied at two or four inches deep and about five weeks before seeding or at sowing time. Increased wheat yield was obtained where stubble was burnt. In treatments which did not include stubble burning there was a heavy infestation of Wimmera ryegrass so that the difference in yield was not high. This work was repeated and the results confirmed.

In general the results supported a recommendation for nitrogenous fertilisers for cereal crops to be applied as close as possible to seeding. Applications more than four weeks after germination were less likely to improve yield.

Work with nitrogen fertilisers continued in 1967. Under continuous cropping profitable responses were obtained at all locations except Merredin Research Station.

Investigations were continued into the appropriate time and method of application of urea, the relationship between wheat varieties and responses to nitrogen, the use of nitrogen/phosphorus compound fertilisers and anhydrous ammonia, and rates of nitrogen used. Later, the results had to be reworked as major changes occurred in methods of planting crops.

In 1971, in 35 field trials with nitrogen, a large percentage gave profitable responses. A higher proportion of these were in the lower rainfall areas, which was unusual. As a result of evidence in 1969 that the drilling of the more soluble or compound fertilisers with the seed had reduced germination, a series of experiments showed that under some conditions drilling the highly soluble compound and nitrogen fertilisers with the seed could be a disadvantage.

In 1969/70 the work on nitrogen fertilisers and stocking rates continued at Wokalup Research Station. The addition of nitrogen to irrigated pasture made a substantial difference in carrying capacity. However, the animals lost weight from March to May despite the presence of feed of adequate quality. A similar experience was encountered using weaned calves at a high stocking rate.

**Lime use**

It has been known for many years that when soils with a low initial buffering capacity were sown to improved pastures and topdressed with superphosphate the pH would fall over time. The concern with this gradual acidification of cropping and pasture areas resulted in a strong recommendation for liming of some soils. In 1997/98 it was reported that almost 400 000 tonnes had been used and was expected to reach an annual use of between one and two million tonnes.

**Pastures**

**Pasture legumes**

**Subterranean clover**

The introduction of subterranean clover as a pasture legume was a major development in agriculture in Western Australia. It appears that subterranean clover had been identified in Western Australia in the early 1900s but was thought to be of little use. In 1907 some seed was obtained and plots planted at the Hamel State Farm. It grew very well and attracted some attention but does not seem to have been used at that time. The mid-season variety which would have been planted at Hamel was heavily promoted by its ‘discoverer’, AW Howard of Mt Barker, South Australia.

In 1922 a graduate agricultural adviser was located in the southern areas. His 1923 report refers to paspalum and Rhodes grass as promising pasture plants for the establishment of permanent pasture. In other experimental plots pastures were based on paspalum and white clover. It seems that the focus was on perennial pasture plants in the European tradition. In 1924, 27 other farm experiments or demonstration plots were established in the South West but they surprisingly do not appear to include...
subterranean clover. Yet presumably by that time it was being used in the group settlements.

According to AB Adams, writing in the Journal of Agriculture in 1924, an early maturing variety was identified at Wilga in the early 1900s but was not developed. Some seed was reported to have been brought to Katanning from South Australia as early as 1902. It would have almost certainly been of the mid-season (Mt Barker) variety and would not have been suitable.

Separately in 1908, a farmer named Martin obtained some seed from South Australia. He planted it at Mt Barker in 1910 but it was 1912 before it was noticed. Subsequently it was spread over the whole property by livestock. This variety became the basis of the pastures of the higher rainfall areas of WA but would not have been very successful outside the 700 mm rainfall belt.

Adams recommended that the seed should be sown at shallow depths or topdressed before the first rains ‘on the burn’ without any cultivation. He recommended that it be topdressed with 106 to 176 pounds per acre (120 to 200 kilograms per hectare) of superphosphate followed by 106 pounds (120 kg) each year. Sowing on the burn became very popular in the Group Settlement Scheme, where subterranean clover became the basis of pasture development, but the fertiliser rates were low for new land. Nevertheless, these were sound recommendations.

It is likely that the rate of superphosphate used was generally low. In a 1925 report there is reference to impressive results from superphosphate topdressing trials. There were also experiments reported from the Northcliffe plain and the Cranbrook district. By 1928 the practice of topdressing pastures based on subterranean clover would have been universally adopted for the developing dairy farms in the South West.

During the 1930s, following the collapse of the export wheat price, there was increased interest in sheep management on cereal farms in order to improve income. This focused farmers' minds on pastures and, aided by demonstrations of topdressed sown pastures by the department in association with the fertiliser companies, there was an increased interest in pasture. This extended to the medium rainfall areas. Unfortunately the variety of subterranean clover planted outside the higher rainfall areas was Dwalganup.

The availability of tractors, which permitted much faster working of land, made it possible to take advantage of the fertility build-up under the legume-based pasture through the use of an alternative farming system for cereal production. Initially the State's wheat industry was based on a system of crop-fallow. While horses were the main source of traction it was necessary to crop onto well prepared fallow to achieve the combination of good weed control and early sowing. There had been a progressive change in the rotation from fallow/crop to a fallow/native pasture/crop rotation with the crop planted on a ‘late’ fallow. Tractors allowed crops to be sown where the pasture was ploughed and weed control achieved after the first rain immediately before the crop was planted. This possibility was seen by department researchers, TC Dunne and FL Shier, whose paper An Alternative Rotation for The Wheat Belt in 1934 became the basis for the development of the ley farming system which was the basic crop rotation for the 1950s through to the early 1980s.

The crop/sown pasture/crop rotation of the ley farming system provided an opportunity to increase farm productivity, provided the resources were available to achieve weed control before planting the crop. With a pasture legume, fertility was increased for the cropping phase as well as improved pasture for the stocking phase. Subterranean clover was equally important in the dairy areas. It was obvious from records that available feed was a major factor in the variations in year-to-year production of the dairy herd on established farms.
In the medium rainfall cropping areas pasture improvement became important. In the 1953/54 report the statement was made that “the most outstanding development of recent years has been the establishment of subterranean clover on Chapman, Wongan Hills and Avondale Research Stations”. Interestingly, it was reported that subterranean clover had re-established itself at Avondale and Chapman but not at Wongan Hills. This situation changed over the years.

In 1956 barrel medic and subterranean clover were planted at Wongan Hills Research Station. Barrel medic did not do well there but did on heavier soils of the eastern wheatbelt and was planted extensively on Merredin and Salmon Gums Research Stations.

The large amount of work on the breeding, nutrition, establishment and varietal comparisons on subterranean clover, which has been a foundation stone of Western Australian agriculture is dealt with elsewhere in this book.

After 1990 there was a major change in the available pasture legumes, which changed the pasture landscape in Western Australia.

**Legume establishment**

A major service provided by the department in the pre-World War II years was the provision of Rhizobial cultures, with instructions on their use, to farmers planting legumes, mainly subterranean clover.

During the development period of 1948 to 1968 substantial areas of sandy soils were sown directly to pasture, particularly in the southern higher rainfall agricultural areas.

While legume establishment had not been a problem on older developed soils, a problem of mortality of 40 to 60 per cent or even 100 per cent of young clover plants was observed on areas of recently cleared and ploughed sandplain which had been sown to subterranean clover pasture. The problem became known as ‘clover mortality’. It normally occurred where the native scrub was burnt and the land ploughed and seeded in the same year. It was worse if some vegetation was ploughed in. It did not normally occur on land which had been left fallow for a year or had been cropped following clearing. As a result there was a general recommendation that subterranean clover only be planted on recently cleared land which had been fallowed or cropped before planting clover.

The start of detailed experimental work to determine the cause of this seedling mortality was delayed due to other important issues occupying the time of the limited number of pathologists available. Their work showed a favourable response to fumigation, which suggested that the cause was an antagonist produced in the soil organic matter following clearing. This proved to be the case.

In 1957 studies of the establishment of subclover and barrel medic on new land, *Rhizobium* strains and protection of inoculum at planting were investigated. As a result of this work lime pelleting of inoculated seed was recommended for all legume plantings instead of inoculated bare seed.

In 1953/54 extensive trials on acid peaty sands demonstrated the necessity of lime together with adequate dressings of superphosphate and trace elements on these soils. However, most WA soils are less acid and the addition of lime to new areas to adjust the pH was not necessary. Lime was also known to accentuate zinc and some other trace element deficiencies through raising the soil pH and reducing the trace element availability. On the other hand it increased the availability of molybdenum.

Variation in the effectiveness of different Rhizobia was shown in a clover establishment trial on sandy soils at Badgingarra Research Station. The best second year establishment of one variety was produced by a strain of *Rhizobium* which was relatively inferior in the first year. This suggested that some strains have better survival over the summer, and that on some sandy soil other strains did not survive the
hot dry summer conditions. Selection of Rhizobia capable of surviving through to the second year of development, and the use of alternative deep-rooted pioneer plants proved necessary on these soils.

Due to the evidence of differences in strains of Rhizobium for various annual legumes and for lucerne, specific strains better suited for particular pasture legumes were identified. These strains were included in the commercial inoculum and would have had a large unmeasured impact on productivity. This work on testing and improving the legume Rhizobia has continued. A large number of strains have been collected in the field and tested for effectiveness on subterranean clover, lucerne and barrel medic over the years. Field work has shown that there is delayed nodulation on a large number of established clover pastures.

Further work on nodulation was reported in 1971. In that year strains of inoculum available commercially were compared and the new strains. The methods used in commercial pelleting were also examined and found to be deficient. Examination of nodulation in the field showed that some subterranean clover cultivars had greater problems in nodulation in the first year than others.

Some experiments were also carried out on inoculation of lupins. It was found that on new land nodulation was only effective where there was an extremely high rate of inoculum on the seed. On old clover land however lupins appeared to be healthy and well nodulated.

During the 1980s two medic Rhizobium strains which were more acid-tolerant were identified. This allowed medics to be established on more acid soils than previously and extended their range significantly.

In 1992/93 an acid-tolerant strain of medic Rhizobium superior for lucerne and disc medic was isolated from a Greek island and was adopted Australia-wide.

**Land development**

The building blocks of agricultural development had been produced but the challenge was to produce viable systems of farming from these building blocks. For a particular area the issues were to determine the right cereal/pasture combination and the right species, cultivars and fertiliser treatments to maximise production.

**Examining pasture species**

In the mid-1960s a number of grass and legume species were tested on the wheatbelt research stations and on farmers’ properties over a wide range of environments. The environments included deeper sands, the drier parts of the wheatbelt and some saline areas. Some 60 legume species trials were established. The range of species included subterranean clover, barrel medic, rose clover, cupped clover and serradella. The grasses included soft brome (Bromus mollis), which was being tested in collaboration with CSIRO over a range of situations, and bluebush and saltbush on salt-affected soils at Salmon Gums. The use of deep-rooted species such as blue lupins, lucerne or serradella proved reasonably satisfactory on deep white siliceous sands of the western sandplain with serradella achieving better production than other legumes.

A range of grass species was tested in the higher rainfall areas, mainly under grazing. At Bramley Research Station promising strains of soft brome did not withstand heavy continuous grazing under conditions where Wimmera ryegrass performed satisfactorily. In a trial during the 1960s at Bramley lucerne and kikuyu grass were the only perennials which contributed to grazing. Kikuyu in particular was later used in a number of areas in the South Coast and South West. At Esperance Research Station lucerne, which had been continuously grazed for four years, was also almost eaten out at a stocking rate of three wethers per acre. The rotationally-grazed lucerne, at the same overall stocking
rate, remained as a vigorous dense stand after four years, producing about 18 pounds (8 kg) of wool per head in 1964.

Perennial grasses were tested at Kendenup, Mt Barker and Forrest Hill in trials established in 1965. They were tested under continuous grazing to determine whether they could stand a low input grazing management regime. It was concluded in 1969 that under continuous grazing, these perennial species made little contribution to pasture productivity.

Experiments were carried out on methods of establishing legumes in the wheatbelt. The relative merits of spacing and under-sowing a cereal crop were investigated. This work showed that under-sowing with even a light rate of clover seed could result in substantial losses of yield, probably due to competition for moisture.

Nine trials comparing the production and persistence of a range of legumes were sown in 1966. These legumes established under intermittent stocking but were tested under the heavy continuous stocking which subclover withstood. On the deeper sandy soil in the West Midlands which had gravel or clay within 15 to 30 inches, Pitman's serradella grew better than other species.

A grazing trial was established on heavy land to compare Cyprus barrel medic, Geraldton subclover and Kondinin rose clover. These species were compared separately, with a mixture of all of the species and with a volunteer pasture consisting mainly of barley grass and woolly clover. The trial was subject to continuous grazing at two rates of stocking – 1.5 and 2 sheep per acre.

In a higher rainfall trial the fertiliser and establishment needs for lucerne were investigated at Lancelin. It was also compared with other species. A further species trial under grazing was established on light yellow sand west of Moora. The trial included lucerne under a range of management techniques. In the grazing trial at Lancelin, rose clover became sparse and serradella proved susceptible to insect damage, leaving the subterranean clover and medic providing the best pasture contribution in the second and third years. Lucerne was also satisfactory under rotational grazing of one week in every four.

A grazing trial at North Bannister showed that following a dry season when seed was low in the late maturing cultivars, there was a drop in body weight compared with the early or mid-season cultivars. Extensive pasture production trials were carried out at Denmark Research Station through the 1960s related to plant introduction, fertiliser sources and rates and use on specific soils, lucerne management and carrying capacities.

**Phased pasture species**

One approach to obtaining a dense legume-dominant pasture sward in the year between crops was to rely on a high degree of hard seed in the selected legume. This process was shown to work with hard-seeded species such as serradella and biserrula which could be sown with a crop at high seeding rate, having seed which did not germinate until the season broke in the following year. The alternative approach was to take the emphasis off pasture regeneration (selecting for hard seed etc) and use cultivars with a high level of seed production and ease of harvesting so that growers could produce their own cheap seed and sow pastures at high seeding rates in the inter-crop years.

**Testing new areas**

In 1959 an area was established at Forrestania some 40 miles (60 km) east of Hyden to determine the suitability for agriculture of yellow loamy sandy soils similar to those at Wongan Hills. The experiments were successful but it was decided not to develop that area. There was adequate rain during the trial period and growth of crops and pastures was good. Molybdenum was essential for legume growth.

A further area was selected in April 1965 half-way between Lake King and Salmon
Gums, south of the Johnson Lakes, with an estimated average rainfall of 12 inches. No rainfall records were available and rain gauges were put in strategic locations. Sites were selected for two experimental areas near the 90-mile tank.

The experimental program gave quite good yields even though conditions were relatively dry. The yield on fallowed land was much better than on non-fallowed areas, apparently due to increased moisture. This raised the question of whether fallowing should be part of the normal cropping practice in the outer wheatbelt where moisture can be very important in dry years. Subsequently a decision was taken not to proceed with any development to the east of the rabbit-proof fence at the level of Lake King or Salmon Gums.

Both the Forrestania and the 90-mile tank areas were within the area originally considered for the 3500 farms scheme of the late 1920s. At that time the sand and gravelly-surfaced soils were not considered, as the trace element needs had not been understood.

In 1966/67 the demonstration of suitable pasture species, fertiliser and lime requirements for two of the main sandy soils of the Scott River area increased the possibility for pasture development in this high rainfall area. The development of the sandy soil west of Harvey was also proceeding rapidly following demonstration of successful pasture growth under grazing on the winter-wet Joel sands. The Scott River Plain has been developed largely as pasture for dairying. In 2009 it was reported that two major dairies of over 1000 cows each were planned. However, with its underground water it has the potential for more intensive forms of production.

**Fertility build-up under legumes**

In 1947/48 research included studies of the effect on crop yields and soil properties of legume pasture and the capacity of the legume to recover when mature subclover pastures were cropped. In the early 1950s crops grown on old clover pasture were compared with crops grown on areas not previously under legumes. As expected, there was a marked improvement in both yield and flour quality of the grain.

After 14 years of a rotation experiment at Wongan Hills Research Station it was concluded that crop yields rose rapidly after a short period of clover pasture but did not reflect the accumulated nitrogen level of an area which had been under clover pasture for seven years. The explanation appeared to be rapid mobilisation of nitrogen in the early years and a slower mobilisation of nitrogen from the more complex soil organic matter existing in later years.

In other trials the crop yield after two years of clover pasture increased about 10 bushels per acre (680 kg/ha) over virgin land but only increased by a further 4 bushels per acre (270 kg/ha) after seven years under clover. The soil nitrogen and soil carbon build-up and overall fertility increase was examined. It was found that soil carbon increase under clover pasture was confined to the top 2 inches (5 cm). At Wongan Hills a nitrogen build-up under dense clover of 30 to 40 pounds per acre (35 to 45 kg/ha) each year was measured.

An experiment to determine the effect of harvesting clover seed on the fertility of clover pasture showed that the soil carbon and nitrogen were substantially reduced. Yield was reduced by almost 4 bushels per acre (270 kg/ha) in the most severely treated experimental area.

In 1983, 1984 and 1985 there was increased focus on tillage research and development. Alternative methods of planting to achieve a one-pass sowing with minimum soil disturbance were studied and there was increased work on crop rotations. This is dealt with later.

**Alternative crops**

At Mt Barker Research Station a sunflower trial using two seeding rates, three row spacings and three planting times produced
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low and uneconomic yields. The experiment was part of attention given to alternative crops which included a detailed economic examination of oilseed crops and grain legumes including linseed, rapeseed, safflower, sunflower, lupins and peas. Numerous trials investigated aspects of lupin production across the wheatbelt. The results indicated that the low alkaloid lupins available at that time were generally disappointing. Experience showed that these early cultivars did not indicate the potential for this developing crop.

Weeds and diseases

Weed control

Weed control remains a fundamental part of crop production and the work of the weed science and control group was fundamental to the earlier ley farming system and the basis of the ‘new agriculture’ which developed in the 1970s and early 1980s. The group carried out extensive experiments and demonstrations of the effectiveness of the wide range of herbicides on a wide range of weeds. Work was also needed on the tolerance of important crop and pasture species and cultivars to the range of herbicides potentially in use. Part of the work focused on hard-seededness in legumes.

This work also included management techniques for weed control where herbicides were not available. For example, the weed radish, which was difficult to control in the lupin phase of a rotation, could be relatively easily controlled in the cereal phase. However, this was not always successful and in 1986/87 it was found that a second application of simazine had potential for substantially better control. With satisfactory radish control it was estimated that lupins could be grown on an additional half million hectares.

The threat of skeleton weed to the grain growing areas was examined. A study found that it was liable to be a problem across most of the wheatbelt but the area from the south-eastern wheatbelt to Esperance appeared to be at particular risk. Based on this work the statewide program for skeleton weed eradication was continued.

The possibility of herbicide used in drilling programs affecting later crops and pastures was examined without evidence of residue carry-over being found. Nevertheless monitoring of the effect of herbicide residues continued.

Over time some important weeds, including radish, became resistant to an important herbicide in the cropping system and management solutions or alternative herbicides had to be used or developed. This became a cooperative program with the University of WA.

Flue gas toxicity

In 1971 it was reported that investigations had shown that the flue gas emissions from a brickworks were damaging vines. The likely cause was fluoride in the emissions. The same report suggested that vegetation damage on the areas surrounding the Alcoa refinery was due to sulphur dioxide from fuel oil. Toxicity was also suspected as the cause of damage to vegetation near phosphate works at Picton Junction and Esperance.

At Esperance damage to the Norfolk Island pines and Moreton Bay fig trees suggested that the dust from loading operations of shippers was contributing. Chloride and/or nickel toxicity was suspected and investigated.

Plant diseases

Every year the Plant Pathology Branch examined a wide range of diseases. For example in 1965/66, 20 different diseases were examined and work was done on them. Some of the more common and important ones are listed below.

Lupinosis

This major problem caused many animal deaths and limited the use of lupin stubbles which were a valuable summer feed. It was diagnosed early as caused by a fungal toxin
but little progress could be made in developing a control measure until the fungus was identified. The Plant Pathology Group showed that the fungal spores infested lupins much earlier than previously thought. They also showed that fungicide sprays were ineffective in controlling the disease. Lupinosis is discussed in detail elsewhere.

Cucumber mosaic virus
By 1988/89 cucumber mosaic had been identified as a serious problem of lupins. It was shown that lupin plants grown from seed infected with the virus died during any long dry period. Other work showed that it was spread by particular aphids. Control was proposed through the monitoring of aphid population and strategic spraying.

Nematodes
Attempts were made from 1945/46 to obtain responses to fertiliser on grapevines which were not thriving in the Swan Valley. The responses were variable and unconvincing. Over the years attempts to revitalise vines with nutrients largely failed.

In the early 1950s, the possibility of root knot eelworm being a factor in grapevine decline in the valley was investigated. In 1954/55 experimental work on eelworm was stepped up as new techniques and fumigants became available. Increased yields following fumigation reached 28 per cent on sandy soils. Studies of the resistance of rootstocks to eelworm resulted in a number from the United States being tested in the Swan Valley in 1971, with good results.

The 1973/74 report referred to an apple replant problem. This was shown to be caused by two disorders. One was an infestation by nematodes and the other was a complex of diseases, the cause of which had not been identified. Soil-inhabiting micro-organisms were suspected to be the main cause of the problem as outstanding control results had been obtained with soil fumigation. Experimental work showed that by the second year replant apple trees showed a marked growth response to fumigation before planting.

Studies of citrus decline in the 1950s also showed that an eelworm could be involved, together with a Phytophthora rootrot. In general, there was a realisation that eelworm was more important than had previously been thought. Extensive work including testing rootstocks for susceptibility and testing pesticides and fumigants on eelworm problem areas was undertaken with both vines and apples.

The general interest in eelworm focused attention on whether the nematodes were involved in orchards where dieback was a problem. At Manjimup an area of poorly performing orchard was removed and the soil fumigated. The area was then replanted. Apple nematode control by fumigation was shown to maintain healthy tree growth for some time but in the fifth year at one site growth had stopped and nematode numbers were increasing. In other cases fumigation did not show a response after two or three years. The question was whether the increase in the yield was more than offsetting the cost of fumigation. Further work was being carried out on eelworm-resistant rootstocks for vines.

In 1966/67 a major part of the investigation work related to eelworm of cereals, apples, citrus and grapes. In grapevines an infection by citrus eelworm was found for the first time. All rootstocks were found to be susceptible. With apples a large experiment was started at Donnybrook.

Cereal eelworm was found on some older properties in the Geraldton-Dongara district.

Virus diseases
Considerable work was undertaken on virus diseases. Granny Smith and Jonathon apples and the Pomme de Neige were freed of the apple mosaic virus. In 1961/62 studies of the impact of viruses on tree growth were started. Virus indexing of plums for the line pattern disease had also started, as well as a study on the effect on growth in the commercial plum varieties of this disease.
Virus indexing of the grape varieties had also started.

Clover stunt virus was identified at Esperance. In 1961/62 the yellow dwarf virus was discovered in WA for the first time. Tests at Avondale and Esperance found no evidence of yield losses from yellow dwarf virus infection on cereals. This situation changed later.

Jarrah dieback
The 1964/65 report described a joint study in the Forest Research Institute led by a Department of Agriculture pathologist and involving the Forestry and Timber Bureau and Department of National Development, was successful in identifying the causal organism of Jarrah dieback. *Phytophthora cinnamomi* was the causative agent. This finding enabled the development of control approaches.

Wheat stem rust
Stem rust was periodically a serious problem in the wheat industry. Two epidemics mentioned in 1934 and 1943, reflected favourable climatic conditions for the development of the fungus. The overall policy was to control it by breeding resistant varieties. There was no other general problem before the early 1960s, then in late 1962 there was evidence of a new race in Esperance.

In 1963 rust was widespread in the wheatbelt due to a general incidence of the new races 21-2 and 21-12. Only the New South Wales-bred cultivars Gamenya and Mengavi and the WA-bred Moora remained resistant. In 1964 three new strains of stem rust were found. All three were capable of attacking Gamenya, Festival and Dowerin. One of the strains could also attack Mengavi. This meant there were strains of rust capable of attacking all current varieties. An Australia-wide survey of rust strains showed that six of 56 submissions from Esperance were a new strain designated as 21-2,3,4,7. This was known to break down Gamenya and Mengavi. In 1968/69 a survey of the whole State showed that the situation appeared to have stabilised with 21/1,2 and 21/2 being the common strains present. Gamenya was resistant to both.

A garden to identify varieties of rust was established at Denmark Research Station. Loose smut of wheat and barley is seed-borne and not controlled by usual fungicidal seed dressing. Overseas work suggested that a systemic fungicide, Vitavax, may control the problem and an experimental program was started to examine this possibility.

Root rots
Root rots were a serious problem of cereals in clover ley cropping. No treatment apart from a cleaning crop had been successful in overcoming them. With the rotation experiment at Esperance, wheat sown after pasture, barley or wheat was severely affected by take-all whereas wheat after linseed, oats or vetches was relatively free from this disease. Experiments at Esperance Research Station showed that barley grass and rip-gut brome grasses were extremely important carry over species of take-all in WA. Silver grass and blando brome grass, although susceptible, do not carry take-all so effectively. Wimmera ryegrass and perennial veldt grass were not obviously affected by the disease.

In 1977 it was reported that that some nitrogen fertilisers reduced the incidence of root rot on wheat. Sulphate of ammonia and Agras18:18 were the fertilisers involved.

Septoria
The 1968/69 survey of the incidence of *Septoria tritici* across the wheatbelt found it to be present in 95 per cent of the 200 wheat crops examined. There was a higher incidence in the southern wheatbelt, particularly in the higher rainfall regions. Examination of 28 isolates showed no significant difference in their parthenogenesis. Testing of 400 wheat varieties in the glasshouse identified some which could be of use in differentiating
strains in future isolate testing. In a 1968 study *Septoria* was found to be present in almost all crops sampled but did not generally cause yield losses of more than 10 per cent in areas which received less than 16 inches of rain. In 1969, which was the driest year in the wheatbelt since 1914, there was some infection with *Septoria* but no crops were seen where it would have had any impact on yield.

*Seed emergence of wheat*

An examination of the fungicidal seed dust used for disease control showed that there was either no effect on the emergence of wheat, or emergence was assisted by the presence of the fungicides. However, it was shown that emergence could be reduced by the presence of large amounts of stubble incorporated in the soil. In this case the fungicide could have a protective effect.

*Powdery mildew*

In an outbreak of powdery mildew on barley it was shown that this was unlikely to cause any significant commercial problems. This was the case with a large number of other diseases of less importance dealt with by the plant pathologists during most years.

*Subterranean clover damping off*

Work at Donnybrook in 1952/53 and 1953/54 demonstrated that heavy grass residues reduced the subterranean clover content of the pasture in the following year. In the mid-1960s researchers identified two organisms capable of causing damping off of subterranean clover when it emerged under heavy trash cover. They were identified as two species of *Fusarium*.

*Subterranean clover scorch*

Clover scorch reached serious proportions on subterranean clover pastures in south coastal and south-west districts. In 1973 it was reported for the first time in the Dandaragan district. While promising results have been obtained with a systemic fungicide to prevent the disease build-up, it was uncertain whether this would be economically feasible. Breeding for resistance held the solution, provided by the later release of the Esperance cultivar of subclover.

*Subterranean clover root rot*

The 1973/74 report dealt with large areas of subterranean clover pasture in the south coastal and lower South West districts which were affected by a root rot disease which was particularly widespread in the Walpole, Denmark and Manjimup districts. A number of *Pythium* and *Fusarium* fungi were isolated and tested for their capacity to cause the disease.

*Pesticide residues in pasture*

Analysis of pastures and fodder crops in the South West showed a marked interaction between soil type and the level of organo-chloride residue in the plant. A peaty soil with a high organic content gave a low level, whereas the reverse was true on a red silty loam. The work involved the collection of 300 soil samples and 700 samples from crops and pastures.

*Vegetables*

Routine work of the pathologists included examination of a range of disease control measures using old and new fungicides across the large number of diseases. Pedigree seed of the rust-resistant Westralia bean was produced to meet national demand. In 1967 advice was received that the Queensland Department of Agriculture had shown that the Westralia bean was resistant to all six known rust races in Australia.

Bacterial wilt, pink rot and rhizoctonia of potatoes were among many diseases investigated, plus powdery mildew of capsicums, bean rust, diseases of root crops and the freezer pea industry.

Continued effort was made to ensure the potato cyst nematode did not establish in Western Australia. Discovery that it survived
on the sour thistle, a plant not of the Solonaceae family which had been thought to be the only plant family affected, was a concern. This increased the difficulty of controlling the nematode. While outbreaks were eradicated from WA, national agreements required the department to contribute to its eradication in Victoria.

Powdery mildew of potatoes
Powdery mildew had reduced marketable potatoes in winter and spring crops in the Spearwood district for many years. It was reported in 1973 from all of potato growing areas. Serious losses in some plantings occurred in the Manjimup and Pemberton districts. Experiments indicated that a range of fungicides could control the disease but conflicting results were obtained with trials.

Agronomy and soil studies
Soil structure
Over the years there has been concern about the loss of soil structure in most cultivated soils. Some soils which had poor structure under natural conditions were difficult to manage. Experimental work had shown that cultivation reduced soil structure and periods under pasture resulted in full or partial recovery. The loss of structure was much more significant on clay and clay loam soils where it was likely to reduce water penetration, make root penetration difficult, and could affect germination. It also increased the difficulty of cultivation and reduced the period when soils could be worked. Soils with naturally poor structure experience all these problems.

Gypsum was regarded as a valuable soil ameliorant capable of improving the structure and general characteristics of these soils. As a result, extensive experimental work was carried out to test the effect of gypsum. Some examples of this work follow:
- At Merredin Research Station 12 experiments were carried out to study the effect of sulphur and gypsum on soil structure. No positive results were reported.
- Studies of the effect of different cultivation methods (mouldboard, disc or scarifier) showed no difference in effect on yield or soil structure, between cultivation methods. This cast doubt on the claim that deep ploughing aided water penetration and organic matter build-up to depth. Experiments with speeds of cultivation at Merredin and Salmon Gums showed no difference. Similar results were obtained at Wongan Hills where, in clover/wheat rotation experiments, a speed of cultivation trial gave inconclusive results.
- In 1961/62 at Merredin Research Station and Corrigin, soil structure was again studied, including a comparison of the relative impact of soil amendments versus continuous subclover pasture. This included a study of soil moisture penetration and utilisation under different vegetation cover.
- Gypsum was studied as a possible soil amendment for soils which had been difficult to cultivate and showed poor emergence if there was heavy rainfall post-seeding. The rates of gypsum were 2 and 4 tons per acre. These experiments showed some minor differences in two locations but generally no major effect on yield. Samples however showed that the water stability of the soil had been increased. Trials of gypsum as a soil amendment showed significant yield increase in one experiment. While on other sites the value of the incorporation was hard to identify, there was a general improvement in the soil structure of the treated areas, which could be described as being ‘softer’ than the untreated areas.
- In Carnarvon gypsum studies on irrigated soils showed no effect of gypsum dressings in the first year.
- Other work showed that sheep grazing very wet areas of pasture reduced the soil structure through a trampling effect.
In an experiment at Merredin Research Station the soils protected from grazing in winter for two seasons had a greater water-stable aggregate than soil which had been grazed for that period. In another structure experiment, soils in an area which had been under a long-term clover wheat rotation, were sampled on four occasions. The samples were collected once before any cultivation, once during fallow, and on two successive years of wheat crop. It was found that over the four years total nitrogen was lowered by cropping and cultivation, as were the water-stable aggregate and bulk density. Organic carbon values showed no consistent trend.

At Merredin Research Station the stable soil aggregate after four years of pasture was higher under Wimmera ryegrass than under medic or volunteer pastures. This work also confirmed the effect of compaction during winter stock grazing in reducing the level of stable aggregate.

A study of the effect of pasture and cropping on the water-stable aggregates showed that under pasture the water-stable aggregates increased but cropping quickly destroyed this improvement.

A similar result was obtained from an experiment at Wongan Hills. In 1969/70 studies of soil structure under two long-term pasture/wheat rotation experiments showed that the water-stable aggregates were maintained or built up under pasture but were destroyed by cultivation and cropping. On the other hand, the decline in the water stable aggregate after the two years of crop was reversed after the first year of subclover pasture.

The advent of chemical weed control and virtual elimination of ploughing and cultivation revolutionised the impact of cropping on soil structure and protected the build-up of fertility in the soil following periods of pasture. In one experiment comparing different planting methods on a clay loam at Merredin Research Station, it was observed that the ‘no till’ treatment had returned to a natural ‘soft’ state to walk on after only a few years. This further demonstrated the detrimental impact of cultivation on soil structure.

Value of cultivation
Experiments investigating cultivation practices in crop planting showed that weed control was the main concern. Repeated ploughing before seeding risked delaying seeding, which was detrimental to yield. Depth of ploughing was only relevant to the extent that it improved weed control.

Saltland revegetation
Saltland revegetation studies were carried out over many years. In the early 1960s yield and grazing trials were conducted with bluebush and saltbush and seed viability was investigated. It was found that bluebush and Wimmera ryegrass seeds were able to survive for an extended period under 3 per cent salt water. But the trials showed that the growing plants did not like areas where they were waterlogged in winter. Puccinellia grew in these conditions, as it could grow successfully in extremely salty water.

In 1962/63, demonstration plots showed that revegetation of saline land was feasible and potentially productive. After repeated establishment failures with bluebush it was found that it was necessary to remove the floral parts to expose the seed, which resulted in an increased speed of germination. This was in part due to removal of a physical inhibitor but also to the removal in the seed husk of a water soluble germination inhibitor. It was also found that the salt level could inhibit germination of bluebush.

Surprisingly when the bluebush seed was allowed to stand in a 3 per cent salt solution for three weeks and then the salt solution was removed, the seed germinated more quickly than the untreated seed. Bluebush seed maintained its viability in the solution for at least three weeks. Both bluebush and saltbush have been planted on salty land as
potential feed in the eastern wheatbelt. Given that the statistics available showed that large areas of formerly good soil had become salt-affected, and that this was increasing, a capacity to revegetate with a productive species was important.

Seed of two varieties of samphire was collected from salt-affected areas in both the ripe and unripe condition. When the unripe seed heads were allowed to dry, the seed germinated as well as the ripe seed. It was found that there was a wide temperature range for germination, occurring in both species between 5 and 35°C. The varieties were tested for sensitivity to the concentration of salt present at the time of germination. One variety gave a 50 per cent reduction at a concentration of 0.8 per cent of sodium chloride and the other at 2.0 per cent of sodium chloride. It was concluded that from the point of view of salt tolerance at germination, both varieties were no more tolerant than most common crops. This indicated that the varieties have naturally selected to germinate in periods when the salt concentration was low.

Sheep grazing saltbush. The department demonstrated that saline land could produce very valuable high protein summer feed.

The bluebush and creeping saltbush plantings established at Merredin Research Station grew well and provided good autumn grazing in two years. A number of salt-tolerant species were planted at eight salt-affected sites in the Central Agricultural Region and provided both demonstration and research information. Also experiments were carried out to find a solution for the difficulty experienced in establishing bluebush on some wheatbelt soils.

Over 10 years to the late 1960s more than 70 demonstration plots on management of saltland were established throughout the agricultural areas. They served both as a source of additional knowledge and provided farmers with a demonstration of how saltland could be utilised.

In 1966 the program of saltland trial plots, samphire studies, and puccinellia and bluebush establishment continued. Leaf coatings were also compared as a means of reducing the amount of salt uptake through spray irrigation with saline water. In 1967 the issues examined were puccinellia germination and establishment, plant introduction and testing, the use of tamarisks in saline areas and groundwater studies at East Pithara and Busselton. Renewed interest in tamarisks arose from reports of success in lowering the groundwater in parts of the United States.

In 1969/70 it was reported that the collection of the salt-tolerant plants had been increased by a further 29 accessions so that a total of 478 plants were available and that this work was continuing. By 2000 it was regarded as a mature technology which could be built on from time to time. A major contribution to the use of salt-tolerant plants was the development in cooperation with a farmer of the ‘Mallen’ seeder. This facilitated the planting and establishment of larger areas of saltbush. These in turn provided the resources for carrying capacity experiments and demonstrations. The program was the catalyst for formation of the Productive Use and Rehabilitation of Saline Land (PURSL) program.

Other issues such as the demonstration that citrus grafted onto citronelle rootstock did not take up salt from variable salt levels in irrigation water but did take up salt if grafted
onto trifoliata rootstock had potential commercial application.

**Water balance studies**

Water balance studies were carried out to evaluate the change in water usage on different soils after clearing. Studies of a saline groundwater table in a salt-affected valley showed that the water was under pressure in underground aquifers and would rise above the surface when the impermeable barrier was penetrated with a drill. This confirmed the view that the source of the water was from higher country where water seeped into the underlying aquifer which progressively filled and produced hydraulic pressure in the lower parts of the aquifer.

In 1967 studies of the watertables in the Busselton area showed that saline water was present in salty valleys at a depth of 6 feet and that it was under pressure. In 1967 the work on watertables in the Harvey area and Elgin, and soils studies in Carnarvon continued. Examination of the Collie irrigation area showed that some 400 to 500 acres were salt-affected due probably to leaching of salt out of the naturally saline soil which was being irrigated.

**Soil conservation**

Land use surveys and mapping were done for two catchments.

A study of water run-off from a 60-acre catchment at Berkshire Valley was initiated. After a number of years it was contoured and the run-off compared with the previous experience. A system of banks was constructed in November 1965. The catchment was cultivated and sown to wheat in 1966 and 1967. It was then sown to Geraldton subclover and left without cropping for another five years. Recordings of rainfall and run-off continued through that time.

This work was expanded to include two further catchments in the eastern wheatbelt. Preliminary information on the run-off from one catchment in 1963 was reported in 1964. In the very wet winter of 1963 the catchment, with an area of 27 300 acres, received 6.9 inches of rain over the measured period, and had a total run-off of 6100 acre-feet. Similar results were obtained from other catchments.

Nitrogen fertilisers were tested to determine their effect on the density of grass on a waterway in a contoured paddock. As with other soil-related activity, cultivation had an overwhelming influence on run-off. With modern farming systems, there will be little or no cultivation and depending on the farmer’s approach and total farming system there may be little or no farm soil exposure. However, with large machinery and up-and-downhill cultivation, contour banks have been largely destroyed.

**Soils Division in 1970/71**

The year 1970/71 is chosen to illustrate a ‘normal’ year in the Soils Division, with the focus on soil conservation, research, pastoral catchment surveys and assessment and irrigation advice and oversight. In later years the division's role was expanded in helping to supervise and assist community groups involved in the new focus on natural resource management. Fortunately there was reduced focus on soil conservation because of the advent of the minimum tillage farming system.

The erosion problems in the wheatbelt, rangeland vegetation deterioration, advice to private irrigation schemes, extension and advisory services to 1200 properties, water and soil testing were the main issues addressed that year. In the Kimberley, general liaison with the Kimberley Research Station and extension and advisory services on irrigated crops, including advice on irrigation and drainage, were required. In southern areas the issues were irrigated pasture trials, saltland amelioration, trials on trickle irrigation, orchard investigations and demonstrations of drainage and catchment treatment to increase run-off for on-farm water storage.
The Soil Conservation Branch was substantially involved in providing advice on contour surveying, development of soil conservation plans, demonstrating the possibilities for farm water conservation in the northern wheatbelt, providing advice in the non-farm areas in relation to management of coastal lands, recovery of mining sites, roadside erosion and the subdivision of land. Staff were also involved with 12 catchment groups, stabilising coastal sand dunes, saltland management and runoff, and soil loss investigations.

Contour banks in a roadside revegetation project.

The introduction of minimum cultivation dramatically reduced the need for contour banks.

The Soil Research Branch was involved in salinity investigations, salt leaching experiments, Carnarvon soil and water issues, plant collection and testing, polythene lining for earth tanks, sealing earth tanks with STPP and Riverseal, soil permeability studies and catchment sealing trials. Soil structure studies were carried out on a continuous wheat crop experiment at Merredin and long-term work aimed at reducing the percolation beyond the root zone was undertaken, particularly in identified intake areas.

In 1977/78 the first mention was made of 'interceptor banks'. These banks were bulldozer-built with a deeper channel than used in the normal contour banks for erosion control. They were similar to the absorption banks built to control water movement where very high water flows were anticipated. It was claimed by the promoters that these banks would cure the salt problem. They needed to be built where the subsoil clay was within 45 cm of the surface, allowing it to be pushed up to line the face of the bank. The procedure was based on the belief that the salt problems were wholly caused by water moving in the top 45 cm of soil from the higher slopes to low-lying land and that interceptor banks would prevent such movement. The approach was given widespread publicity which led to significant criticism of the Department of Agriculture's approach to the management of salt-affected land, which depended largely on revegetation of affected areas.

The department carried out research into interceptor banks to critically examine the proposition. The approach taken was to place test wells on either side of interceptor banks to see if there was any difference in the accumulation of water in the low-lying areas. In practice no effect was seen and in one area north of Dangin, the water was under pressure, causing it to rise from the subsurface aquifers, in one case to 3 metres above the surface. Another well was overflowing at a discharge rate of 11 litres per minute before casing was fitted. The conclusion was that there might be some small impact through a reduction in waterlogging but the interceptor banks were of no value in addressing the main problem.

Raised beds

While the use of raised beds is not a major issue for most of Western Australia it is very important in areas prone to waterlogging. The issue is really one of drainage, which has been recognised for many years. Raised beds have helped carry the message about waterlogging and provide a relatively low cost solution. In some cases the beds are very wide and probably are the spacing between micro-drainage lines.

Minimum tillage

Minimum tillage was first reported in 1975/76. Initially there was a lack of interest in the technique due to relatively poor weed
control. However in the late 1970s selective weed control improved and use of minimum tillage for crop establishment became commercial practice.

In 1979 about 700 farmers were direct drilling in one form or another. This was reflected in the areas sown, which in 1971 had been 10 000 ha, rising to 70 000 ha in 1974 and falling to 25 000 ha or less for 1975, 1976 and 1977, then increasing to 40 000 ha in 1978 and 100 000 ha in 1979. 

Earlier interest appears to have been based on availability of commercial numbers of the triple disk drill which was a specialised machine for direct planting without cultivation.

There was initial concern that without cultivation the mineralisation of soil organic matter to release nitrogen would be reduced. It appeared possible that additional nitrogen would be required to optimise yields if direct planting was to achieve its potential. In research carried out it was noted that seed placement in slots had not been covered sufficiently and direct planting with a combine gave a very cloddy seedbed and poor seed placement, which caused poor germination. There was also more webworm and insect damage with zero cultivation and ryegrass densities generally increased proportionally with the amount of soil disturbance. An examination of the impact on nitrogen nutrition in four centres gave mixed results. In two locations only, early season crop growth was poorer on uncultivated treatments and yields on direct-planted treatments were generally lower than on cultivated treatments.

The department's research effort and involvement with industry grew rapidly in the intervening years, with a working party of 15 scientists brought together from within the department's resources to bring a coordinated approach to research projects in this field. The experimental program was rationalised and expanded with long-term trials established on most research stations to allow a reliable monitoring of the many facets involved. Soil structure, nutrition, weed control, insect and disease patterns, yields and economics were examined. Parallel paddock-sized plots using different reduced tillage techniques were established on research stations. District office personnel were involved with farmers in paddock-sized demonstrations. There was a particular interest in erosion and stubble management.

Overall, the work demonstrated that provided minimum tillage techniques were properly applied and follow-up post-emergent herbicides used, yields compared favourably with those from conventional systems of cropping.

The final solution was the result of the combined efforts of the department and the farming community. Who did what first is a grey area. In general however, the farming community made a major contribution in the machinery area and the department was more prominent in the biological aspects. The critical tools were the array of selective and general herbicides provided by the chemical industry. Advice on their safe and effective use was part of the department’s contribution. Critical contributions were the provision of the legume in the rotation and the development of wheat and other cereal varieties suitable for the changed conditions, particularly planting times. A rotation using a legume as a break crop was important to maintain disease and pest control.

In 1990 it was reported that record crop yields had been achieved by some South Coast cereal producers following adoption of a new crop management package using a lupin/cereal rotation to reduce the weed and disease burden. Some of the issues involved are listed below:

Reduced tillage and the management of stubble retention

Mixed results were obtained on stubble retention. Initially, burning stubble was favoured but a re-examination led to the conclusion that retention was an advantage. It was seen to aid water penetration and protect the soil surface from wind damage.
**Row spacing, precision placement**

The use of press wheels and knife points to obtain germination on low rainfall areas became part of industry practice. With press wheels germination was possible on 5 to 10 mm of rain provided stored moisture was available. While the development of the knife points was an industry initiative it was based on the department’s demonstration of the value of separation of seed and fertiliser and the advantage of placement of fertiliser deeper under the seed.

**GPS guidance systems**

Guided steering saved fuel and chemical overlaps, which was an important benefit of the use of GPS. As indicated earlier the use of GPS resulted in a lot of up-and-back working and removal of contour banks. Using GPS guidance in a tramline farming situation could also increase available spraying time as spraying could be done at night. While GPS was available, the technology had to be developed for on-farm use. CSIRO did some early research into use of GPS systems.

**Wider planting rows**

The issues driving wider rows for planting included reducing early crop water use to save it for grain fill, seeding tractability into dense stubbles, better weed control with herbicides and more efficient use of fertilisers. Hardpan ripping may have also been an issue.

**Better decision support systems (DSS)**

Decision support systems made a big difference to modern farming and were largely developed by the department. The systems were initially for the use of fertiliser and lime but developed to cover a wide range of issues such as variety choices, water supplies, disease and weed control.

It has been suggested that the introduction of the GST (Goods and Services Tax) resulted in more computers on farms than any other factor influencing farmers to computerise their work. Without farmers being computer-literate decision support systems and GPS could not have been adopted.

**In summary …**

The advent of minimum tillage, satellite guidance, computers on farms and the associated availability of decision support systems has meant that many of the accepted ‘truths’ of cropping have had to be re-examined. This has required a lot of objective research and investigation by the Department of Agriculture.

**Crop physiology**

Crop physiology and soil moisture studies were carried out for a short time during the 1960s.

In 1965/66 experiments on the physiology and growth of wheat showed that:

- Adequate nitrogen levels are needed for wheat early in its growth to attain its potential. High nitrogen levels were more likely to occur under those field conditions without nitrogen additions, towards the end of the growing season.

- Soil moisture levels on a loamy sand were higher to a depth of 6 feet under plots with low nitrogen levels, reflecting better vegetative growth on the medium and high nitrogen plots.

- After the end of September soil moisture at depths below 18 inches changed very little, suggesting that plant growth and survival in October depended primarily on additional rainfall. Further studies showed that for the normal time of sowing the critical period for finishing rains was early October at Wongan Hills.

- The number of grains set per head was important. The highest yielding WA variety, Gaminya, set 41 grains per head under standard conditions compared with Pitic, a Mexican variety, which set 93 grains per head.

Studies on crop moisture extraction showed that a crop reduced the moisture in the soil
to a level of 24 inches as early as the third week of September and to 48 inches by the second week of October. In the Wongan Hills loamy sand cereals were capable of influencing soil moisture to a depth of 7 or 8 feet. With clovers this influence was recognisable to 4 feet. Varietal differences in moisture use by wheat caused by maturity differences became evident later in the growing season.

Extensive experiments were carried out to determine the root pattern underneath cereal crops in terms of both varying soil types and varying moisture levels.

In 1966/67 the effect of factors such as light, temperature and length of day on the growth of cereals and the effect of environmental differences on the translucency of wheat grain using different cereal varieties were studied under a controlled environment.

Separately, field work was carried out on the impact of variety and nitrogen in different locations through the wheatbelt, on time of planting in the Esperance district, and on the impact of row spacing and seeding rate on yield at Wongan Hills.

In other physiological work:

- Examination of the interaction between variety, nitrogen and location showed no clear indication that one variety was more efficient than another in making use of nitrogen.

- Study of the relationship between head weight and the overall weight of the above-ground parts of the wheat plant showed that varieties with a higher ratio of head weight to overall weight normally gave higher yields.

- Investigation of the environmental effects influencing grain mottling showed that a number of different climatic variables could influence the condition.

Radioactive isotopes were used to determine the availability of fertiliser from 11 soils in a glasshouse, a problem of root penetration in a field experiment, and the availability of cobalt from soils in the glasshouse.

It was shown that as a result of early rain there was deeper moisture penetration on a deep yellow sand than on a sandy loam or a sand over clay. On a grey clay the water penetration was limited to only 12 inches. In the subsequent dry period the crop on the grey clay failed while that on the deep yellow sand yielded almost 24 bushels an acre, and on sandy loam almost 27 bushels. On sand over clay the yield was 16 bushels.

The impact of nutrition on root growth was studied in various situations under controlled conditions. Root numbers were lowest with low nutrient level but plants without an adequate potassium supply ceased root growth dramatically 10 days after planting. Moderately low levels of phosphate gave best root growth. An examination of the root growth of 30 varieties of wheat selected from a large range showed that there was little difference in the pattern of the time of initiation. There were marked differences between the degree of branching and the length of root per plant. However, it was not possible to establish any relationship between the degree of branching and yield.

In addition to providing overall guidance for agronomists the plant physiology work provided plant breeders with valuable insights for their work.

**Tobacco**

The tobacco industry operated principally at Manjimup from 1925 to 1962, when the tobacco companies decided that the leaf quality from there was inferior to other sources.

Downy mildew in seedbeds was a serious initial problem and the discovery that benzol would control the problem was an important advance. The experimental program initially compared varieties and fertiliser use and placement but later covered trace element needs, rotations, times of planting, row spacing and inter-row cultivation. Advice was also given on seedbed design and curing barn design, and the department produced high quality seed which was made available to growers. Results indicated that yield could
be increased from closer rows, earlier planting, the correct variety and selected seed. Clear production benefits were shown from irrigation but irrigation increased the chlorine level, which impacted on quality. As quality became an issue the research focused on the influence of chloride content on burn time. Glasshouse trials confirmed the sensitivity of tobacco to chloride but could not identify a solution.

**Horticulture**

**Fruit crops**

Horticultural and viticultural industries were established throughout the Colony in the early days as the technology required was very similar to that used in Europe. When production outstripped consumption in the early 1900s, development of an export industry was necessary and cold storage experiments were carried out. These proved successful and an export industry developed. By 1921, 193 000 cases of fruit were exported out of a production of 793 000 cases. As resources increased in the department, a range of work was carried out.

**Irrigation**

It appeared that under ‘dryland’ cropping, moisture was the limiting factor on growth, particularly on lightly pruned trees. Trial watering with brackish water from the Blackwood River was tested to determine whether salt deposited in the summer was leached out of the root zone in winter. In 1940/41 some work on the relationship between pruning and root growth began at Bridgetown and some work was started with alternative rootstocks. The work on rootstocks could not be done on farmers' properties and had to wait until Stoneville Research Station was commissioned to be addressed seriously.

**Canning and dehydration**

Largely in response to conditions during World War II extensive canning of vegetables and dehydration of potatoes was carried out for the first time in WA during the 1940s. The department was responsible for inspection and provision of technical advice to the processors. In 1943/44 the issue in apple canning factories was achieving satisfactory packs suitable for long storage. Three plants were engaged in canning and four in dehydration at the time. Few problems were experienced with dehydration.

Research was carried out into canning or dehydration of vegetables. Vitamin C levels were of particular interest. Some preliminary work was done with potatoes to determine relative nutritive value of samples from different soil types and districts. Cooking tests showed considerable differences between products from different soil types. In 1944 a rapid drying technique was evolved for apples, with the help of US Army personnel. An investigation of the sugar to acid ratio helped in the selection of fruit for canning and dehydration. In 1945/46 manufacturers were faced with the need to move to packs more suited to the civilian population. New techniques were necessary, and these produced their own set of problems.

**Fruit storage and packing**

Experimental and demonstration work on the problems of fruit storage and packing was done over the years. Broadly this work demonstrated that:

- it was important to pick at the correct time
- with pears, it was particularly important to minimise the time between picking and cool storage
- with oranges, much of the loss of fruit in storage was due to rough handling earlier
- potassium bisulphite was a valuable fungicide in packed fresh grapes.

Two physiological problems arose with apples - superficial scald and bitter pit. Superficial scald was finally overcome by the adoption Australia-wide of diphenylamine-
dipped wraps when packing. This simple statement hides a lot of work using a range of materials over years before the final solution was identified. Correct storage temperature was also important. Later, when apples were shipped in various bulk containers, techniques for diphenylamine treatment had to be developed.

In the case of bitter pit of Granny Smith and Cleopatra apples, work continued over many years. Calcium shortage in the fruit was identified as the problem quite early. However, it was the late 1970s before a solution was found. In 1977/78 it was found that good calcium treatment for bitter pit in Granny Smith apples could be achieved where the calcium chloride was applied under forced infiltration using a vacuum or pressure. Some further protection could be provided by the addition of diphenylamine to the calcium chloride dips. In 1979 it was reported that the adoption of an American technique of using a diphenylamine concentration of 1500 ppm in conjunction with a 3 per cent calcium chloride dip on freshly harvested apples gave complete protection. This resulted in the virtual elimination of the problem from export Granny Smith apples.

Other work on the storage life of a range of apple varieties and pears found that:

- Jonathons could not be stored past June.
- Storage life of the Yate apple was favoured by polythene-lined boxes.
- Pear storage was favoured by sealed polythene boxes, coupled with correct picking time.
- Comice pear life in storage was particularly affected by the time of picking and time between picking and storage.

Management issues were also investigated. Some examples were:

- In 1953/54 chemical treatment of Jonathon apples was tested to accelerate maturity.
- Control of budburst and foliation on Granny Smith apples, with oil sprays, in areas with insufficient cold periods.
- Increased fruit and fruit size were achieved.
- 2,4-D was shown to reduce premature fruit drop in citrus. Effectiveness was not affected by mixing with copper oxychloride it was affected by mixing with Bordeaux mixture.

Grapes

In 1952/53 the use of PCPA (parachlorophenoxyaceticacid) spray was shown to be effective in removing the need for cincturing of dried fruit vines. This work was confirmed and recommended to the industry in 1953/54. Subsequently it became clear that cincturing had reduced the vigour of the vines and sprayed vines gave better growth and yield. This revolutionised the currant industry.

Experiments were carried out with a new dipping material developed by CSIRO for drying sultanas. The chemical PCPA was also used for setting Early Madeleine table grapes and prevention of shattering in Santa Paula grapes. Alternative hormone sprays to set currants continued to be tested. It was shown that gibberellic acid was not as effective as PCPA.

Routine work continued on other issues and included:

- studies of the value of different cover crops in different soil and drainage situations
- setting Ohanez grapes with pollen sprays which showed that pollen spray from a late variety of grape was a superior source
- study of currant grape buds and in 1996/97 the department started to provide quality propagation material true-to-type and of known disease status
- demonstration of the use of deficit irrigation stress of the vine in the vegetative phase with an adequate supply of water in the berry stage
- cold treatment was approved for export of fresh grapes to Japan in 1999/2000
• the Mid-West was shown to be suitable for table grape production.

New apple varieties and trellising

By 2008 the Department of Agriculture was responsible for the National Apple Breeding Program, which became a major undertaking. The program is centred on the Manjimup Horticultural Research Institute. In 2009, 140,000 seedlings were planted. Of these 17,000 were expected to fruit and require evaluation in 2010, and about 3 per cent were expected to be taken forward for further evaluation. A further selection of this fruit will be made and the third generation put on rootstocks. The process is repeated on an annual basis and is very demanding on time and resources. In 2009 six selections, protected by plant variety rights, were being grown on selected commercial orchards for evaluation.

A 1971 report refers to the testing of two new apple varieties considered to have commercial possibilities at Stoneville Research Station. An early variety called Stark Early Blaze ripened in mid-January and had good market characteristics but did not become a commercial variety. The second variety was called Lady Williams, a development from a seedling at Donnybrook, which was being grown in a small way commercially. This proved to be a valuable variety for storage and late season marketing. Other varieties from New Zealand, Canada and the United States were tested, having been through quarantine after importation. None of these varieties appear to have become commercial in Western Australia.

An experiment on training apple trees to meet the trend for smaller high yielding trees, more densely planted, was started at Manjimup during 1971. Apparently the high capital cost resulted in some growers rejecting trellising. Work on rootstocks for apples and other species was continued from 1971 through the 1990s but would have been terminated with the sale of the Stoneville Research Station.

Cripps Pink (Pink Lady™) apples bred by the department were adopted worldwide and led to a 30 per cent increase in apple exports.

It was reported that 20,000 Cripps Pink apple trees had been planted by the industry to June 1990. In 1998/99 there was a 30 per cent increase in apple exports, driven by this new variety. The Cripps Red variety was also distributed about that time. In 2008 a variety Enchanted®, which does not brown after cutting, was released.

The southern wine grape industry

Interest in grape growing in southern Western Australia was stimulated by recommendations of Dr Howard Olmo, from the University of California. In his 1955 report he stressed the need for lighter-style table wines in the State. He suggested the region around Frankland and Mt Barker should be examined for this purpose and that the climate south of Bunbury was suitable for viticulture. This resulted in two 2-hectare demonstration vineyards, one planted to Riesling and one to Cabernet grapes, being established by the department at Forest Hill near Mt Barker. The demonstration proved an incentive for a number of farmers in the Mt Barker/Frankland River area to plant vines.

Almost at the same time several growers began planting vines in the Margaret River region. An article in 1965 in the *Journal of the Australian Institute of Agricultural Science* by Dr JS Gladstones of the University of WA, described the potential of the area for viticulture. The first cuttings were
planted at Mt Barker in 1966 and by 1975, 220 ha were under vines in the district. A further 120 ha had been planted in the South West involving 23 growers. Most of this area had been planted in the previous five years. It was expected that a further 100 ha would be planted in 1975. Expansion of this industry in new areas resulted in a heavy demand for advice from the department. It also resulted in a boutique industry which revolutionised the reputation of WA for table wines. Wine growing extended to the Manjimup–Pemberton area following demonstration of its suitability by the department at its Middlesex Research Station through the 1970s and early 1980s. It is now a major industry in these districts.

Vegetables

In an industry with multiple species and often multiple varieties, in sandy or swampy soils in an environment favourable to both insects and pathogens, there is no end to the work for professional advisers and research workers. The introduction of a canning pea industry in 1946/47 merely added to the challenge. While the first trials were at York the longer growing and processing period made Albany more suitable and the industry was established there.

A wide range of research was carried out over the years. The focus was on fertilisers, varieties, disease control, pest control and potential for processing. Potatoes received the greatest attention. Below are some examples of the work on vegetables:

- In 1950/51 the aim was to improve on the Delaware variety; comparisons indicated that Delaware potatoes were better for WA conditions than Kennebec but they later proved to be unsuitable for processing.
- In the early 1950s width of spacing, fertiliser rates, sett spacing and size were conducted on well-drained soil showing the highest rate of fertiliser (30 cwt per acre), the widest sett spacing and the larger setts gave the best yields.
- Potatoes from high quality seed were shown to produce more first grade potatoes. For many years the department provided virus-free seed as a service to growers.
- Fertiliser trials demonstrated the most economical use of fertilisers for potatoes under irrigation.
- Dithane to protect potatoes in storage proved valuable.
- A survey of Geraldton tomatoes showed the main factors influencing quality were fungus (alternaria), cold injury and mechanical injury.
- Variety trials were carried out on onions at Manjimup and at Albany.
- Tomato hybrids resistant to spotted wilt were tested through to 1957/58 and resulted in a hybrid which was largely resistant.
- Trials with brown globe onions showed that they could be kept for six months in cool store with only 4 per cent loss from all causes, provided only sound material was stored in crates instead of bags, to allow better air circulation.
- A sprout-inhibiting agent, maleic hydrazide, was tested for onions in storage but did not seem to have an effect.
- The value of zineb for the control of mildew in onions was tested.
In the 1950s extensive testing of new fungicides and pesticides was undertaken.

The rust-resistant bean variety Westralia was developed and released.

Management techniques were developed for vegetables growing on acid peaty sands.

In 1971, experiments covering potato fertilisers, production from small potatoes, dormancy, cooking quality and control of potato tuber moth were in progress. Other work covered rockmelons, zucchini, tomatoes and egg plant.

In the north, at Gascoyne Research Station work was proceeding on the nutrition, watering and plant densities for bananas and on conditions for the successful growing of pineapples, as well as a range of work on vegetables and other fruit crops. In 1992 the results of a five-year trial demonstrating improved irrigation scheduling encouraged more than half the Carnarvon growers to adopt the department's recommendation.

In late 1976 a new potato named Cadima was released. It was selected and developed from a seedling bred by the Victorian Department of Agriculture and introduced into WA in 1964. It met all of the culinary requirements for a potato and had similar yield potential and growth period to Delaware, almost the only variety grown in WA at the time. It was also found to have a long rest period and remained sprout-free for up to five months. In storage trials it suffered minimal loss of weight or culinary qualities. The results indicated that it could be suited to a single planting each year. This would contrast sharply with the traditional Delaware cycle based on a succession of plantings from June to January. The variety also had processing potential. Seed supplies were being built up in 1977 but in 1979 it was reported that the Cadima variety broke down in plastic bags after washing and it never became a major variety. This emphasises the difficulty of developing a variety for all purposes.

During 1979 the department released two new potato varieties, Geographe and Bremer, for testing. It was considered likely that Bremer might gain a place as a processing variety while Geographe may be suited as a boiling variety. They are not seen in shops today.

In 1990 it was reported that new technology had been developed for the production of potatoes for the frozen French fry industry.

In 1992 fungicide treatment to control problems in export carrots proved successful.

**Wildflowers**

In the 1980s the Department of Agriculture started limited work for the floricultural industry then began research into the issues involved in the production of four major groups of native plants. The research program was designed to examine agronomic factors such as nutrition, weed control, soil salinity tolerance, general management and the range of soil and climatic conditions in which the plants would grow successfully. Propagation was also examined, together with the opportunities for extending the period of supply by using a range of climates.

In 1995/96, two new wax flowers had been selected and released, and were marketed as Jurien Brook and Esperance Pearl.

Commercialisation of wildflowers was assisted by departmental research.
In 1998/99 a biotechnology program was established to include studies of the expression and development of floral pigments, development of the floral parts and a transformation technique. A Centre for Australian Plants was also established.

**Alternative fuels**

Following the oil shock in the mid-1970s, the department looked at a range of alternative fuels from agricultural crops which could be used in diesel engines. The successful use of such a fuel would depend on efficiency, cost effectiveness and small-scale extraction systems suitable for operation on the scale of existing country fuel depots. It was also desirable that a by-product be produced; in the case of an oilseed it would be a high quality meal. This work was carried out in cooperation with the Government Chemical Laboratories. Rapeseed (canola) oil was found to be an effective source.

Preliminary work was also successful in generating producer gas from pig manure. The product could be harnessed through a gas producer similar to those used in World War II. Use of the gas in diesel engines in conjunction with diesel fuel was shown to result in an increase in power rather than a decrease as occurs in petrol engines. This producer gas was also suitable for steam boilers. However, the total amount of material available was limited. Considerable research efforts elsewhere on the use of ethanol and methane meant that further direct research by the department in those areas at that time was not justified.

From 2005 on there has been a sharp increase in the price of liquid fuels. This again triggered interest in alternative fuels. Rapeseed varieties which are only suitable for fuel but are higher yielding than other varieties have been introduced from India. It was proposed that a small group of farmers could combine to establish a simple processing plant and grow their own diesel replacement.

**The northern areas**

The northern half of Western Australia was always seen as having vast untapped potential. In the early years of settlement the native grasslands and shrublands had been used for extensive grazing. In the early 1900s one of the earliest professionals appointed to the Department, AJ Despeissis, was commissioned to report on the potential of the north. He produced a positive report and was subsequently (1909) appointed as Commissioner for the North West.

However, apart from desultory experiments little action was taken. In his 1924 report FJS (Frank) Wise, who had been appointed as a tropical adviser, commented on a range of areas, crops and issues surrounding development. While he saw some possibilities, he pointed to the need to consider market access. The possible need to dam rivers to obtain reliable water supplies for irrigation was also suggested. He did not see cotton as a likely dryland crop. He thought that with suitable water supplies and fertiliser the Pindan areas could be used for intensive agriculture. He also commented that the Carlton Plain had considerable potential. However, he was not convinced that banana growing could be a big industry in Carnarvon. In retrospect, this was a perceptive report, except for the comment on bananas.

He resigned at the end of 1925 but was reappointed in September 1929. He then worked in the Carnarvon area until March 1933. He later became a prominent State politician, becoming Minister for Agriculture and later Premier of Western Australia. His final appointment was as Administrator of the Northern Territory. When the Department of Agriculture took over the Kimberley Research Station from CSIRO it was renamed the Frank Wise Research Institute.

Access to markets was a major constraint in early days. It was a serious problem at times for the Kimberley cattle industry until after World War II. It had certainly been a problem for the fledgling horticultural industry on the...
Gascoyne during the war. While a limited irrigated agriculture had developed on the Gascoyne River at Carnarvon, no attempt was made before the war to develop intensive agriculture on the large northern rivers.

Separate from the potential for irrigation there were problems with the management of the fragile native pastures of the Kimberley and the semi-arid shrublands of the Pilbara and southern pastoral areas. These areas were used for pastoral activities without any understanding of their long-term carrying capacity, particularly the impact of drought, which was part of their natural environment.

After the war the department carried out extensive rangeland surveys throughout the pastoral areas, which gave an indication of the true carrying capacity of these native pastures at the time of the survey. In the main these surveys showed that the areas were being overstocked. Over much of the area exclosures were established to monitor future pasture development. Extensive field days were carried out in the surveyed areas to explain the outcome of the surveys and to recommend action which could or should be taken to ensure sustainable land use.

In some cases, such as at the Fitzroy Pastoral Research Station, it was possible to demonstrate the impact of cattle over-grazing the native pastures. It was also possible to illustrate pasture responses both to over-grazing, and grazing restrictions. Later, at regenerated areas of the Ord River catchment it was possible to demonstrate the value of both proper pasture management and changed herd management. Trials of Townsville stylo on cockatoo sands and studies of breed differences in beef cattle were also carried out.

At the Woodstock/Abydos Research Station in the Pilbara, the focus was on sheep and rangeland pasture management and this work is reported in some detail below.

**The Ord River Catchment Regeneration Project**

The Ord River Catchment Regeneration Project was probably the largest such undertaking in the world. It started in 1960 when the Department of Agriculture was given the task of halting erosion and restoring vegetation on a severely eroded part of the catchment. The area involved approximately a million hectares. The issue was long-standing as it was described in 1944 by a surveyor and reported on by CSIRO and the department in subsequent years.

Some parts of the Ord River catchment were completely denuded.

In 1960 the problem was tackled with a major fencing and pasture regeneration project. The two basic techniques were control of grazing animals and soil disturbance for seeding of pioneer and potentially valuable species. Livestock were not removed in the early years but it became evident that complete removal of grazing animals was essential. More than 1000 km of cattle fencing was erected after 1960. Some 45 000 head of cattle and 30 000 donkeys were removed over the years after the area was destocked by the previous lessee. Even so, some cattle and donkeys remained.

In many areas degradation was so complete that virtually no seed sources of perennial grasses were left and soil disturbance and reseeding was necessary. This resulted in many thousands of kilometres of
discontinuous strip contour ploughing and reseeding. The strip ploughing of the broad slopes and undulating plains was aimed at breaking the surface to promote water penetration, slow the rate of run-off and supply a seedbed for introduced and native grasses. Seed from plants established on these sites was washed into the lower gully systems, where new vegetation was also established.

Initial recovery was slow after a series of below-average seasons and inability to exclude stock. However, a series of above-average or average seasons and the exclusion of stock had a snowballing effect as vegetation and seed built up. Recovery of both native grasses and introductions was reported in 1977 as being spectacular in parts of the project.

Unfortunately the renewed vegetation resulted in fires becoming a regular feature. New management methods were needed to deal with this problem. Some fully recovered parts were used for pasture management and breed comparison studies and the area became a centre for cattle and pasture research in the Kimberley. It became the rangeland research area for important cattle management work when the Fitzroy Pastoral Research Station was closed in 1978.

The eastern part was destocked and fenced in the 1960s and 1970s. The west, on the western side of the river, was not so seriously eroded, and was not initially protected by fencing. It was fenced and a major destocking program started in 1984/85. Nearly 12,000 cattle were removed from this area. At Kununurra, the shrub leucaena was tested under irrigation as the basis of an intensive cattle grazing project.

A study reported in 1992/93 showed that 80 per cent of the silt from the Ord catchment came from channels and gullies rather than sheet erosion. The progressive revegetation of these areas was particularly important and was happening as seed washed down from the revegetated areas. The cattle work on the regenerated area produced results that demonstrated the potential for increased production from better herd management in the area. The main gains, apart from those due to the use of Brahman bulls as opposed to pure British breeds, came from weaning the calves and sending a large part of the annual drop south for development and fattening instead of retaining them on the rangeland until they were three to five years-old. The space vacated would allow many more breeders in a reconstituted herd. This information was packaged into a recommended change in herd management in the Kimberley. It is reported to be slowly being adopted across the industry. The changes were made more possible because of the investment in infrastructure that had occurred during the TB eradication campaign.

The Ord River development

Apart from a small site at Carlton Reach on the Ord River where various pasture plants were tested, no experimental work had been done on east Kimberley rivers before the end of World War II. In the dry season of 1942/43 a soil survey was carried out to determine the potential for irrigation of the Ord River basin. This survey showed that there was an extensive area of soil types suitable for some form of agriculture under irrigation.

A Commonwealth/State agreement to develop irrigation on the Ord was signed in 1946. In 1945/46 a comprehensive plan was prepared by CSIRO for investigational work. The development of the necessary infrastructure was a State responsibility and there was to be joint technical oversight of both the research program and of policy development. The State was responsible for providing farm staff while CSIRO was to provide the research staff.

By 1950/51, work started in earnest on the Kimberley Research Station.

Over the next decade many crops were grown, largely successfully. Pasture species were also tested. A diversion dam was built and completed in 1963 and land was prepared for the first farmers to take up blocks. The experimental work provided the
basis for the first commercial cotton crop, which was planted in 1964.

The saga of the Ord cannot be dealt with here. It is sufficient to say that the department progressively developed a research capacity aimed at identifying a crop or crops which could provide the basis for a sustainable productive agriculture on the whole of the potential irrigation area. This work built on the foundation laid by the work at the research station, which was substantially planned and carried out by CSIRO.

Due to insects becoming resistant to available insecticides the cotton industry failed. Sugar was the ‘natural’ crop for the area and a successful pilot farm was developed. However, despite a number of attempts a sugar industry could not be developed due to powerful political opposition from Queensland. In the late 1980s the department took over the Kimberley Research Station from CSIRO and it became the Frank Wise Research Institute. A great deal of work was done on alternative crops after the cotton industry failed and for a period a small industry produced sugar for the local market. More recently, genetically modified cotton has been grown successfully and may lead to development of a new cotton industry. In today’s environment of climate change and need for reliable agricultural areas, the potential of the Ord may be more fully realised.

**Rangeland research in the Pilbara**

In the late 1940s the department decided to investigate ways of improving the carrying capacity of the degraded spinifex-based pastures of the eastern Pilbara. The landscape consisted of broad swales between low hills. The dry tops of the hills carried spinifex and in the undeveloped State the swales had largely carried tussock grasses. These swales had been poorly managed, resulting in the grasses disappearing and the vegetation becoming unpalatable spinifex.

In order to examine ways of reversing this process the State Government purchased two abandoned sheep stations, Abydos and Woodstock. Initial work had to focus on renovating the infrastructure. It was necessary to fence the properties and control wild dogs so that sheep could be run. Improvements were completed and the dog problem largely controlled so that sheep were put on the area around the end of 1950.

In 1951 a graduate officer took up residence on the stations. There was a heavy load of euros in the area and a CSIRO officer was stationed at Woodstock to study this problem. With the problems largely under control, experimental work began and continued through 1954/55 and 1955/56 it was shown that the practice of winter burning and grazing immediately green shoots appeared after summer rain caused the grasses to disappear and spinifex to become dominant. Early summer burning and deferring grazing until the grasses were well established after summer rain allowed the swales to revert to their grass-dominant condition. With this treatment swales could carry one sheep to three acres. The grazed areas also appeared to be superior, possibly due to seed being trampled in by the stock. It was shown that it was important to maintain the spinifex in an actively growing condition. This could be done through continuous grazing or the regular burning of the spinifex at the correct time of the year.

On a private property (Mundabullangana) a problem existed through bad management on coastal country where poverty bush had become dominant. With the same treatment of burning in the early summer and deferred grazing of the grasses, the native grasses would recover. In this case bare areas were seeded with buffalo and Birdwood grasses. About 50 000 acres of poverty bush were transformed into natural pasture through this management approach. This and work at Woodstock-Abydos were the focus of very successful field days.
In 1957/58 a study was initiated of the factors involved in the low oestrus levels and low conception rates among ewes in the area. This research showed that it was essential that lambing be timed with the rainy season from January to March. Studies also showed that the fertility of locally-bred rams was better than that of introduced rams and their libido was higher, so they covered the flock earlier. This probably contributed to better lamb survival. Weaned lambs did well on buffel grass, which appeared to benefit from the closer grazing. In 1970, a 76 per cent lambing was obtained from ewes lambing in February. In the very dry summer lamb survival was reduced due to various problems including dingo attack. A range of different climatic conditions called for this work to be revisited but this has not been done.

**Experimental work out of Broome**

In the early 1950s an officer based at Broome began plant introduction work. The 1956 report refers to proposals to investigate producing fodder crops in the Kimberley. This work stimulated interest among pastoralists in pasture improvement and regeneration. By the late 1950s the planting of Birdwood and buffel grasses had been successful on six stations in the west Kimberley as well as in parts of the Pilbara. In the 1960s establishment of grasses on Pindan country at Derby and at Broome was attempted but met with great difficulty due to competition from wattle germinating and growing rapidly from a massive seedbank. While the grasses grew satisfactorily nitrogen and phosphate fertilisers were needed and wattle had to be controlled. This made them uneconomic. Intensive horticulture could be possible if required in the future.

In the north Kimberley it was shown that fodder crops and tropical legumes could be established in areas receiving more than 35 inches of rain annually. A study of the value of spreading water on a private station ran into difficulty because of the development of the dense stands of trees and shrubbery along the water course, which crowded out the grasses.

At the same time an experiment on rice production at Camballin also ran into serious difficulties because of flooding and heavy grasshopper infestation. Despite these difficulties yields of over 2 tons per acre were obtained. Experimental plantings continued over the next two decades. They all failed due to uncontrolled flooding, with heavy financial losses to investors on some occasions. Any irrigation from the Fitzroy River would have to wait for water control by damming tributaries upstream.

**Southern pastoral areas**

In the southern pastoral areas the department carried out some regeneration work and some demonstrations of the impact of grazing. This involved various types of vegetation and regeneration of denuded areas using discontinuous contour-ploughed furrows to gather seed. This work was not on a station but was a study of deliberate revegetation of areas which had been degraded by mining or the construction of services such as roads and telecommunications.

![Denuded overgrazed pastoral land cross cultivated to encourage seed germination and water penetration.](image)

Since many of the species had not been grown previously, considerable research was needed to develop the best methods of propagating them in a new environment. A study of regeneration was also set up in the form of exclosures and enclosures across the southern pastoral areas, part of a national program. Change is measured
Chapter 7 – Important plant and soil research

largely by photographic record but also includes some physical measurements. These assessments are made today under contract by a previous employee of the department.

**Insect pests**

Insect pests are a continual problem for agriculture. Biological control of introduced pests was the early focus of the bureau and department. In 1902 entomologist George Compere was given the task of travelling internationally and to other colonies in search of predators of major insect pests present in Western Australia.

Mediterranean fruit fly was a major pest as early as 1903 and the search for a predator was a high priority. Over the years the Entomology Branch of the department has been active in achieving control through introduction of parasites. It has used available insecticides as alternatives.

The advent of new synthetic insecticides revolutionised insect control initially but was challenged by the gradual development of resistant populations. This resulted in renewed interest in biological control.

Extensive insect control work was done over the years on a wide range of pests of agriculture and horticulture. A few examples are listed below.

**Grain storage on farms**

Grain is stored in bulk on farms as a reserve stockfeed and seed for the following crop. Insect control was historically achieved by using phosphine gas as a fumigant, and malathion insecticide.

In 1977 it was reported that resistant grain insects were found in 35 of 850 grain samples from farms. In a further survey of farms in the Merredin area, 92 per cent of the rust red flour beetles were resistant to malathion. This compared with 20 per cent found resistant during a 1972 survey. The developing resistance made ‘on-farm’ storage more difficult and focused attention on finding a simple method of achieving airtight conditions, resulting in insect suffocation.

Two methods were examined. The first was to bury the grain using plastic sheeting in carefully excavated pits. The alternative was to line an above-ground bin lined with butyl plastic supported in a weldmesh frame which had proved airtight. The underground storage was tested at both Merredin and Salmon Gums research stations. Most of the grain from the Salmon Gums pit was still satisfactory after more than three years. The butyl-lined bin also proved airtight and appeared suitable for on-farm use. It was a simpler and more flexible method than underground storage. One approach would be to use the butyl-lined weldmesh for an annual reserve and the underground storage for a longer-term drought reserve.

The 1988 report records work on the eradication of resistant grain insects.

The Agriculture Protection Board collected samples of grain insects thought to be resistant and tested them in a laboratory. If they proved resistant the location where they were collected was fumigated to eliminate that population. The same approach was taken with Cooperative Bulk Handling. As a result CBH was able to continue to use first-generation insecticides until the time of reporting, with a major saving to the industry.

**Armyworm**

Armyworm became a problem for cereal cropping once pasture areas were cultivated on the first rains and sown when weed control had been achieved. The insect was controllable with DDT initially and then with other insecticides, but this was costly. Outbreak of armyworm in 1975 and 1976 was the first for nine years. It gave opportunity for investigation of new control techniques and a study of the life cycle of the insect. It was shown that the problem related to the caterpillar stage of three moth species. The study also showed that the caterpillar was often parasitised by a wasp. The incidence of the problem related to the relative numbers and time of hatching of the...
caterpillars and the wasp. In 1979 a further parasitic wasp (*Apanteles ruficrus*), which had successfully parasitised cutworms and armyworms in New Zealand, was introduced into Western Australia.

Later the introduction of six parasitic wasps which were predators of 11 species of caterpillars which attacked cereals and a wide range of broad-leafed crops was reported. In 1988 it was reported that two of the six parasites imported from overseas earlier had become well established. The first released was a small wasp imported from Pakistan, which was attacking armyworms and cutworms in early 1988. The second, imported from Greece, was found to be breeding in the native budworm. Monitoring of the effectiveness of these predators was continuing.

**General biological control**

A predatory mite was introduced successfully into the South West in 1976 for control of two-spotted mite.

In 1979 the department undertook a campaign to eradicate the Mediterranean fruit fly from Carnarvon. The campaign involved the use of irradiated male flies, supported by an intensive and area-wide baiting campaign. Mediterranean fruit flies were bred in large numbers and the population was then irradiated to sterilise all males. Sterile males were released every week from August 1980 for six to eight months.

As the female fruit fly only mates once, mating with a sterile male meant no live eggs were produced. After six months the releases ceased and the population was trapped to find the impact of the releases. The population was eliminated but the fruit fly was subsequently re-established by introductions from Perth.

Two predatory mites were introduced by CSIRO for control of redlegged earth mite and lucerne flea in about 1960. Inspections showed that they were well established. Both species were shown to be effective predators but the natural rate of spread was very slow. Secondary releases appear to have failed.

Parkinsonia is a prickly bush found around waterholes in northern Australia. A search was made for predators, and some beetles which appeared to be potential candidates underwent host specificity trials in Queensland. The WA Government contributed to this program. In 1993, two biological agents, a mirid bug and a mimosestese beetle, were released as parasites on parkinsonia in the Kununurra area. The wet season was known to have killed the mirid bugs. Efforts were being made to locate colonies of the mimosestese beetle.

Biological control programs were also aimed at the weeds dock and doublegee. Two clear-winged wasps regarded as having potential to control dock in pastures across southern Australia were imported from France into quarantine glasshouse facilities at the department. No further record of these predators is available. A predator from Morocco, which had been fully tested against becoming a threat to non-targeted plants, was released in June 1981. In 1994 it was reported that 23 populations of a dock control agent were established in WA. New release technology had increased and the potential for future establishment improved.

In 1988/89 biological control of Paterson’s curse became possible due to the introduction of small leaf mining moth from France. In 1994 it was reported that a root boring weevil for control of Paterson’s curse had become available for national distribution from Victoria in late 1991. After a colony had been established in Perth, 1650 weevils were released at four selected sites.

A parasitic wasp was introduced by the department’s entomologists in an attempt to control the blue-green aphid. This insect was first detected in June 1979 and by 1981 was recorded from virtually every pasture growing district from Geraldton to Esperance. It caused serious damage to lucerne, subterranean clovers and annual
medics. The multiplication of the wasp was aided if lucerne was continuously available through the summer. Up to 74 per cent of plants in a Hunter River lucerne paddock had parasitised aphids in 1981. The predator (*Aphidius ervi*) was released in other districts but did not prove as effective on subclover because of the difficulty of surviving the summer; other approaches were being examined.

Work was proceeding on a weevil pest of lucerne which became important to growing areas.

Eradication programs for Argentine ants, green snails and the European wasp were all in progress or had been carried out. Biological control of the cowpea aphid, which attacked medics, subterranean clover and other legumes was attempted through the introduction of a tiny wasp from India.

Queensland fruit fly was successfully eradicated, using the sterile male technique. This major campaign involved intensive baiting and a coordinated sterile male release program.

Queensland fruit fly.
Chapter 8

Extension, modelling, publications, education, research stations

This chapter describes a range of activities which were vital to the Department of Agriculture’s work but which individually do not warrant separate chapters. Extension, to a degree, was the raison d’etre of the organisation. Publications issued by the department were a key part of the organisation’s information flow to the farming community and are covered in this chapter. Education deals with computer modelling, a new but very important activity. The department’s contribution to formal agricultural education is also covered. The final section covers the 29 research or experimental farms which were part of the department at various times. While all of them were important, only a handful still operate as research farms and many are closed.

**Extension in summary**

The extension officers (generally district advisers) were the face of the department, being seen on farms, at meetings and living in the community. They were also its eyes and ears. They were in contact with farmers on a daily basis, visiting farms, living in the environment and observing issues with professionally-trained eyes. The development of the extension services over the years was initially slow due to the small size of the department, communication difficulties, shortage of hard information and the shortage of trained people. Having trained officers in the field was a high priority for the first professional Director of Agriculture, GL Sutton. In 1937 departmental staff were stationed at 16 country centres. They had varying qualifications and responsibilities but would have been experts in their fields.

Ten years later there were just four country offices and three professional advisory officers recorded as being in the country. No record was made of the number of inspectors and instructors in the field at that time. This reduction was doubtless associated with World War II.

As increased numbers of trained officers became available after the war it was possible to develop a fully operational and equipped extension staff. As the capacity of the offices increased it was decided to increase their responsibilities. In the mid-1970s some research officers were placed in the major country centres and in 1977 the offices became independent branches in a Regional Services Division.

In the early 1980s they took over control of the research stations in their areas. This process of regionalisation of services continued through the next two decades with substantial offices established at Bunbury, Albany, Esperance and Northam with a significant research capacity. The Animal Breeding and Research Institute was established at Katanning and the Dryland Research Institute at Merredin during the early 1980s. These facilities were not initially part of the district offices. Significant research capacity also existed at Geraldton from the mid-1970s even though no major facilities had been established there.

The issues faced by an extension officer changed with the season. A wide range of knowledge coupled with a capacity to go back to first principles was essential. Experience in general and experience of the issues in ‘your’ district was important. For this reason the department in the 1960s, 1970s, and 1980s, moved away from single
officers in towns. Fewer larger offices were established. Not only was there a mix of experienced and less experienced officers at the larger offices but they were equipped with libraries, post-mortem rooms and later, machinery for managing their experimental programs. Interaction at larger offices with experienced staff was invaluable to a young officer. The re-establishment of single officer locations at a number of centres following the 1994 review reverted to a system found to be unsatisfactory earlier.

Geraldton district adviser Peter Nelson (second from right) discusses a lupin problem with farmers at a farm field day.

As farmers became more aware of the value of professional advice, and the need for this advice to be considered against the background of their personal and financial capacity, the private consultant sector grew. This was followed when a third arm of professional advice became available to farmers through private company advisers. This happened as the products sold by commercial firms became more complex and they saw the advantage of having professional staff to explain and sell their products and services to the rural community.

These developments, which began in the 1960s, caused a progressive change in the role of the departmental extension officer. Initially the public and private extension services operated comfortably side by side with the private advisers concentrating mainly on financial management and the government services on the technical issues. In the cropping areas the 1970s saw major technical changes in cropping which provided new challenges for the farming community and a need for extensive soundly-based professional advice on technical issues. By the 1990s the ‘new agriculture’ had been substantially settled, computers were appearing on farms, the internet was being used and changes were inevitable.

In the major downturn in the wheat and sheep areas of the late 1960s and early 1970s when wool prices collapsed and wheat quotas were introduced, the department’s advisers were instructed to provide both group and individual financial advice to farmers, if requested. A short training course in financial management prepared them for this work. During the 1969 to 1972 economic downturn Australian governments introduced the first Rural Reconstruction Scheme. In the scheme’s early years the department’s rural economists provided assessment advice to the State Rural Reconstruction Board and extension officers were involved in the process to varying degrees.

As the financial crises passed and the board became more independent, the department operated at arm’s length from the rural adjustment process. This allowed the advisers to revert largely to technical advice. The introduction of minimum tillage to cropping was very challenging, requiring both detailed advice to some farmers and the development or assisting with the development of new information over the 1970s and 1980s.

In 1986/87, faced with continuing economic pressure on the farming industries the department again became involved in the provision of individual and group financial advice. This was initially successful and provided a new opening for the officers to maintain their contact with farmers. However, there were always going to be questions asked about the government providing services which could be provided
by private consultants. Even if the private industry was not concerned, the Treasury would have asked questions. The final outcome was that the administration decided in the mid-1990s that it was inappropriate for departmental extension officers to deal with farmers on a one-to-one basis.

‘Development officers’
This was later reflected in the change of advisers' titles to 'development officers'. It appears that this policy was based both on the same logic that resulted in charges being made for all services by the department which were for the benefit of the individual farmer and contained no public benefit. There appears to have been no recognition of the importance of raising the efficiency of 'second tier' farmers who did not have private advisers, or the importance of transfer of knowledge, particularly of current issues from farmers to field staff. It effectively ignored the value of such services in maintaining contact with the farming community and advertising the department's problem-solving role.

There also appear to have been significant unintended outcomes on the regional centres of the move to program planning and funding. For a time this process included the Funder, Purchaser, Provider approach. The 1977 reforms had aimed at making the regional centres separate branches of the department, with the officer-in-charge determining the response and focus of the office on the rural industries in the district. This was reinforced by transferring control of the research stations to the appropriate district offices. The new arrangements with statewide or regionally-based programs meant that staff at a district office were primarily responsible to their program leader. That person might be in head office or another regional centre. The officer-in-charge of a regional centre therefore had a much reduced influence over the activities of the officers there, except where those people were part of a program which he managed.

A research station manager was in a similar position. For instance, at Mt Barker Research Station in 2008, the manager's 'senior officer' for the animal program was different to his 'senior officer' for the cropping program, and neither was the OIC of Albany. The changes appeared to have effectively returned the district OIC to the position that existed before 1977, but the interactions were potentially more complex.

In effect it seemed that staff were located in the regions but were not necessarily primarily committed to addressing regional problems. It also seemed that servicing of the needs of the immediate district had become a secondary consideration of the regional centre. This, together with the policy of not attending to individual farmers' issues, appeared to have uncoupled the past close relationship between farmers and the department and was reflected in serious criticism from some farmers and farmer groups.

The Natural Resource Management (NRM) Program, which developed to operate substantially on a catchment basis, did not appear to suffer from this separation but seemed to operate partly outside the general work of the department. However, the introduction of minimum tillage cropping and the dominance of cropping as a farming activity in the medium and low rainfall districts, removed many of the problems which drove the focus on natural resource management in the early 1980s. Some of the remaining problems are not as directly related to farming practices which can be changed or modified. There is some evidence that the drier seasons over the past 20 years have reduced the potential impact of secondary salinisation which has been another key natural resource issue. This probably means that the significance of the NRM movement as a separate function to general farm research and advice may need to be reviewed.

After the 1977 review, advisers were required to deal with the whole farm and its issues. There may be scope to return to this approach.
**Farm experimental work**

One of the strengths of the department's extension services in the 1960s, 1970s and 1980s was farm experimental work. All offices were progressively equipped to carry out this work efficiently. By 2008 there was a substantial drop-off of this activity, probably related to the focus on program management. At the same time a number of farmer groups employ researchers to carry out on-farm research. This work is often funded by the research corporations and therefore competes directly with the department for funds. This development further reduces the contact of departmental officers with the farming community and probably reflects dissatisfaction with the current focus of the department in this area.

The issue which had always existed in providing advice to farmers was timing. Like all individuals, farmers will listen to and consider advice given to them most effectively at the time they need it. This made general group extension such as spring field days less effective. It should also make one-to-one advice as given by the private consultant, who is also aware of the farmer's personal and financial situation, the most effective method of providing advice. But in the case of the private consultant a high level of technical competence in addition to financial expertise was required if they were to be effective advisers.

From the department's point of view the advent of the internet gave farmers immediate access to technical information from departmental or other websites.

**Extension service beginnings**

In the early years the shortage of field staff and the difficulties of travel and communication meant the department depended largely on printed material to communicate with farmers. The Bureau of Agriculture was aware of this situation from the time it was created and published the first issue of the *Journal of Agriculture* in April 1894. In this publication it set out its immediate objectives, noting that it would take some time to become fully operational. In the first six months of the bureau's existence over 16,000 copies were distributed. It was available free to members of agriculturally-related associations. Non-members were charged an annual subscription of 2 shillings (20c). The Journal continued to be a valuable communication tool and in 1896, 51,450 copies were distributed. Much later the Under Secretary reported that there continued to be a big demand for it. It is surprising therefore that the new Under Secretary decided in 1909 to terminate its publication. It was not published again until Sutton revived it in 1924.

As recorded elsewhere, the department had a small staff in those early years and there was a focus on the infrastructure and financial issues involved in farming. Also it was not until mid-1921 that a professional officer was appointed as Director (Under Secretary). Presumably in those intervening years farmers depended on interpersonal communication, and the department must have placed a lot of reliance on providing advice through field days and other group activities and publication in newspapers and magazines.

From the beginning to 1920 the department's only field staff were stock, fruit and other plant inspectors, rabbit inspectors and managers of the experiment farms with one or two 'experimentalists' or plant breeders. In 1905 there were eight professional/administration staff plus some 18 inspectors and two farm managers. In 1909 there were three state farm managers and two stock inspectors outside Perth and 16 plant and produce inspectors, most in the country. At this time rabbits were not supposed to be west of the barrier fences.

In the 1909/10 financial year the department took on the responsibility for providing water supplies and road clearing in advance of settlement and as an aid to settlement in the new 'outlying' areas. It also provided some initial capital to civil servants who were retrenched and as compensation had the opportunity to take up blocks in the Tammin area.
In 1911 a new branch with eight traction engines was established to pull trees as part of the development process. These activities, along with those of the rabbit and other inspectors, provided some opportunity for information transfer.

In 1916 under the headings of the Development of the South West, Potato Industries and the Wheatbelt there were two inspectors. There were also 10 inspectors working on diseases and 18 concerned with pests of the fruit industry. In addition, there were two stock inspectors, a rabbit inspector and the Chief Rabbit Inspector.

By 1920 there was an assistant field officer at Narrogin, two stock inspectors, 23 fruit inspectors and two inspectors of rabbits in addition to the Chief Inspector. The Merredin State Farm manager and a sheep and wool inspector (probably an instructor) were employed under heading of 'The Development of the Wheatbelt'.

These officers were in the farming areas and would have had an information transfer role. This would have also applied to the professional officers who were based in head office.

In this early period the field stations or state farms were important sources of information for farmers. Hamel was the first such field station and was established in 1898. It was a small area of 114 acres on the Drakes Brook near Waroona, for growing wheat varieties and crossbreds and testing various fodder plants.

The 1903 Journals report that the Chapman Field Station and Narrogin Experiment Farm had been established and were being developed. The 1905/06 report states that ‘the farm (Chapman) was now useful to test various crops and pastures and to provide practical instruction in farming for intending settlers in quest of training’. The Narrogin farm was established to demonstrate the advantages of improved cultivation, to raise stud stock for the benefit of farmers, and to provide training for farmers’ sons and others wishing to settle on the land. Early in the 1906/07 financial year the Nangeenan (Merredin) State Farm was transferred from the Lands Department to the Department of Agriculture. It was also used for testing crops and demonstration of farming methods.

**Extension – early development**

GL Sutton was appointed Commissioner for the Wheatbelt in 1911 and soon after made the following comments: “Most areas are in a pioneer stage of development, most settlers have had no farming experience but are anxious to learn and a vigorous information service is needed”. There is little evidence that this was either funded or staffed before the 1920s. Any plans would have been disrupted by the outbreak of war in August 1914 and the loss of staff to the army.

In 1919 Sutton suggested that consideration be given to settlement east of Merredin, which was then regarded as the eastern margin of the wheatbelt. He went further and said that in his opinion if such settlement was undertaken the department would need a cadre of graduate agricultural advisers to advise the settlers. No action was taken until Sutton became Under Secretary in mid-1921. He immediately took steps to recruit available graduates and locate them in close contact with the industry.

In his first report in 1922 he noted that two agricultural advisers with the necessary training had been appointed, one to the ‘southern’ areas. His duties were to cooperate with the Agricultural Bank inspectors and to advise farmers in order to reduce defects and improve farming methods. While a position was available for an adviser in the north, Sutton had been unable to obtain a suitable graduate. The policy of having the field advisers cooperating with the bank inspectors is interesting. It had been discussed with the hierarchy of the bank and subject of a conference in early 1922. It was presumably based on the view that the bank was likely to be dealing with people of limited resources and/or new to farming and were in most need of advice.
In 1923 another two graduates and a diploma holder were recruited. At the same time an agricultural adviser had been appointed to the Geraldton district for five months to “stimulate interest in dairying”. This proved so successful that it had been decided to place three graduates and a college diplomate, who had been recruited at that time, in the country. One was located in Wagin, one in Bridgetown, one in Bunbury and one in Geraldton. This was the beginning of the department’s regional extension services staffed by well trained officers.

At the same time Sutton took further steps in developing the extension services. He was perhaps the first to use the word ‘extension’ to describe the conveying of knowledge to farmers through demonstration or the written or spoken word.

An early action was to re-establish the Journal of Agriculture after a break of 15 years. The first issue of the new series was available in April 1924. In addition 13 Bulletins were issued. The second step was to accept an invitation from Westralian Farmers Limited in 1924 for officers to give talks to the radio audience from their new radio station (6WF at the time, but 720 ABC today) in Perth.

In the light of later developments it is worth noting that in 1921/22 there were 14 trials of wheat or oats varieties, nine fertiliser trials, four depth of ploughing and four drainage trials carried out on farmers’ properties.

In the 1920s a series of crop competitions was started through the wheatbelt to demonstrate cropping potential through the efforts of leading farmers. The Royal Agricultural Society initiated the first cropping and fallowing competitions, starting in 1921 with the entry being a paddock or limited area of the farmer’s crop. There was also a competition for the best wheat yield across a grower’s whole crop. This competition started in 1924 and ended in 1926. The minimum size crop was 150 acres.

In 1928 the District Challenge Wheat Yield competition was inaugurated. Teams of five farmers from a district competed against groups from other districts.

In 1929 another major competition was inaugurated. This was for a sum of £150 ($300) provided by a successful farmer. The farmer’s mean yield of his best five crops over a period of 10 years was calculated. This yield was further modified by calculation of bushels per inch of rain.

These competitions were judged by departmental officers. While time consuming it gave the officers contact with good farmers who would have been interested in new information and also a source of advice on their methods and experience. These young officers also spent a lot of time visiting and advising farmers, either on their own or with agricultural bank officers. By this stage motor transport was available and communication was greatly improved.

In those early days much of the information prepared by expert staff was also published in the local newspapers.

In the higher rainfall areas the main activities of the department centred around the developing Group Settlement Scheme in the 1920s. It was heavily involved in planning the clearing and pasture development of these settlements. However, there were many problems for the new farmers and from a departmental viewpoint young advisers were exposed to the difficult situation of many group settlers. These ‘groupies’ had little experience in farming and probably none of dairy farming.

The scheme resulted in the clearing and development of a great deal of forest country with new soils which took time to become productive and had special nutritional problems. These soils demanded a high level of scientific work by research workers before they became fully productive. This work was largely done in the years during and after World War II. While the development of the groups finished in the early 1930s, the problems continued.
Sutton outlined his view of the importance of the extension services. His retirement was approaching in 1937 when he wrote:

The practical value of the work of the department is largely determined by the effectiveness of the extension services in disseminating information and advice in the farming areas. An endeavour has been made to keep farmers informed with respect to the most effective methods of managing their holdings … and also to keep them in touch with the latest advances in agricultural techniques. The general work is in the hands of a group of field officers located at key positions throughout the agricultural areas, and this is supplemented by specialist advice from head office. The country personnel includes 14 agricultural advisers, seven veterinary officers and 32 officers engaged in herd recording, orchard inspection, stock inspection and other work affording an opportunity for the dissemination of advice by means of personal contact. This is further supplemented by Field Days, attendance at agricultural shows and by field demonstrations. The heavy demand for their services … is testimony to the high value placed on them by the farming community.

Sutton went on to say that in order to make technical advice and assistance available to the district managers and inspectors of the Agricultural Bank, the headquarters of agricultural advisers were still located with them or in as close as possible.

In 1937, agricultural advisers, instructors or inspectors were stationed at Geraldton, Carnarvon, Northam, Katanning, Bunbury, Harvey, Roelands, Manjimup, Albany, Narrogin, Bridgetown, Denmark, Gosnells, Mundaring, Northcliffe and Vasse, while veterinarians were at Beverley, Bunbury and Derby.

The numbers reflect a commitment to country services. In 1940 the total staff recorded in the Public Service List was 146, of whom 60 were professionals, 52 were general division officers (largely inspectors) and 34 were from the clerical division. Thirty-five per cent of the professional staff were in rural areas.

World War II and the period of recovery after the war had a major impact on the department's staffing and services, including its developing extension service. This is detailed in Chapter 3.

The outbreak of war with Germany in 1939 caused an almost immediate loss of experienced and senior staff. The war with Japan, starting in December 1941, resulted in a loss of supplies of fertiliser, rubber and significant amounts of oil. The diversion of the manufacturing industry to the war effort meant that farm equipment supplies virtually disappeared.

To achieve an informed approach to the control and distribution of scarce equipment and materials District War Agricultural Committees were established throughout Australia to deal at the local level with these problems. Their task was to plan and solve the problems at a local level. They were all chaired by departmental officers and included the local manpower officer, a paid executive and four others, at least two of whom were farmers.

Thirteen of these committees were formed throughout WA. They proved very valuable but absorbed a lot of field staff time.

After the war another wave of land settlement took place. During 1946/47 the Under Secretary commented that the department was less than holding its own in providing extension services desperately needed by new settlers and an agricultural industry which was slowly starting to develop again after two decades of stagnation.

Whereas there had been 14 graduate advisers in the field in 1937, there were only the four country advisory offices and the three officers mentioned in 1947. They were Gerry Throssell, who had served with the AIF and was posted to Geraldton when he rejoined the department; Jim Marshall (who would later lecture at Muresk and Fremantle Technical College) was at Beverley; and Eric
Watson (who later joined CSIRO and managed 'Glen Lossie' Research Station at Kojonup) had offices at both Kellerberrin and Merredin. The reduction in comparison with 1937 reflects the impact of the war. Of these officers, only Gerry Throssell remained in the department by 1950.

Post-war developments
The increase in staff following World War II resulted in 97 professional officers in June 1950 and 114 by June 1952. Although there was some lag in appointment to the country pending young officers getting basic experience, the numbers in the field rose quite rapidly. Office accommodation was often unsatisfactory and this was progressively upgraded. By 1958 there were 115 officers engaged full time in extension activities and a further 98 engaged partly in extension and partly in administration or research. In the wheat and sheep areas there were seven district offices—at Geraldton, Northam, Narrogin, Katanning, Moora, Mt Barker and Esperance, with another planned for Merredin in 1959. New offices had been built in Moora and Katanning and a new one was planned for Esperance.

Examples of the work undertaken in the 1960s are given below.

Extension work in the 1960s
In the fruit industry there was continued demand for advice on the use of new hormone sprays, pest control, disease and packing and storage. In 1960/61 the main issues related to the heavy apple fruit set and advice on how to carry out chemical thinning. Also, new information was available on control of bitter pit in Granny Smith apples in storage, which needed to be conveyed to growers. New quarantine requirements by countries importing fruit from Australia required special attention in the packing shed, checking for the presence of San Jose scale and woolly aphis. There was a very heavy stone fruit crop and a need to promote and advise on thinning. In the packing sheds it was the year the wooden box was to be replaced by the cardboard carton and there was a need to instruct the industry on its use. Other important annual issues included soil fumigation of apple trees; control of citrus disease; packing of stone fruit and oranges for export; hormone sprays for setting Early Madeleine grapes.

In 1961/62 the apple crop was light, harvest was short and not enough fruit was available to meet export requirements. New owners, methods and general issues such as disease and pest control were the main areas requiring advice. These two years reflected the work in the fruit industry over the decade. In the vegetable industry the 1960/61 focus was on the certification of areas for potato seed production. In this year there was a greater demand for certified seed than could be met. It involved inspection of the areas planted for seed production to ensure there were no aphids present capable of transmitting virus. Advice was given on a range of other issues including to processors on selecting areas for growing peas for snap freezing, to growers on producing the crop and to others on growing green sprouting broccoli. In 1961/62 the same issues were the focus of advice. Advice was given to the Onion Board on cool storage of onions. The department also conducted schools on a range of horticultural issues.
Sheep field day on a farmer’s property.

The cropping and livestock industries of the medium and lower rainfall areas were serviced by offices at Geraldton, Moora, Northam, Merredin, Narrogin, Katanning, Albany and Esperance. The area covered included 12,000 holdings and 22 million cleared acres. Officers were advising farmers on all aspects of crop production and pasture and stock management. They were involved in conducting 329 field trials and judging 43 crop, pasture and fodder conservation competitions in 1961/62. Visits to the offices, to farmers’ properties, ABC talks, film evenings, field days, field walks on farmers’ properties, telephone discussions in and out of hours were all part of the contact with farmers. Officers were also involved in stock inspection, animal health issues and vermin and noxious weed control. This was the pattern for the decade.

The work of the general advisers in the high rainfall areas broadly mirrored that in the wheatbelt in relation to all aspects of pasture production and stock management. They also dealt with issues in servicing the dairy industry such as solids-not-fat, antibiotic residues in milk, management of milk or cream production, storage and collection from farms. During the decade a new type of field day was organised combining the farm and factory with a focus on milking machine performance, sanitation, antibiotics, marker dyes, factory quality tests, calf rearing, etc.

The pig industry was in part associated with the dairy industry, in part with cereal production, and a developing intensive housing industry. Numbers fluctuated, being particularly affected by the price of grains. When wheat prices were high pig numbers in the wheatbelt were low and vice versa. During 1960/61 numbers increased dramatically by 45,000. Visits to farms, attendance at field days and sales were all part of the pig specialist’s work.

Veterinarians were located at the larger offices and attended to animal health problems on farmers’ properties. There was more demand from the larger animal-based industry but they advised sheep owners on general issues and attended to any unusual deaths. Like other specialists they attended field days, visited farmers’ properties, and gave talks and demonstrations as required.

Euthanising a stranded whale. Department veterinarian Brian Gabbedy checking for a heart beat. District veterinarians were often called on to undertake unusual community services.

Until the 1977 reorganisation, soil conservation specialists were at most larger offices. Their role was advising on, demonstrating and implementing soil conservation works. They also gave advice and carried out demonstrations on saltland.
management. For example, in 1961/62, 180 farm visits were made from one office giving advice, planning and supervising construction of soil conservation works. In the early 1960s these specialists were called on to undertake a special and long-term role of stabilising a major eroding and degraded part of the Ord River catchment.

Officers of the North West Branch were located through the pastoral areas. They provided advice to horticulturalists in the Gascoyne and to the pastoral community. Pastoral work was particularly challenging as it involved stocking rate management. This advice in turn was based on catchment surveys being carried out progressively by specialists in the field. Where it involved reducing stocking rates it was quite threatening to the enterprise and usually not well accepted. This work continued and over a period of 10 to 15 years brought about a progressive change in the attitude of pastoralists.

Separate from the field staff, most head office staff had a partial advisory role. Specialists such as the plant pathologists, entomologists and weed control experts dealt with problems referred by the field staff but also had a large demand on their services from farmers and householders who came direct to head office. They also attended field days at research stations or in areas with special problems. The plant pathologists gave advice on all aspects of plant disease control, management and avoidance. In particular they dealt with issues related to new types of fungicides, antibiotics, nematicides and plant protectants.

The entomologists gave similar advice related to a wide range of insects. In particular they were involved with advice on new insecticides. An example of the potential demand for this sort of advice was the appearance of new organo-phosphate insecticides, dimethoate, fenthion and trichlorfon, which all became available in 1960/61.

The Weeds and Seeds Branch officers were also involved in advice on weed control, seed production, strain identification and certification and the use of new chemicals. They dealt with material presented at head office but also spent considerable time in the field.

The staff of the Western Australian Herbarium provided a plant identification service, particularly poison plants. They also gave advice on tree planting and to apiarists on location of potential sources of honey.

Officers of the Plant Research Division and the Soils Division spent a significant part of their time in the field inspecting or sampling experiments, discussions with field staff and providing specialist advice to farmers and farmer groups at field days and meetings.

Part of the funding of the extension services came from two special Commonwealth grants, the Commonwealth Extension Services Grant and the Dairy Industry Efficiency Grant. These made a valuable contribution to developing and equipping district offices.

In 1960/61 the *Journal of Agriculture* was published monthly and the circulation reached 17 600 of which 16 000 were sent free to farmers.

A new style of publication was the *Agricultural Memo*, initiated by Jim Doyle, the officer-in-charge of the Esperance District Office, in July 1964 and mailed direct to all farmers in the region. Its aim was to overcome the difficulty of contacting and making farm visits to new land farmers who were spread across a rapidly developing region extending some 180 miles (300 km) between Ravensthorpe in the west and Boyatup in the east, and up to 75 miles (120 km) north of the coastline to beyond Salmon Gums.
Regionalisation of the department

As the department expanded there was a progressive improvement in the facilities in the country. Dedicated office buildings were available at all centres, or good quality office space was leased. Specialists were located at Geraldton, Albany and Bunbury. These major offices had their own equipment for field trials on farmers’ properties.

In 1977 as part of the reorganisation of the department a decision was taken to establish the major offices at Albany, Bunbury, Busselton, Derby, Esperance, Geraldton, Katanning, Kununurra, Manjimup, Moora, Northam and Narrogin as independent branches responsible to a new Assistant Director of a Regional Services Division. In addition all staff at the district office were made responsible to the officer-in-charge. These officers retained their divisional affiliations but were seconded to the district office. The small offices of Broome, Three Springs, Merredin, Lake Grace, Jerramungup, and Bridgetown were attached as part of the nearest larger office.

In 1980 the regionalisation process was expanded by the appointment of research officers at Esperance and Merredin, development of the Animal Breeding and Research Institute at Katanning, and the launch of the Farm Machinery Unit at Merredin to provide research and extension support in farm mechanisation, primarily to the heavily mechanised grain industry. In 1983 this process was extended through the transfer of responsibility for most research stations from the Division of Plant Production to appropriate district or regional offices.

In 1983 the status of Merredin changed to an independent branch when the Dryland Research Institute was opened and became part of the office.

In 1984 the new Director of Agriculture saw a need for a change of direction in the country offices. He felt that they were likely to become less involved in providing ‘recipe’ advice but would take on an important analytical role in studying farming systems, identifying problems and selecting target areas for technical improvement.

In February 1980 a Metropolitan farm advisory office was set up at South Perth. It had been found that many farmers contacted head office seeking advice related to farming districts while the enquirer was an absentee owner or a farmer visiting the city. Since there was an increase in this type of enquiry it was decided that advisory staff would be located in head office. Most professional staff at head office were specialists without the whole-farm understanding necessary for effective advice. Very particular advice was still referred to specialists but it was intended that most enquiries would be handled by competent general advisers. As a result, the Kelmscott District Office was closed and its functions taken over by the new Metropolitan and Midland District Offices.

Strategically placed trees are important in reducing salt encroachment on arable land.

As further development of the regionalisation concept, a major new combined research and extension facility was opened in Bunbury in 1985. Kununurra had had these facilities for some years. Over the next decade similar facilities were built in Esperance, Northam and Albany. Specialist research staff were located at all these centres. They were now fully equipped regional research facilities. Interestingly, the Geraldton office, despite its lack of a major new facility, was very active in the development of management systems for the ‘new agriculture’.
Following a further review of the department presented in 1987, the rural areas of the State were divided into six regions: Kimberley, Southern Pastoral, Northern Agricultural, Central Agricultural, South West, and South Coastal. A senior officer was appointed to take charge of each region and the district offices became responsible to that officer. With these changes the regional structure of the rural services of the department was complete.

Cooperative extension activities and on-farm research in association with other divisions of the department or with commercial organisations were a significant role of the extension officers. In this way solutions to local problems were resolved or issues of special interest extended to the farming community and possibly to business interests in the district. While initially the program for each individual office was planned in Perth and handed to the district office as a \textit{fait accompli}, in later years the OIC and/or specialist officers on his staff took part in the planning process.

Services such as herd recording, milking machine testing or soil and tissue analysis were organised through the district office. For example, where a soil testing arrangement for vegetable growers was developed by a research officer, the district officer used his contacts and skills to inform the farmers of the proposal, its implementation and the potential outcomes. As a result, there was general support for the program and progressively wider acceptance and extensive use of the results by growers.

The expansion of the on-farm experimental program was such that by the 1990s around 1000 on-farm experiments were carried out annually by district officers in association with head office specialists. These experiments were estimated to take about 30 per cent of the time of the district office. The district officers were also involved in organising regulatory services where these were needed. At one district office an export vegetable industry had grown which required an inspection service to maintain quality control and to ensure that the product met the specification of the importer.

By 1990 the country staff had increased and there were 64 graduates in the wheat and sheep areas supported by 43 technicians. In the high rainfall areas there were 17 graduates supported by nine technicians at six offices. The effect of the policy commenced in the early 1980s to have research officers and equipment in the rural areas had a major impact on the work of the department.

The focus on regionalisation was demonstrated by a 1991/92 report which referred to 40 per cent of the department’s staff being in the regional advisory and research support program.

\textbf{Regional research}

There had always been a role for extension workers in on-farm experimental work. However, the staff were not initially equipped to carry out this work efficiently. In 1957 a mobile planting unit which consisted of a 12-row disc drill on loan from the Massey Ferguson Company and a four-wheel-drive Land Rover plus a two-wheeled trailer arrived at the Geraldton office in time to plant the experimental program. This unit was supplied by the companies in response to pressure from the Mendel-Wongoondy Pasture Improvement Group. The Land Rover transported the unit and acted as a tractor for the drill.

The success of the Geraldton program encouraged the supply of mobile planting units to other regions, resulting in more active engagement by advisers in the research process throughout the cereal and sheep areas. The units became universal across the department's offices and led to a substantial increase in on-farm research. It meant that farmers did not have to provide machinery and help with planting at a time critical to them. Many more trials could be planted at the right time and more accurately in areas with conditions different from those encountered on research stations. The enlarged program reflected the need to
investigate problems across different soils and rainfall conditions. This need across the State was further reflected in the large statewide program outlined above. In Geraldton the district office established a field unit which largely replaced the work done on and from Chapman Research Station, which closed in 1994.

On-farm experimentation brought special benefits for extension workers:

- Locally relevant information for extension to farmers and visual demonstrations for farm groups at meetings and field days.
- Research officers from Perth were able to expand their research station programs to do more on-farm research in collaboration with advisers.
- Advisers improved their technical expertise through closer association with subject specialists and in turn, research officers were better informed on farm problems and were helped by district office staff who planted and harvested the trials.
- Over time the original drilling equipment was replaced with better equipment and machines for small plot work.

There was a progressive increase the regional offices' role in regional research, with increased numbers of research staff based at the district offices in large well equipped offices. By the early 1980s the effect of the policy to have research officers and equipment in the rural areas was having a significant impact on the quality of the work. Some academics, commentators and politicians believe central organisations such as universities and CSIRO can do all the research necessary for agriculture. This view is flawed because of the differences in the environment and soil types across an area as big as Western Australia.

Examples of the type of programs managed by district offices in the 1980s and early 1990s follow.

In the Albany region a survey found an apparent high level of footrot undetected on a large number of properties which resulted in a test which allowed investigators to separate the benign footrot strain from the virulent strain. This test was accepted nationally.

Jerramungup office identified a need for different techniques for sowing crops on deep sandy soils compared with soils with a shallower sand cover. They also demonstrated that the new Polymorpha medicos were well adapted to the hardsetting grey clays of the district. Minimum tillage planting was particularly important because of the risk of wind erosion.

The Bunbury Centre was involved in:

- cattle grazing trials, breeding and production studies, cattle and sheep parasite studies and the examination of the methods of growing and handling conserved forage for grazing animals
- an alternative farming system involving sheep, ongoing crop variety trials and dryland and irrigated pasture studies, horticultural trials featuring a range of alternative fruit crops and viticultural studies in the Margaret River area
- ongoing research with pathogen-tested potato planting material
- a trial to evaluate melon varieties from all over the world.

The specific research programs covered a range of enterprises. Studies were undertaken in the grape industry which included the physiology of vine dormancy, chemical control of vine growth and importance of the time of pruning. In pasture research new clovers were compared with Trikkala subterranean clover as winter pasture legumes. Staff was also involved in studies of the biological control of dock and doublegee, and saltbush selection trials. The Harvey office concentrated on improved methods of grading paddocks for irrigation, management of recently graded paddocks and selection of new and improved pasture species for use under irrigation.

At the Esperance office a whole-farm systems approach was taken in the experimental program; no one topic
considered in isolation. All aspects of the farm business were considered involving stock, crops and land management and the effects of insects and diseases on production. There was also interest in exploring alternative production systems including the growing of wildflowers or perennial pasture such as lucerne on the deep sandy soils. This was coupled with continuous cropping of the better soils, leaving the soils unsuitable for cropping with a permanent cover involving other forms of production.

At Geraldton office during 1985/86 the development of stable farming systems through conservation farming was a major extension objective. The objective was the provision of the technical information to allow farmers to double yields on the extensive sandplain soils of the region by the year 2000. To do this, crop rotations, disease and pest control and water use efficiency of crops as well as issues of soil compaction were investigated.

At the Katanning office the trend was towards an increased proportion of crop on the farm enterprise. The research focused on the evaluation of medic pasture varieties and appropriate Rhizobial bacteria for more acid soils. The work included investigation of the digestibility of medics and other pasture species. Trials were also conducted in pens on ammonia-treated oats compared with other grain rations as a supplement during summer.

The Manjimup office directed its horticultural research towards the expansion of export markets. This was achieved through the introduction of new varieties and crops believed to have export potential. A small trial consignment of a range of vegetables was air-freighted to Singapore and was well received. Agroforestry research was also being conducted jointly with the Department of Conservation and Land Management.

The Bridgetown office was developing a farm water supply database. With 35 000 records of water tests on the whole State, work was undertaken to monitor subsoil water salinity trends. There was also a major concern about the development of stomach worm resistance in sheep to the available chemicals. The staff had developed considerable knowledge of goat husbandry and their help was sought in seminars and field days throughout the State.

At Merredin office, research focused on developing longer-term sustainable rotation systems for all soil types in the region, the use of a new medic, and continued work with field peas on soils unsuitable for lupins. They were also involved with testing serradella on suitable soil types. In the machinery field, studies were directed at reducing seed loss of lupins during harvest and improving the field efficiency of boom sprays. Techniques for stubble retention and managing stubble during seeding, where it had been retained, were also studied.

At Moora, work was focused on cereal varieties and testing herbicides, pasture species and fertilisers. The research station also investigated summer supplementation of weaner Merino sheep and showed that lupins were much better than cereal grain for this. Trials were also conducted on the first lupin varieties bred for resistance to the Phomopsis fungus.

Narrogin staff were involved in catchment hydrology, salinity, land drainage and pasture variety testing. Preparations were made for a major grazing trial to test the value of saltbush. Farmers were helped to plant 300 ha of wavy-leaf saltbush on the Tulibin flats. An area had been planted with trees on a salt-affected site in an endeavour to lower the watertable. It was found that the watertable was more than a metre deeper than on adjacent control areas. This provided an effective method of treatment of land threatened by salt encroachment. Analysis was carried out of the costs and returns for individual enterprises on a number of farms. The results were the subject of discussion within groups of farmers and proved valuable in showing economic trends both to the farmers and to the department's officers.
Staff at the Northam office investigated growers’ concerns about *Rhizoctonia*, which affected the establishment of the first crops of lupins sown on grey sands. A problem with cereal cyst nematode was found to be more widespread than previously thought. Research into the impact of transient waterlogging on nutrition and root rotting was also in progress. A different nematode affecting subterranean clover was also identified. The office was also testing the adaptation of the new medic, *Medicago murex* and *M. polymorpha*, to a range of soil types and refining the techniques to help farmers get the best establishment results. New subterranean clover varieties were also tested on different soil types.

The Kalgoorlie office was heavily involved in the study of the grazing behaviour of goats in the mulga shrublands with strong support from the pastoral industry. Kalgoorlie officers were also investigating techniques to establish vegetation to stabilise overburden heaps. A program aimed at maintaining and improving the resource base of the pastoral industry while gaining maximum productivity was in progress on the Nullarbor Plain.

The Kununurra Regional Office was involved with both the pastoral industry and the irrigation areas. The research program in the pastoral industry was largely located on the Ord River Regeneration Station and the Fox River Station, with some work also in the west Kimberley. The major research projects were studying the suitability of different Asian and locally adapted European cattle breeds, the dynamics of a typical Kimberley cattle herd, the effects of different grazing systems on cattle and on the pasture, and the value of weaning as a management strategy. There was also continued assessment of irrigated leucaena pastures for finishing young pastoral cattle. Indications were that the best results were obtained where Brahman-cross steers were used and the leucaena grazing intensity had been maximised.

Work on the degraded Fitzroy River frontage was successful and a team of departmental officers was working on regenerating the many thousands of hectares of grazing land which had been degenerated through previous poor management. A high salt level in some soils was seen as a problem and various techniques were used to overcome this. In the irrigation areas there was some work at Camballin and on a small horticultural development at Broome. Staff were also involved with implementation on-farm of relevant results of the work being undertaken at the Frank Wise Research Centre.

It seems likely that the move in the early 1990s to partial and then full program planning and funding has not left these district-based programs focused in the same way.

**Key sources of information**

The 1994 report of the department refers to a survey of 150 wool growers which identified influential groups providing interpretation of production and market information to producers. These included private consultants, the department, wool brokers, ram breeders, sheep and wool classers and their peers. There would have been conflicting information provided between some of the sources.

The results highlighted the difficulty that producers had in identifying the most reliable information on issues such as the characteristics of wool having greatest influence on price. The survey showed that the market signals needed to be clear and extension initiatives needed to be broadened to encompass influential providers of information, as well as farmers. As a result a new project was developed to focus on key producers who provided information to others and on improving the information available to other information providers.

**Pastoralist liaison committees**

The department was aware that the transfer of information to pastoralists was difficult due to the problems of communication. Staff were not satisfied that communication was
effective. In 1980, quite independently, two groups of pastoralists met with departmental officers to address this problem. The outcome was the setting up of regional committees of pastoralists and departmental officers which would meet annually to discuss mutual problems. On the basis of this experience liaison committees were set up in the Kimberley, Gascoyne and North West, Murchison, and Goldfields regions. In practice the committees' prime role was to act as a coordinating body between the department and pastoralists. The meetings would review research needs in the area of interest and examine progress of research being conducted. Importantly, they would advise and assist in the dissemination of technical information to other pastoralists.

**Home Garden Inquiry Centre**

A home garden inquiry centre was established in 1977 as a service to the metropolitan community, who were really the department's major funders. Part of the centre's role was to intercept inquiries which otherwise would have been directed to specialist staff, distracting them from their core business. It was an immediate success, with inquiries increasing from about 50 a day to more than 100 in peak seasons. About a quarter of the 15,000 inquiries made during the summer concerned lawns and resulted from the dry summer and the water restrictions. A further quarter concerned flowers and trees and shrubs, including water and insect problems. Another group sought advice on establishing native gardens. As well as providing useful information to city people, the centre raised the profile and prestige of the department among the general community.

**Market Information Service**

This department's information service was expanded in 1977/78 to supply more information covering a wider spectrum of industries to farmers. An innovation was a 24-hour phone-in service introduced early in 1978 to provide farmers with up-to-date information on livestock sales. The reports were recorded on automatic answering machines. Information concerning livestock was also covered in two new weekly reports entitled *Meat Comments* and *Meat Notes* introduced early in 1978 for newspapers and ABC rural radio. In 1979 the information service was extended to include all country sales.

*Grain News*, which was a weekly report on world grain, oilseed prices and trends, was started in 1977 and used by the country radio and rural press. This publication provided information on changes in oil, grain and oilseed prices over the past week and month and the reasons for the changes. A weekly market sheet summarised relevant news received from AAP Reuters, grain news, meat and wool news and relevant prices for commodities.

The department published an annual *Farm Budget Guide*, dating from the early 1970s. It was widely disseminated and accepted as a reliable reference for farmers. A farm finance booklet was also published, outlining the availability of finance to farmers and including practical hints on how to approach lenders.

**The Avondale Project**

As part of the celebrations in 1979 of the 150th anniversary of the foundation of Western Australia and a lasting tribute to the State's agricultural development, an historic exhibit was prepared at the Avondale Research Station. While Avondale remained an important research establishment a display was designed to provide, on one site, aspects of agriculture of the past, present and future.

The Avondale property dated from the early days of the Colony and occupied land formally assigned to Governor Sir James Stirling and Captain Mark Curry before 1836. The original homestead, garden and stables appeared to have been built in the 1880s. The classically constructed stable was restored and returned to its former use. Clydesdale horses were housed there and
occasionally used to demonstrate horse-powered machinery. Harness and similar artefacts are also on display. Avondale houses a collection of machinery dating back to the 19th century; much of it donated by the farming community and restored by a special 150th anniversary fund. The project was opened by the Prince of Wales in September 1979.

Machinery research and extension

In the early 1970s, through the Narrogin District Office, an arrangement between the department and the Kondinin and Districts Farm Improvement Group examined farm machinery and labour efficiency in the cropping industry. The issues examined were:

- efficiency of spraying in relation to size of the boom spray, the need for and timing of replenishment of chemical and water in a spray as it affected the output and efficiency of particular machines
- relative efficiency of air seeders compared to the combine, where variations in field efficiency between machines was overshadowed by variations between farms; particularly the time spent handling seed and fertiliser
- durability of scarifier tyne points, following farmers' complaints about their poor wearing characteristics
- farmers' experience on the reliability of all major brands of seeding machines as collected in a survey
- the reliability of boom sprays
- efficiency of handling seed and fertiliser, which had proved to be a major issue.

Based on the results, highly successful seminars were conducted at Hyden and Geraldton. Some 400 people attended the two-day seminar at Hyden and 170 attended a one-day seminar at Geraldton.

General advisory work in the 1990s

By the June 1992 report the extension services had been operating in the six regions defined for some five years, and operating before that for a further 10 years as independent branches of the Department of Agriculture. The important issues and trends are summarised below.

In the Agricultural Regions:

- Collapse of the wool and wheat prices in late 1990 placed farmers and pastoralists in a precarious financial position.
- The rural downturn affected the farming community’s capacity to implement high cost land conservation measures.
- Awareness of the quality of the product and the market opportunities resulting from improved quality was increased.
- A wheat price rally in 1991/92 improved farmers' position marginally, but it was 1992 before the wool market recovered.
- Industry support for research and development had continued to decline and the activities of several research stations were reviewed to maximise efficiency and maintain effectiveness.
- The number of producers leaving the industry increased, particularly in the lower rainfall wheatbelt. Some remaining farmers needed financial assistance.

- International markets became more demanding in the specifications of product required.

- Agriculture continued to be under community pressure from environmental groups.

- Land Conservation District Committees had increased their activities and farmers were increasingly forming catchment groups to improve their sustainable farming practices.

- In general, to remain competitive, farmers were having to become better skilled technically, with an increased need for specialisation aimed at supplying high value products to meet specific markets.

In the **Southern Pastoral Region**:

- Carnarvon growers using irrigation water were establishing export opportunities for vegetable and fruit crops.

- Cauliflowers, Chinese cabbage, mangoes and grapefruit were all being exported and the potential for more exotic subtropical fruit was being examined.

- Technical issues centred around improved use of irrigation which was based on work which began in 1986. These irrigation recommendations were being extended to crops other than bananas.

- A feral goat eradication program began in mid-1991. This depended on a coordinated approach across station boundaries; 13 Land Conservation Groups and one group of pastoralists had split into a number of cells. This reduced the risk of reinfestation once the goats have been removed. The department was involved in coordinating the campaign.

- In the pastoral areas there was growing concern about the total grazing pressure on the vegetation, with kangaroos and goats providing as much pressure as sheep.

In the **Central Agricultural Region**:

- Twenty-two sub-catchment planning groups were established to undertake farm and catchment planning under the Avon Catchment Plan. Six of the groups was partially funded under an ALCOA landcare project.

- Landcare education had started at school level.

- A comprehensive plan was drawn up to support farmers through the rural downturn. During spring 1991, 2057 farmers were contacted at 118 meetings, representing half of all farmers in the region.

- District advisory committees for extension and research had been strengthened and revamped in each centre.

- Farmers were moving towards more sustainable farming systems, with an increased focus on soil type.

In the **Northern Agricultural Region**:

- The use of groups through farm walks, field days, seminars and technical update meetings had allowed contact with 60 per cent of the farmers in the region.

- Producers had rapidly adopted improved production practices including earlier sowing and high yielding wheat packages. This had highlighted the advantage of integrated extension work with plant breeders, physiologists, agronomists, advisers, economists and farmers involved in the development of the extension program. These programs were based on the developing lupin/wheat rotations.

- Land Conservation Districts and landcare groups were providing a focus for a wide range of research, demonstration and the extension activities with an unprecedented focus on landcare projects and the development of sustainable farming systems.
• Land management extension concentrated on farm planning and low-cost techniques. About 8 per cent of farms were planned through catchment groups.

• There was concern about deterioration of pastures in the West Midlands, which needed more research input.

In the South Coast Agricultural Region:

• Cooperative work by the department and industry developed a production package which could lift productivity by 100 to 200 per cent. The technology to produce yields close to the biological potential had been adopted rapidly by the industry.

• Research, development and technology transfer advisory committees based on district offices or research stations provided assistance in developing programs and priorities. Four of these committees were chaired by farmers. They highlighted the need for further research into the stubble management component of the high yielding crop package.

• The Esperance Downs Research Station was redeveloped to demonstrate sustainable farming systems.

• Water use had become an important issue and the department had re-allocated resources to appointment a plant water use research officer to coordinate a multi-disciplinary research, development and technology team at Esperance.

• Soil sampling and the use of the department’s fertiliser use analysis computer model had saved farmers up to $2 million through adopting the recommendations for reduced fertiliser use.

• The monitoring of fertiliser run-off from catchments had produced benefits through improved efficiency and reduced fertiliser wastage.

In the South-West Agricultural Region:

• Extension focused on milk quality, particularly improved control of mastitis. This resulted in the somatic cell count of the WA milk being the lowest in Australia.

• Reduced pollution of the Peel-Harvey estuary through planting trees and shrubs on the banks of streams, monitoring sources of phosphorus entering streams and the treatment of leaching sands with red mud were significant programs.

• Flood irrigation districts were surveyed for salinity.

• Nutrients leaching into other streams and estuaries were monitored.

• Biological filters as a means of treating dairy effluent were demonstrated.

• Adverse effects of over-watering of flood-irrigated pastures were shown to be important.

• Assistance was given to sand dune stabilisation projects.

• The Wokalup Research Station was redeveloped as an industry-managed commercial dairy. This was supported by industry to the extent that 130 animals were donated to establish a herd. The farmer members were exploring the means of raising another 100 animals and $170 000 in working capital needed for running costs.

• Discussion groups were active south of Bunbury, focusing on the development, production and utilisation of dryland pastures.

• Dairy groups at Waterloo and Harvey showed more interest in irrigated pastures. The department used the Dairy Farm model to demonstrate the impact of a range of management decisions on profitability.

• There was concern about the need to refurbish the delivery system for irrigation water.
• Beef discussion groups were developed in relevant districts. The Beef Farm financial model had been used in discussion groups.

• Horticulture and orchard improvement groups were active at Harvey-Donnybrook, the Perth Hills and north of Perth.

• Quality assurance was actively promoted for all fruit.

• The Peel-Harvey Estuary Catchment Management Plan was implemented with the same issues as above. Similar work was carried out at other estuaries in higher rainfall areas.

In the Kimberley Region:

• Siltation of Lake Argyle has been a major issue since the inception of the project. Nearly a million hectares of degraded pastoral land was resumed for rehabilitation and protection from overgrazing. A review indicated that despite considerable sediment flow continuing into the lake, there was long-term security of water supply for a fully developed Ord irrigation area. In a seriously eroded and degraded area of 35 000 ha, where there were major gully systems, there has been no evidence of new gully development during the past 40 years. The gullies were stabilising and will probably be stable within 100 years.

• A management plan for the Ord River catchment was developed and provided for comment at the end of 1992. Degradation of pastoral lands was a major issue based on historic overgrazing. The department enrolled community and industry support to develop a framework for sustainable land use.

• Ongoing planning and infrastructure development resulted in dramatic improvement of range condition on the Fitzroy River frontage since the 1980s. Infrastructure cost around $15 million and 500 000 ha of river frontage land was either totally destocked or under strategic grazing management.

• A watering program was developed for the important banana industry in the Kununurra area.

• A pilot control of the Heliothus budworm which was 80 per cent resistant to pesticides was being assessed.

• There was increased demand for research-based technical information on horticulture, with a move to diversify into alternative crops.

Staff located at country offices are shown in Table 5.
Table 5 **Staff located at country district offices in mid-2009**

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<th>Location</th>
<th>Veterinary officers</th>
<th>Development officers</th>
<th>Research officers</th>
<th>Technical officers</th>
<th>Biosecurity officers</th>
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Modelling

Modelling is in the education area because it deals largely with decision support systems. While these are probably used more by researchers and farm advisers than by farmers, that will change as the farm population becomes more computer-literate.

The development of decision support systems and modelling began in the department in the mid-1970s and early 1980s. There were two streams of work. One was concerned with the development of decision aids for the operational and day-to-day decisions made on the farm and the other was concerned with simulating the whole-farm enterprise. The first had its roots in the Plant Research and later the Plant Industry Division and the other in the Marketing and Economics Branch.

However there were substantial ‘spin-offs’ from the original economics work which had direct operational application. The more complex of these systems were modified to meet changing demands over the years, or to meet special needs.

Two important outcomes were the development of the NP Decide model by the Plant Industry Group and the development of the Midas model by the Marketing and Economics Group. But many other decision support systems of varying complexity were developed over time.

In the Department’s 1988 annual report the Dairy Branch of the Animal Production Division commented: “In keeping with the general movement to farm models a dairy farm model was developed by the Dairy Branch. This model aims to optimise the use of all dairy farm resources and activities together to give the best financial performance for the individual enterprise. The model shows that profit could be increased on most farms by adjusting the breeding pattern, feeding more concentrates in summer, calving heifers at an earlier age and, in the irrigation areas, increasing the area of early-germinated pastures”.

Feeding was a key issue and intensive research was being carried out. Other key issues were early calving of heifers and maintaining high reproductive performance so that the cows maintained a 12-month calving interval through their productive life. A 1990/91 report refers to the development of a computer program, Dairyfeed to help producers make decisions about grain purchases, which were a high cost item.

At a 1990 conference 10 decision support systems which had been developed to that time were listed.

On the basis of the work in the various parts of the department, an electronic directory Tools to Assist Decision-making was produced by the department on its website in 2007. This was designed to identify for farmers and advisers some 40 tools which had been produced to aid decision-making on various aspects of farming. They were primarily focused on broadscale farming of the medium and lower rainfall areas. The tools listed were:

- **e-Variety Profile** helps growers to choose a variety to suit their circumstances. It was based on yield trials, agronomic characteristics, disease risk and herbicide sensitivity. The model included 53 wheat, 24 barley, 14 oat and 37 canola varieties.

- **e-Variety Guide for Stripe Rust** assists in the selection of the right variety for stripe rust giving two varieties for each agricultural zone, relative yields, costs of varietal change, chemical control, and returns as affected by variations in wheat pricing.

- **Flowering calculator** estimates flowering time for a selection of crops and varieties to ensure optimum flowering for selected varieties.

- **Potential Yield Calculator** estimates soil moisture at start of the season and estimates potential yield for a range of crops as season progresses.

- **Select Your Nitrogen** is a quantitative support system to address soil nitrogen issues and their effects on yield and
quality and dollars in a broad acre cropping system. The major emphasis is on the effects of rotation, tillage, soil type and rainfall on soil nitrogen availability.

- *Imagine* provides a financial analysis of alternative land uses. It can include long rotation crops such as trees and allows spatial configuration within the paddock, for example an alley farming scenario.

- *Step* deals with the cost of making the transition from one farming system to another, based on whole-farm development budgets.


- *Potassium in Agricultural Systems* allows users to assess short and long-term potassium nutrition of agricultural production systems. It provides a great deal of user flexibility as it operates on a weekly time step.

- *Damcat 4* allows the user to design dam and catchments for supplies based on expected monthly demand. It allows for different climate and demand variables.

- *Dam-Volume Calculator* can calculate potential supply reliability based on a given demand and evaporation in a scenario of no rainfall over the period being considered.

- *Rain tank 2* is a simple program to determine optimum roof area and tank size for rain water collection to meet a nominated demand and reliability of supply.

- *AgET* estimates the degree of aquifer recharge under different soil and crop combinations. It does this for the range of agricultural regions and soil profiles and landscapes over defined times.

- *Catcher* uses the AgET data to calculate the water balance for a farm or catchment. It can operate for a whole region, paddock, farm or a small catchment at any time.

- *Flowtube* can predict the area of shallow watertable under different management scenarios for whole farm regions, catchment or hillsides, based on inputs from transect bores and other hydrological information.

- *Leakage Calculator* makes a first pass aimed at raising awareness of leakage from a landscape.

- *Profile Manager* can be used to manage the wool fibre profile through the season.

- *Agroforestry* estimates the profitability of a farm forestry project.

- *Fleece Calculator* is a simpler decision support tool for Merino producers to consider the costs and benefits of in-shed flock selection.

- *Lamb Planner* is a non-electronic wheel planner to assist farmers make informed choices on timing of lambing and management of the breeding flock.

- *Green Feed Budget Calculator* assists farmers to manage their feeding regime during the green pasture period including autumn deferment, supplementary feeding, stocking rates, different pasture species and climatic areas.

- *Pasture Watch and Pastures from Space* provide real time pasture information and a range of tools to make grazing decisions. Pasture growth at the farm scale is provided as a basis for managing stocking rates. The base data on pasture growth is sourced from the internet. It costs $500–750 annually to take part in the system.

- *Anthracnose Calculator* aims to measure spread of infection from infected seed and infected blue lupins along fencelines. It needs special skills and software.

- *APSIM (Agricultural Production Systems Simulator)* measures rangeland which has been affected by a range of variables. It is primarily for researchers.
• **Blackleg Sporacle** was designed to forecast the onset of blackleg ascospore shower from canola stubble as a basis for sowing and fungicide decisions.

• **Blackleg Risk Appraisal Tool** is based on an assessment of risk of ascospore showers from canola stubbles and the growth stage of the canola. It aims to give guidance on fungicide use and possible strategic sowing dates.

• **Blackspot Manager** is based on black spot history in the region. It aims to forecast the spread in the region as affected by climate.

• **Barley Yellow Dwarf Virus Risk Forecast** aims to predict yield loss due to disease spread in cereal crops by forecasting aphid arrival, disease spread and yield loss, mapped on a shire basis, rainfall and temperature for the period.

• **Cucumber Mosaic Virus Risk Forecast** is similar to BYDV but focused on cucumber mosaic virus on lupins.

• **RIM (Resistance and Integrated Management Model)** is a decision tool for investigating and evaluating the biological and economic impacts of weed management options for annual ryegrass control over a long rotation.

• **NP Decide** is dealt with in some detail elsewhere. It is primarily concerned with decisions on nitrogen and phosphorus fertiliser use.

• **Optlime** is based on a wealth of information developed for WA conditions. It assists with soil acidity management including lime quantities and potential crop decisions.

• **Rootmap** simulates the interaction between the plant root and the soil as affected by issues such as nitrogen and moisture levels. Makes a pictorial representation.

• **Splat** aims to help with the selection of cultivar and nitrogen rate within the context of seasonal variation. The model estimates yield, nitrogen and dollar responses for a range of environment and management scenarios.

• **Tact** aims to provide critical information for assessing risk in sowing wheat. The model uses climate analysis and simulations of yield and development as its base data.

• **WA Wheat** enables users to predict yield and quality resulting from seasonal conditions and management of the crop. It also estimates possible leakage of water and nitrate beyond the root zone for particular soil types and locations. It allows planning for the coming season but has little flexibility within the season.

• **Regional Farm Model** allows for analysis of potential whole-farm financial outcomes resulting from developing seasonal conditions. It allows a quick overview of a farm business and the outlook at the end of the season.

• **Climate Calculator** uses historical rainfall data for a location to develop a picture of the climatic risks. It is useful both at the start of a season and through the season.

• **Quarantine Significance Model** simulates, using a base of no government intervention, the potential damage from the introduction of an exotic pest or disease. This sets a base for considering what is reasonable to spend on eradication.

• Pastoral models included, **SCHAF** for the sheep areas and **CATMAN** for the cattle areas. The models could use station records and district averages to examine a wider range of management options than those which might have otherwise been attempted. In addition, the University of WA developed a computer model with the assistance of the department’s rangeland management staff which simulates the pastoral system and can test the economic consequences or opportunities of different management practices.

• Four global models have been used to look at the potential impact of climate
change. Comparisons were made in terms of simulated monthly rainfall and maximum and minimum temperatures for eight selected locations in the grainbelt with estimates of the impact on potential yield. The simulation of future yields showed a decline in most locations but increases in some higher rainfall locations due to the combined effects of increased carbon dioxide and reduced waterlogging.

- **Decide** had two or three iterations. Originally it focused on the use of phosphate and was called *P-DECIDE*. As nitrogen fertiliser became an increasing part of the accepted cropping system, the model was developed further and became *NP Decide*. It was a computer-based program designed to predict wheat yield or pasture growth responses to varying applications of nitrogen and phosphorus fertilisers. It predicted yield and dollar responses for any yield potential and soil nitrogen and phosphorus levels. It contained a facility to include a test result for soil phosphorus and an allowance for the root disease take-all. It could be used for deciding on fertiliser type, rate and time of application and could be applied to individual paddocks, particularly where individual paddock fertiliser histories were available.

- Simulation models were also produced to help research workers understand agronomic systems and the interaction of agronomic practices and the environment with crop growth. By understanding the systems it was possible to transfer the results between sites. The simulation of situations allowed researchers to examine hypothetical issues such as the interaction between phosphorus response and levels of disease in lupins. The outcome could then be incorporated in the *DECIDE* model to improve its accuracy. The simulation approach was also used to test the use of lupins in a cereal-based rotation. Various ways of using the lupins could be tested to give guidance to likely field outcomes through using existing knowledge coupled with considered assumptions in a hypothetical range of situations.

- A major commercial fertiliser manufacturer provided a soil analysis service to farmers for many years. Initially this was based only on a chemical analysis. The department has collaborated with the company to develop a service which utilises *DECIDE* in its assessment of the advice to be given to farmers. As the body of data has accumulated that service has become more valuable to the farming community. In one instance after a serious period of droughts in the eastern and north-eastern agricultural areas the company offered a free soil analysis service to the farmers. In a cooperative effort between the department and the company some 7000 samples were analysed and the data combined with analysis by *DECIDE* resulting in advice being given to a large number of farmers in just 100 days.

- **MIDAS**: The second major development also began in the early 1980s with a group centred on the Marketing and Economics Branch. They undertook the challenging task of developing a whole-farm bio-economic model that became known as *MIDAS* (Model of an Integrated Dryland Agricultural System). This model was initially developed to examine the economic validity of the trend at the time for farmers to crop a very large part of their farms with a large reduction in the area of pasture. This was a major move away from the ley farming system which had been a major part of the farming system for the previous 20 to 25 years and its overall economic validity was questioned. Development was initially a collaborative effort between a small group of influential agricultural economists, scientists and farm advisers. The model facilitated the analysis of various farming system issues.
One of the principal authors of MIDAS commented that for over two decades there was a reasonably sustained commitment to the revision, extension and application of the MIDAS-based farming system analysis. There were now many regional versions of the original MIDAS model and despite the vagaries of funding, staff turnover and change in computer technology, the suite of MIDAS models continued to be applied to topical and strategic research and policy issues facing dryland farming systems in many parts of southern Australia. Associated with the construction and application of a suite of MIDAS models there have been several other related models that complement MIDAS. One such model which considered season and price variability and the farmer’s risk attitudes was called Mudas.

In the late 1990s a group of researchers collaborated in developing a workshop-based farming system management game called Risky Business. This provided an experimental learning game which could be used in a workshop situation to allow the players to experience the annual real life environment of risk and financial exposure faced by most farmers.

A diverse and large set of research outputs was generated by the many participants in the use of the MIDAS models over the 1980s and 1990s. The extent of this work was reflected in a publication list of more than 120 papers in journals or delivered at conferences. In particular the Western Australian group developed a national and international reputation for its modelling skills.

Publications and media services

The Journal of Agriculture

For many years the Journal of Agriculture was the flagship for communication with the farming community and the outside world, providing advice to farmers on one hand and a vehicle for publication of the results of research, surveys or observations to other readers. The articles were reprinted in a Bulletin series and were available singly and mostly free on request.

In the first six months of the Bureau of Agriculture’s existence over 16 000 copies of the Journal of Agriculture were distributed. The initial publication was fortnightly and four pages, increased to eight pages later. It was available free to members of agriculturally-related associations. The Journal continued to be an important source of information for farmers and in 1896, 51 450 copies were distributed.

Much later the Under Secretary reported that there continued to be a big demand for the Journal. It was surprising therefore that the new Under Secretary decided in 1909 to terminate its publication, presumably for economic reasons. It was not published again until the first edition of the new series in 1924. It continued to be published in monthly or quarterly issues until it was finally terminated in 2001.

Over the years the department published many classical articles recording research, advice and other information, and the issues from 1896 onwards remain an invaluable chronicle of the progress of agriculture in Western Australia.

Farmnotes

Farmnotes are brief factsheets on specific issues, usually on a single A4 sheet, which provide up-to-date information in a readable format. Farmnotes were colour-coded and numbered for easy filing and retrieval and were updated as necessary. Most were printed in-house so that new material could reach subscribers within a few days. Farmnotes were introduced in 1974 and were immediately popular. Issues on garden management and other urban matters are also available. They continue to be a popular form of publication with both the farm and urban community although the internet has to some extent taken over their role.
Agricultural Memo

The publication of the district office newsletter Agricultural Memo was the brainchild of Jim Doyle, a young adviser faced with the problem of contacting many new land farmers, absentee landowners and resident managers in the Esperance area. At the time there was no radio station and telephones were either not available or unreliable, leaving mail the only reliable contact. Initially the memo was published as a folded foolscap sheet printed on both sides and produced monthly at the district office. It dealt with issues of immediate importance of which farmers needed to be aware. It required few resources and improved communication with all farmers in the region. Its enthusiastic acceptance confirmed Jim Doyle’s belief that regular contact via the newsletter would help reduce the feeling of isolation in pioneering farm families and would foster favourable attitudes towards the Department of Agriculture, with positive flow-on benefits for extension and research.

The concept of the AgMemo was quickly adopted by other district offices and when Jim Doyle retired from the Department of Agriculture in late 1987 most agricultural districts were producing their own versions. That still held in 2008, 45 years after the first edition, and is testimony to its value and acceptance by farmers and to the commitment of district staff.

Industry and regional newsletters

In all industries the department provided extensive information services, usually organised on a regional basis. Issues being promoted in regional groups in cropping areas were sustainable farming, farming for soil types and the need to adjust the farm enterprise mix in relation to prices. Numerous newsletters targeted at specific regions or industries have been issued by branches and district offices over the years.
Probably the most notable was Dairy Notes, posted regularly to all dairy farmers and containing specific technical information.

**The Direct Mail Service**

Until 1979 the Journal was free to farmers and posted to them automatically. It had been published from 1894 to 1909 and from 1924 to 1991, when electronic media began to take over. In 1960/61 the Journal was published monthly and the circulation reached 17,600, of which 16,000 were sent free to farmers. There was always some doubt about whether it was well enough read by farmers as some articles were clearly too technical for the publication’s intended audience and in 1979 a decision was taken to charge for publications forwarded to farmers. For a fee of $5 per year farmers could receive all Farmnotes in categories of their choice. In 1981 the costs were modified, with the Journal costing $10 per year and Farmnotes $10 per year. The cost of the package was $15 per year.

At 30 June 1981, 540 farmers were receiving the Journal, 322 the Farmnotes only and 3548 were taking both, making a total of 4410. The number had dropped and probably represented around 30 per cent of commercial farmers.

**Specific books**

Starting with the book written by Andrew Despeissis on horticultural and viticultural management in the early days, the department published a wide range of books and comprehensive bulletins on specific topics. Early examples were *Eucalypts of Western Australia* by CA Gardner and *Weeds of Western Australia* by GRW Meadly, both updated and regularly reprinted.

More widely distributed was *Vegetable Growing, a guide for home gardeners*. It was first published during World War II to encourage householders to grow their own vegetables in times of shortage. It became the basic text for vegetable growing and was updated and reprinted many times; it is still available from the department. Poison plants, lupins and insect pests were among other subjects covered in detail.

Some recent books are listed below:

- *Integrated Weed Management in Australian Cropping Systems: a training resource for farm advisers*, was published in February 2007. While initially aimed at the Western Australian situation it has been developed as a national tool.
- A book on perennial pastures for Western Australia was released in June 2007, detailing the current state of knowledge and prospects.
- *The Wheat Book* was produced and sent to growers during 1990/91. This was a crop variety sowing guide and technical manual for wheat producers.
- *Weeds Resistant to Herbicides*.

Although research staff were encouraged to publish their work in national refereed scientific journals there remained some lengthy material and reports of detailed surveys not suitable for this outlet and a Technical Bulletin series was established in 1969 for these.

**Rural press and radio**

Almost from its establishment the Department of Agriculture maintained a productive relationship with the farming press and country newspapers, and especially the ABC Country Hour. The Information Branch issued a weekly package of press releases to the media and ensured that rural reporters had ready access to departmental information and staff. For several decades the ABC Rural Department broadcast a number of radio talks each week by departmental specialists and for a time the department recorded talks and interviews for issue to rural radio stations.

**Film and television**

Early in the 1950s the Dairy Division established a mobile film unit which toured farming districts of the South West to show
films relevant to dairy farmers. The film nights were hosted by district dairy advisers, which gave them added contact with farmers. The film shows also became social occasions for the isolated farmers of developing districts; cartoons and general interest material were included to encourage families to attend. Reacting to a shortage of technical farming material the film unit took the initiative of making their own short extension films on dairying subjects. This led to the production of longer films produced at the request of other branches of the department. The most ambitious was a record of the Ord River catchment regeneration project.

When the first rural television station opened at Bunbury in 1968 its management invited the Department of Agriculture to produce a television program which it titled *Farming Today*, broadcast weekly in two series a year. It was relayed to the Albany and Geraldton channels. While the department's administration supported the concept it proved difficult for the small film unit to maintain an adequate supply of acceptable material with limited resources. Nevertheless it was well received by the farming community and continued for nearly 20 years, after which the increasing sophistication of television production and changing audience interests brought it to an end.

### Some educational initiatives

**Narrogin School of Agriculture**

The Narrogin Experiment Farm was established in 1903. In its early years, along with Chapman State Farm, some experimental/demonstration work was carried out and it was used for young men coming to Western Australia seeking farming experience. They were charged a fee for their training, accommodation was provided and they worked on the farm. The students provided much of the farm labour. There were six students at the beginning of 1905/06 and 14 by June, with more on their way from England. The students paid little more than £2 ($4) a year for the privilege of working on the farm!

At this time 474 acres (190 ha) were under cultivation. By 1907 there were 40 students and the charge for their tuition had increased to £10 a year. At this time new quarters were being built and the Minister decided it should concentrate on farmer training. In his report in 1909 Professor Lowrie criticised this practice, recommending that such training be obtained on a commercial farm. Since experimental work was limited by the variable soil types he recommended that Narrogin be sold. This was not accepted.

In 1913/14 it was changed to an educational facility, named the Narrogin School of Agriculture and became a formal training school for young farmers. New courses were developed under direction of a board consisting of the Director of Education, the Professor of Agriculture and GL Sutton (then Commissioner for the Wheatbelt). The courses provided for a Junior Certificate of Agriculture, a Senior Certificate of Practical Agriculture and a Senior Certificate of Agriculture which could lead to a diploma at the university.

By 1916 the Narrogin School was regarded as being a sound educational establishment. However, by June 1921 the Narrogin School of Agriculture had been transferred to the Department of Education in accordance with government policy that all educational activities should be with that department. It continued to be a valuable facility under the Education Department for the remainder of the century.

**Muresk Agricultural College**

The formal consideration of the establishment of an agricultural college goes back to March 1919 when State Cabinet approved the appointment of a committee to advise on the most appropriate approach to establishing such a college. It appeared the government wanted a college similar to Hawkesbury in NSW or Dookie in Victoria. The committee consisted of the Director of
Education, the Professor of Agriculture from the University of WA, the Commissioner for the Wheatbelt, the Government Analyst and Agricultural Chemist and a farmer, AJ Monger. They were to advise on the location, acquisition of a site, the host department, the scope and operation of the college, relationship with the Narrogin School of Agriculture, and appointment of teaching staff. They were asked to estimate of total cost of establishment and the annual cost of operation. The Commissioner for the Wheatbelt, GL Sutton, who would later be Under Secretary for Agriculture, pressed for the college to be managed by a Board of Governors and closely allied with the University Faculty of Agriculture. The Premier preferred greater use being made of existing facilities in the high schools and the university. A decision was finally taken to establish the college at Spencer’s Brook and the Muresk property of 2220 acres was purchased in 1924. The development of Muresk began as part of the Department of Agriculture. This was a strange decision, presumably based on the fact that similar colleges in other states were part of the departments of agriculture. Although the department wanted the college to have a close relationship with the university this never happened, possibly because of the distance from Perth. Muresk remained in the department until it became part of the WA Institute of Technology (WAIT), now Curtin University, in 1969.

The original cost of establishing the college was £61 000 ($122 000), of which £14 000 was paid for the property. Muresk’s Diploma of Agriculture was initially based on a three-year course in which the time was spent evenly between practical work, hands-on experience and training and study of the underlying theory of farming. The focus was to train future farmers. Unlike similar colleges in Australia about 55 per cent of its graduates returned to farming. The remainder went to agribusiness and the Department of Agriculture.

In 1967 the department decided to reorganise the course to provide the students with additional scientific and business management training and less practical training. The focus remained on training future farmers but the modification was a response to changing needs. It was intended to remain a two-year course. The proposal included raising the educational entry level from year 11 to completion of secondary education. This changed course, which would have required additional expenditure on facilities and staff, was planned to start in 1969.

The first principal was Mr HJ Hughes, who took up his position in November 1925 before the plans for the building were finalised. He was able to focus attention on getting the college to a functional stage. It was opened on 30 October 1926.

In an early statement Hughes outlined his vision for the functions of the college as:

- To train students in the science and practices of farming, in business principles, and in the rural economy.
- To carry out research.
- To raise the standard of agricultural practice by holding short courses for farmers.
- To raise the general standard of stock in the farming districts by breeding and distributing pure bred cattle, sheep, pigs and poultry.

His overall strategy was to give the science courses early and then focus on application of the science to agricultural practice and the business principles of farm management. As part of farm practice he saw a need for the students to be instructed in blacksmithing, engineering and construction.

In June 1927 there were 45 students in residence—26 in first year and 19 in second year. As there was no entry exam the educational standard varied considerably. There were three classes of students:

- 16-year-olds who were to complete the three-year course to achieve a practical
training in farming and an understanding of the underlying science.

- A second group were interested more in the underlying science as a background for employment in business or government in agriculturally-oriented occupations.
- A third group were agricultural science students from UWA undertaking practical work at the college.

Hughes recognised the varied age and qualifications as a problem but chose to deal with it internally rather than limit access for potentially good students.

By 1928 the educational level of students entering the college had risen to a level which would allow them to manage the course. Subsequently, entry to the full-time course required completion of year 10 of secondary education. By 1929 there were 64 students—27 in first year, 21 in second year and 16 in third year. The academic courses were determined by an advisory committee of the principal, two university professors, two prominent farmers and the Under Secretary of Agriculture.

Early in the college’s life a group of merchants from the city decided to set up a fund to help Muresk undertake research. This was known as the Merchant’s Research Fund and was important in adding a research component to the college activities. Initially this was focused on pasture species. Dr TC Dunne was an early Merchants Fund Scholar after he returned from PhD studies in California. His work on subterranean clovers made an important contribution to the use of pastures in WA. In the early 1940s some experimental work was also being carried out in conjunction with the University Institute of Agriculture on the influence of seasonal conditions on wool production.

Muresk continued to develop through the 1930s but student numbers were affected by the onset of the Depression in late 1929. The number stabilised at about 40 students as the financial situation made it difficult for farmers to have their sons at college. There were 41 students enrolled in 1935. The significance of the dairy industry at that time is reflected in the decision in 1938 to establish a course in butter and cheese manufacture and factory operations. Muresk saw the decade out with 36 students.

In September 1938 the original principal, Mr Hughes, retired and was replaced by Mr W Southern.

From a farming point of view there were some difficulties. Initially there were poor yields on much of the area due to the relatively low natural fertility of the soils. There were strips of better soils developed over diorite intrusions which could be seen crossing the paddocks. Early in the life of the college subterranean clover was spread over various fields ‘in the hope of establishing this valuable fodder’. The full range of industries was represented. There was a stud Guernsey dairy herd which performed well at the Royal Show. There were two stud pig herds, Tamworth and Berkshire. There was a small orchard and vineyard. The stud animals were additional to the normal mixed farming activities with grain and sheep.

When World War II began in 1939 enlistments caused a shortage of labour on farms, which affected student numbers as potential students were required on their parents’ farms. Most of the young men finishing the course went straight into the army. In March 1942 the Military required the buildings for defence purposes which effectively closed the college.

The farm operations were continued under the supervision of the Superintendent of Wheat Farming until the college reopened and the staff were absorbed in other occupations or at other locations. In the event, the Military never used the college and at the end of 1944 permission was given for it to reopen. A positive outcome from the army ‘occupation’ of the college was the building of cool rooms, a butcher’s shop, and staff quarters.

When Muresk reopened in 1945, 54 students took up residence. In 1947 Muresk became involved in the Rural Training Scheme and
took in ex-servicemen for training. There were 64 students in 1948. The numbers rose slowly with a mixture of the normal student body with some ex-servicemen. They did well and were regarded as a benefit to the college. Later, most ex-servicemen trained through a short course at Harvey.

In 1954 the entrance level was changed to require completion of year 11 and the course was reduced to two years. These changes together with increased accommodation increased the potential graduates from the mid-20s to 60. The change was achieved by eliminating the first year of the old course, which was largely covered in the high schools.

There were some major improvements and changes during the 1950s and 1960s. These included a new hall, dormitory, sick bay, library, biological sciences laboratory, lecture room, 10 houses, shearing shed, modern dairy, machinery sheds, engineering workshop, grassed oval, improved water supply, SEC electricity, modern kitchens, change to the Large White breed of pig, and inclusion of a polled Shorthorn cattle herd.

Following this change the numbers attending grew slowly and in 1962 filled the available accommodation of 74. However, the increased accommodation of 102 held only 89 students in 1964. In 1967 there was accommodation for 122 but only 78 students were in residence.

This reflected an uncertainty about the future role of the college. The question revolved partly around what training was needed for future farmers. Mixed into this debate was an argument for retaining it as a training institution for the technical officers needed in government, commerce and Industry agencies and companies.

There was eventually a consensus that Muresk should be retained for farmer training but with a changed course which catered for the greater complexity and technology input in post-war farming. Much of this came from the changes in available equipment, fertilisers, modern pesticides, improved knowledge of animal husbandry, breeding and disease and greater awareness of the need to treat farming as a business.

With the retirement of the long-term principal, Mr Southern in 1967, a new principal was appointed and the course was rewritten. The academic subjects were upgraded, there was a large component of farm business management and the time spent on practical farm activities was greatly reduced. The farm was now designed to operate without student labour.

This course was planned to be introduced in 1969, when entrance would require completion of secondary education. However, the Commonwealth Government of the day decided to change agricultural colleges to Colleges of Advanced Education (CAEs). In 1968 the department made a submission to the Commonwealth to have Muresk and its new course accepted as a CAE.

Subsequently the WA Government decided to make Muresk part of the new Western Australian Institute of Technology and this transfer occurred in 1969.

The college then required the upgrading listed above but was broadly equipped to carry out the training proposed by the department. It had accommodation facilities and developed lecturing and science facilities. It retained its coverage of the dairy, pig, and poultry industries. It also had a sheep flock of 5000 sheep, a large beef herd on a well-watered and developed property of a little more than 4000 acres.

When the government decided to transfer Muresk to the WA Institute of Technology, a new course was established. The entry level required was completion of secondary education, the course was of three years' duration and degrees were awarded to graduates. It moved from being primarily involved in farmer training to training professionals who would work in agriculturally-related enterprises or government departments. Some farmers' sons also attended.
The new Muresk has produced young professionals trained to work in agribusiness. While some have returned to the farm the focus has shifted and today there is no educational facility focused specifically on farmer education. It can be argued that an opportunity was lost to produce a college uniquely focused on farmer needs, closely tied to an organisation with the same overall focus at the cutting edge of scientific advances in agriculture.

At the time of writing (2010) it is understood that Curtin University of Technology proposed to close Muresk.

**The State Herbarium**

The first recorded collection of WA plants was made by the Western Australian Museum, which was established before the Bureau of Agriculture. The focus meant that while the collection was properly archived, it was not worked on in any way. As soon as the bureau was established it began a new plant collection. This was driven partly by the need to identify the poison plants of the *Gastrolobium* and *Oxylobium* families and the need to identify plants which might be useful for grazing or would indicate particular soil types but also by scientific curiosity. The Forests Department and the University of Western Australia Botany Department also established collections of flora at about this time.

One of the first professional appointments to the bureau was a botanist, Dr Alexander Morrison. He was a medico with a very strong interest in botany. Appointed in 1897 he made a major contribution to the herbarium collection and the study and identification of poison plants before his appointment was terminated in 1906. The position was not filled again until 1911.

Over the following decade and a half the three collections continued to grow but taxonomic research and a systematic documentation of the WA flora were lacking. Pressure mounted from concerned scientists to establish a State Herbarium.

One of the early stimulants for an amalgamated herbarium came from an unusual source. In 1923 the Seed Merchants Association of Western Australia requested the Department of Agriculture to make routine purity and germination tests on samples of seeds on behalf of members of the association. The Director, George Sutton, advised that he could not agree to this request due to a lack of staff. He proposed an innovative solution. This was to combine the three existing herbaria (Department of Agriculture, Museum and Forests Department) and their staff into one institution. According to Sutton, this would greatly increase efficiency and enable the development of a seed testing facility at no extra cost to the government.

Sutton put his proposal to Conservator of Forests, Stephen Kessell, who agreed, and to the Western Australian Museum, which did not. Sutton and Kessell then put a joint submission to their ministers, who supported it and approached the Public Service Commissioner requesting the amalgamation. However, the museum stood firm and nothing happened.

Around 1920 the Conservator of Forests appointed a young and enthusiastic amateur botanist, with no formal qualifications, Charles Gardner, as a plant collector. Gardner made the first extensive collection in the Kimberley and other collections in the South West. He would become a legend for his contribution to the collection and identification of the State’s flora over succeeding decades. In 1924 he transferred to the Department of Agriculture as Assistant Botanist.

Around 1928 further pressure developed for the establishment of a State Herbarium including the available collections. In 1928 a further joint submission by Sutton and the Conservator of Forests, Stephen Kessell, was agreed by their Ministers and approved by the Premier. The decision was taken to establish the State Herbarium in the Department of Agriculture. This was formally gazetted in January 1929.
The Museum chose to maintain its own collection and it was 1957 before a new Curator obtained approval from the Board of Trustees to transfer the Museum collection to the Western Australian Herbarium. Gardner was appointed as the State’s first Government Botanist in 1929. He held this position until his retirement in 1960. The herbarium has had a number of ‘homes’. The original collection was housed within the department’s first offices in various locations in St Georges Terrace. These were seldom ideal and in 1901 Morrison complained about the conditions. When the State Herbarium was created in 1929, it took up premises in the Observatory building opposite the main gate to King’s Park, sharing accommodation with the State Astronomer. In 1958 it moved to South Perth when the department occupied its new headquarters. The herbarium now had air conditioned space and protection from fire for the first time, but was still far from ideal. In 1970 a completely new, purpose-built building was opened on the site. It was built among a stand of pines. In 1971 the department had the pines cleared and the area planted with a range of native species as a more appropriate surround. The area was planned and planted by the staff and for almost three decades was totally surrounded by native vegetation.

In the mid-1980s, in a submission to a Parliamentary Committee looking at the organisation of a range of agencies in the State, the Director of the Department of Agriculture recommended that these agencies be combined into a single unit and that the herbarium be part of that new organisation. This recommendation was based on the status of the herbarium and the growth and diversity of its collection. Its main function was no longer economic botany, much of which was dealt with in other parts of the department. It had become a high class taxonomic and research facility and a genuine State Herbarium. Subsequently the Department of Conservation and Land Management (CALM) was formed, incorporating the Forests Department, the National Parks Authority and the Wildlife section of the Department of Fisheries. The herbarium was transferred into CALM, thus ending an association of 60 years.

Author’s note

The research stations
Hamel Field Station, established in 1898, was Western Australia’s first research station. It was a small area of 114 acres on the Drakes Brook near Waroona and was used for growing wheat varieties and crossbreds and testing fodder plants. There were 50 varieties and crossbreds of wheat at Hamel in 1898. As the Chapman and Merredin farms developed after 1903 and 1907 the wheat variety trials were transferred to those stations.

One of the ‘fodder plants’ to do well at Hamel was subterranean clover, which was virtually unknown in WA at the time. Most of the grasses tried did not do well. *Paspalum dilatatum* was an exception. Some of the
wheat varieties and crossbreds did well. The manager recommended that the farm produce seed potatoes of a number of varieties for distribution to farmers. This was seen to be important to reduce disease and improve the quality and yield of the crop. This program was undertaken and lasted for many years.

In his 1900 report Lindley-Cowen pressed for a farm to be provided which could be run on commercial lines and provide training for young settlers coming from Europe with no idea of the climate, soils, or farming methods of Western Australia. He believed that WA was the only State which did not have such a facility. He felt there was also an opportunity to use such a station for breeding stud bulls or stallions or even horses or mules for use in the Colony. He stated that there would also be an opportunity for experimental work to be done on such a property.

Over the next 70 years a number of such farms were established. Some were closed after they had achieved their objectives, were replaced by alternative facilities or required for other purposes. They were originally called ‘State Farms’ when their role was largely demonstration of recommended farming methods. As the role changed to a greater focus on experimental work the generic name of ‘Experimental Farms’ was used with those having a special purpose called names such as ‘Stud Farm’ or ‘Light Land Farm’. Finally as the experimental and investigational role became completely dominant they were called ‘research stations’.

The 1982 review of research stations
Following an internal review in 1982 it was recognised that a reorganisation of the research stations was necessary. To do this, funding would be needed and this was marshalled by reaching an agreement with Treasury to dispose of some of the current stations and use the funds raised for acquisition or modification of existing resources. These changes were made progressively over the next two years. Some of the older research stations lacked the capacity to focus on current issues while still providing an administrative base for utilising new sites. An example was the absence from existing research stations of soil types of major significance in the eastern and northern wheatbelt. To address this issue the department established a number of research farm blocks. The new research blocks were situated on land leased from farmers or exchanged under lease arrangements. The new research blocks were at East Chapman, Mullewa, Salmon Gums, South Carrabin and North Badgingarra.

The department also purchased land south-east of Busselton to establish a new research centre, particularly into nutrition of livestock. To finance these changes the department entered into an agreement with Treasury to relinquish control of the Woodlands, Bramley, Northam and Denmark Research Stations. Beef and dairy research became concentrated at the new Vasse Research Station following the transfer of the Northam Research Station to the WA Institute of Technology. The Avondale Research Station at Beverley was upgraded to carry out sheep production research. The work at Woodlands was transferred to the Medina Research Centre. Vegetable research had previously moved there and was integrated with floricultural research. To provide for increasing agronomic work on crops and pastures in the higher rainfall areas the department expanded the Mt Barker Research Station by acquiring an additional block at Manurup. This was partly equipped by transfer of resources from the Denmark Research Station.

The early state and experiment farms
The Chapman State Farm and Narrogin Experiment Farm had been established in 1903. Chapman had a special origin. In 1902 when agriculture was part of the Lands Department, the Dairy Consultant, AF Crawford, was promoted to the position of Land Officer for the Victoria District in the
Lands Department. Shortly after his appointment he conducted members of the Agricultural Advisory Board on a tour through the land districts adjacent to Geraldton. Their task was to report on the agricultural possibilities and to advise the Agricultural Bank whether it would be justified in advancing money on properties in the district. Their report was decidedly condemnatory, one member going so far as to say that “not one bag of wheat would ever be exported from the Geraldton districts”.

Crawford was convinced that this was wrong. In his opinion profitable crops could be grown even on some of the ‘third class’ land. He approached the Minister for Lands and asked that he be allowed 300-400 acres of land and £1000 ($2000) to demonstrate the possibilities of the district. The Minister was sympathetic and the land was allocated “in the Chapman Valley at Nabawa, nine miles from Bowes siding”. Crawford was placed in charge.

At the time the grant was made the sale of land in the area was at a standstill. When it became known that, in the first experiments on the property, the third class land had yielded 9 bushels per acre, there was a rush of applicants for land. The government was soon buying up private estates to provide additional land. As a result, the area was largely settled before the station began to operate. This became Chapman State Farm.

In 1905/06 the department identified three state farms – Chapman, Narrogin and Hamel.

The Narrogin farm was established to demonstrate the advantages of improved cultivation, to raise stud stock for the benefit of farmers and to provide training for farmers’ sons and others wishing to settle on the land.

In 1904/05 the Under Secretary asked for land and funds to be made available to establish a Dairy Industry Experiment Farm. He pointed out that horse breeding was a potential source of income for the State, with the Indian army needing 3000 to 4000 horses annually. Early in the 1906/07 financial year a portion of land in the Brunswick area was vested in the Department of Agriculture “for the purpose of creating a Dairy Farm”. The farm was to have primarily a demonstration role with limited experimentation. The area, which included some deep alluvial soils associated with the Brunswick River, was considered very suitable for dairying. It was intended that the farm be stocked with pure-bred dairy cows and pigs.

Merredin Research Station was established by the Lands Department in 1904 as part of the Nangeenan Land Settlement Scheme to demonstrate farming in an area considered marginal. In 1907 it was transferred from the Lands Department to the Department of Agriculture. It was decided to concentrate farmer training at Narrogin. Progressively the mixed stock at the farm and the older horses were sold and replaced with stud stock. A successful trial of topdressing pasture with artificial fertiliser was reported in 1906/07.

An interesting side issue at this time was concern at the increase in the cost of hessian bags from 6 shillings (60c) to 8 shillings (80c) each. The 4 bushel bags would have weighed 240 pounds (109 kg) if full of wheat. Clearly, men were men in those days, although there had been a suggestion earlier that 2 bushel bags be introduced. By the 1930s, 3 bushel bags were standard. These weighed 186 pounds (84.5 kg) full of wheat and were heavy enough.

A demonstration mentioned in the 1906/07 report was that at the Chapman, Narrogin and Nangeenan farms, practical examples of wheat growing on fallowed land were being provided. For the purpose, one ploughman equipped with a good team of four horses, a three-furrow stump-jump plough, cultivator, set of harrows, drill, and harvester was given the task to sow the seed, plough and cultivate the fallow land for the next season and harvest the crop from a 640 acre (256 ha) area. The only assistance given was in carting the crop off the land.

The trial proved that one man could “with good application and keeping abreast of the...
seasons”, in 12 months, farm 1 square mile (640 acres), half of which was seeded and harvested in every alternate year while the other half was fallowed for the following year. This demonstration may have been the origin of farms which were between 700 and 1000 acres in the eastern wheatbelt. Alternatively, it may have only been meant to show that the size which had been decided on was the correct one.

In 1909 the Acting Director of Agriculture, Professor Lowrie, an eminent agriculturalist, reported on the value of the state farms. He had undertaken an extensive tour of the agricultural areas and concluded that the state of WA farming was such that the need was for advice on practical farming more than experimental and trial work. He had hoped to recommend additional experimental farms and an experimental program but the state of the industry did not make this appropriate. He also concluded that the three wheatbelt farms had been established to show that farming was possible in these areas and since this need had passed, they should now be sold. He considered that Chapman was too isolated and Merredin was outside the wheat growing areas. He saw Narrogin as unsuitable for experimental work because of its variable soils and drainage problems. He did not agree that it could provide practical training for young farmers. In his view, training of potential farmers should be carried out on commercial farms. Fortunately his advice was not taken.

Following the 1911 drought, when many new farmers lost their seed wheat as well as having no crop, legislation was passed to allow farmers to purchase seed wheat from the government. A board, consisting of the Under Secretary for Agriculture, AJ Monger and A Gorrie, authorised the distribution. The grain was produced on the Merredin and Chapman State Farms or bought in. This board apparently absorbed a considerable part the Under Secretary’s time. The same provision was needed after the 1914 drought.

In his report in 1913 the recently appointed Commissioner for the Wheatbelt (GL Sutton) rejected Professor Lowrie’s recommendation to dispose of the wheatbelt stations. He decided that the Merredin and Chapman State Farms should both carry out trials, cereal breeding and demonstration work and should grow considerable quantities of clean seed wheat of certified varieties so that farmers could renew their seed with a variety of their choice. Much of the seed used on farms at this time was mixed and not necessarily of the variety the farmer believed it was. The purchases were authorised by the Grain and Foodstuff Act. As an additional service to farmers dairy bulls were introduced onto wheatbelt state farms for mating cows for farmers who had one or two cows as milk animals. It was also proposed that flocks of pure British breed rams be established to provide farmers with sires to produce crossbred lambs from Merino ewes as an added source of income. It is not clear that this was ever done.

By 1915 the varying roles of the wheatbelt state farms were largely established. Narrogin had a developing educational role. Merredin and Chapman together had assumed the experimental role and wheat breeding work and the development and release of new varieties were their dominant tasks. The 1918/19 report recorded the release of eight wheat varieties including Nabawa, with two earlier oat varieties, Burt’s Early and Lachlan.

In 1918/19 Sutton advocated courses of training for returned servicemen of no previous experience who were taking up farming. While this could have been relevant to Narrogin, the Brunswick State Farm, which was the first state dairy farm, was handed over for the training of repatriated or returned soldiers in 1919/20. Possibly the Group Settlement Scheme was in the politicians’ minds at the time. Brunswick was never returned to the department.

After Sutton’s promotion to Director of Agriculture in mid-1921, the experimental and plant breeding programs were continued
under the direction of the experimentalist. Sutton outlined the main functions of the wheatbelt experiment farms as:

- **growing of pure pedigree seed of the main varieties of wheat for sale to farmers, to ensure farmers had a supply of seed which was true to name and free of impurities**
- **production by selection and crossbreeding of new varieties of cereals and fodder crops suitable for the wheatbelt**
- **experimentation aimed at improving the yield of wheat and/or reducing the cost of production. Such experiments would deal with cultivation methods, fertiliser rates, seeding rates, and comparison of varieties.**

The farms were to be conducted solely for educational and experimental and not for commercial purposes.

This reflected the progressive move after 1910 away from the original purpose of these farms of demonstrating that wheat growing was possible in the districts where they were established.

In his 1922 report the wheat experimentalist confirmed that the work at Chapman and Merredin followed this direction. The field work consisted of depth of sowing trials, soil mulching experiments, seeding rate research, variety trials for both wheat and oats, fertiliser trials and rotation experiments.

The test rows included pure line breeding for the production of pedigree seed, variety test rows for wheat, oats and barley, identification rows for wheat, oats and barley, smut resistance tests, fungicide experiments, seasonal planting experiments and milling tests.

Seed supplied by a Commonwealth Seed Improvement Committee was also planted in that year. The purpose of these trials was to determine the true type of most of the well known varieties of wheat in Australia. Sample plants of each variety were returned to the committee. The work in the identification rows was successful in exposing varieties masquerading under false names.

The distribution of pedigreed seed continued as a very valuable activity of the department. It not only ensured farmers had access to seed of the variety they wanted to use, but it focused attention on the recommended varieties and away from those which had little merit. It was also a method of promoting new varieties which had shown promise in tests on the experiment farms and farmers' properties. This activity continued until the 1980s when the role was transferred to private seed producers.

By the mid-1950s research stations in the medium rainfall zones were operating totally on the clover ley farming system. This change reflected the impact of the clover-based pastures, tractors, higher prices and improved knowledge. It was a huge change when compared to pre-war cropping, when crop/fallow or crop/stubble/fallow were the standard rotations.

**The wheatbelt stations**

**The 1960s**

During the 1960s the wheatbelt stations followed a broad experimental program covering:

- **Cropping systems:** It was found that thorough land preparation for weed control was vital. Ploughing proved superior to scarifying because of its superior weed control. Ploughing as soon as possible after the opening rains was superior to other systems, again probably due to better weed control. Oats was useful as a cleaning crop. Superphosphate levels could be reduced where super had been applied for a number of years before cropping. In 1961/62 further experiments compared various methods of cultivation, trash removal and seeding techniques. Trash removal and disc ploughing gave the best results under the conditions of the experiments.
• Fertilisers: It was shown that there was scope to use nitrogen in later crops in a multi-crop system but use on new land was the most profitable.

• Cereal variety trials were carried out annually.

• Pasture experiments including fertiliser needs, were carried out on different clover species and cultivars across a range of soil types.

• Animal studies: Time of lambing, feeding of weaners, rate of stocking and ‘flushing’ trials were conducted. Management of sheep had become an issue with set stocking favoured from 1961/62. By 1970 it was estimated that half of the stock on the stations was being used for experimental purposes. The 1969 drought provided an opportunity for studies of management of livestock in drought conditions.

• Plant breeding and introduction occurred on a large area of the research stations.

Chapman Research Station
Chapman was initially used to demonstrate farming techniques, varieties, different fertiliser rates and to provide seed wheat. At a field day in 1913 it was recorded that 200 people attended. These numbers need to be considered against the difficulty and distance of transport and the population. In 1925 the range of experiments carried out at Merredin and Chapman was expanded to look at fungicides for the control of smut. At the same time the collection of varieties was tested for resistance to the three types of smut (ball, loose and flag), ear cockle and take-all. While established varieties were resistant to flag smut there was no varietal resistance to loose or ball smut.

The 1927 report on the time of sowing experiments concluded that the most satisfactory yields were obtained from late varieties sown early. The experiments were planted on fallow. The result was relevant to the new cropping system developed later in the century.

A collection of saltbushes and bluebushes was held at Merredin in the late 1930s. Material from the Murchison and Hines Hill had been collected. This was the beginning of work on identifying plants which could be productive on areas which had become saline following clearing of surrounding timbered areas.

By 1957/58 the breeding program at Merredin focused on wheat and six-row barley. The program at Wongan Hills focused on oats and two-row barley and at Avondale on linseed, in a hope of reviving that industry. Merredin was also working on barrel medic, selecting the most promising types and bulking them up.

Merredin Research Station
A field day was held at Merredin for the first time in 1913 when some 400 farmers attended. Cereal breeding, particularly wheat breeding, became a major activity of the station. In 1922 the report states that two varieties Nabawa and Merredin, were proving successful and another two Dindiloa and Carrabin were being tested by farmers. In the 1921/22 summer 500 farmers were each supplied with up to five bags of pedigreed seed. In 1925 the range of experiments at Merredin was expanded to investigate fungicides for the control of smut. At the same time the collection of varieties was tested for resistance to the three types of smut (ball, loose and flag), ear cockle and take-all. While established varieties were resistant to flag smut there was no varietal resistance to loose or ball smut.

Long-term experiments were also established to test different rotations. Chapman continued in this general role over a long period and was used to test and demonstrate the changes in both cropping and livestock management. The first major change was to ley farming and in more recent years to minimum tillage, continuous cropping and different rotations. In 1994 a decision was taken to close the station and it was sold in 1995.
The Dryland Research Institute was established on the property in 1983. Since that time the organisations have performed as a unit. The name of the stations across the department was changed to Research Support Units during the 1990s.

The Merredin Dryland Research Institute. An aerial photo of the Institute established in 1987 to focus on issues in the eastern wheatbelt.

Newdegate Research Station
Like the other stations Newdegate was used as a testing station for varieties, rotations and cultivation techniques. Some work on copper residual values was also carried out. During the early 2000s it was downgraded and most of the land leased. A small area was retained for experimental work.

Dampawah, Ghooli and Salmon Gums
In 1925/26 the government decided to establish three new experiment farms in the eastern wheatbelt. The sites selected were at Ghooli, near Southern Cross, Salmon Gums, and Dampawah Springs (East of Perenjori). Dampawah and Ghooli were established to test the eastern boundaries of wheat production. There had been some settlement in Salmon Gums from around 1910. The poor performance of the area was the subject of a Royal Commission in 1917 and of a major soil survey in the early 1930s. The station was established to obtain information on how to manage the soils of the area. This was substantially identified but some experimental work continued there until it was closed in the early 1990s.

Dampawah was established at the centre of a subdivision for farming which had been surveyed by the Lands Department. Development of these stations was slow, with little record of experimental work at Ghooli and Dampawah. The general performance of wheat at Dampawah was such that the Superintendent of Wheat Farms stated in a memo that "yields in the area may be equal to or even a little better than established areas if sound practices were used". The proposed settlement around Dampawah never proceeded and settlement never proceeded east of Southern Cross, although successful wheat farming was established west of the town. The poor prices following the Depression, poor seasons through much of the 1930s and the outbreak of war in 1939 led to Dampawah and Ghooli both being closed in 1940/41.

Wongan Hills Research Station
In 1923, after examining a number of possible sites, it was decided to establish an experiment farm at Wongan Hills. This was an area of light land and the farm was to be used to determine the best methods of using that land. It was planned to carry out trials with a range of potential fodder crops, tillage experiments, and wheat and oats. While this was clearly an experiment farm its role was initially different from Merredin and Chapman and it was titled Wongan Hills Light Land Farm.

Wongan Hills Research Station – the beginning of development. From humble beginnings it became the department’s premier wheatbelt research station.
Opening of the Wongan Hills office.

It was officially opened in 1925. Very little experimental work was done at that stage with most of the cleared area planted to wheat and oats to determine how the crops grew. This was an experiment in itself. The seed produced was sold as part of the pedigreed seed to farmers.

Early results from Wongan Hills were disappointing but the fertiliser level used on virgin country was relatively low. In 1928 the results were of the same order even though the area had been previously cropped in 1925/26. However, in the dry year the sandy-surfaced areas performed better than the gravelly country. The average yield was about 10.5 bushels per acre (710 kg/ha). Subclover sown under an oat crop did not perform well.

In the post-war period legumes were planted and were successful. Following improved performance Wongan Hills became the major research station for the wheatbelt. The station was used particularly for work on understanding the soil and fertility changes under ley farming. Wongan Hills also became the centre for plant breeding, with testing also done at Merredin, Esperance and Mt Barker. In 2006 a major seed storage and preparation facility for all cereal breeding was established there.

In 2008 a company was established with the Department of Agriculture and the Grains Research and Development Corporation as joint owners to undertake all the department’s barley and wheat breeding. While the company used the major processing and storage facility it did not use the farm areas, which were largely leased to private farmers.

Avondale Research Station

In 1924 Avondale State Farm was transferred from the Lands Department. The intended role was to produce seed of selected pedigree varieties of wheat and oats. It was to be known as the Avondale Seed Farm. However, virtually from the time of purchase it was used as a depot for assembling dairy cows, heifers and bulls for despatch to Group Settlement farms. This continued for the period of the Group Settlement Scheme.

From 1928 to 1930 Avondale was the headquarters for Bennett’s study of the braxy-like disease. During this period a small laboratory was built and equipped on the station. It was also used in the 1930s for extensive studies related to the development of a fat lamb industry following the collapse of wheat and wool prices in 1929/30.

When a small flax industry was started during the war a flax breeding program was started at Avondale. This produced two rust-resistant varieties from field selections of resistant material. WADA was released in 1944/45 and the other was named Boyup. Both varieties succumbed to rust in 1956 and breeding was discontinued when the industry collapsed. Linseed breeding and
selection was also undertaken at Avondale with considerable success before that industry also failed. Avondale was also used to test peas, vetches, lupins and a range of pasture species.

In 1979 the collection of historically important machinery was housed at the station and is still maintained there. The display was prepared as part of Western Australia's Sesqui-centenary celebrations.

In 2008 the station was transferred to the National Trust, due to the machinery collection and the historic buildings which dated back to the early settlement of the Avon Valley. The Avondale Project is covered earlier in this chapter.

**Esperance Downs Research Station**

Esperance Downs Research Station was established in 1949 to determine the best methods of developing almost a million hectares of sandplain soils within a good rainfall zone in the Esperance Shire. It was initially an outstation of Salmon Gums but quickly became a very important station. The station received an average rainfall of 450 mm, of which 300 mm fell from May to October. Experimental work revolved around the establishment and maintenance of legume-based pastures (usually subterranean clover). This development continued through the 1950s to 1960s. The experiments included cropping on virgin land and on land which had grown a number of years of clover, determination of fertiliser needs including trace elements, and comparison of subterranean clover cultivars and alternative legumes. Lucerne was successfully established and managed under grazing. Later experiments investigated stocking rates and the impact of a range of subclover cultivars on sheep fertility. Some work was also done with cattle following the introduction of 160 Aberdeen Angus to the property in 1965. The stocking rate in June 1965 was nearly nine dry sheep equivalents per hectare. The station was the focus for successful development of what has become a major agricultural area.

In later years, due to a salinity problem the station was partly restructured to demonstrate salinity control and management methods on part of the station and commercial livestock/cropping on the rest.

**Badgingarra Research Station**

Badgingarra was established west of Moora in 1959, to investigate methods of development of the area known as the West Midlands. Work involved studies of problems of initial development, pasture establishment, stocking rates, and monitoring breeding problems on subterranean clover pastures. Studies of lupinosis were also part of its role. It was located on an area with a higher percentage of better soils than the average farm in the district but there was enough poor deep sand for experimental purposes. Additional crown land was later acquired at north Badgingarra. The station was used extensively through almost 50 years of active use. It had a particular role in the use of lupins as part of the new farming system developed in the 1970s and 1980s.

It was decommissioned in 2008 in preparation for handing over to the local community.

**The Animal Breeding and Research Institute**

The Animal Breeding and Research Institute (ABRI) was established in 1980 as a result of a recommendation by the Rural and Allied Industries Council Conference in July 1977. It was developed using State funds and located in the Great Southern 6 km east of Katanning. A policy advisory committee was appointed to oversee the selection of the property. Staff were appointed in late 1980 and the committee had its first meeting in July 1980. This committee decided on programs relevant to the extension and training services, and the sheep breeding and research objectives to be implemented. A comparison of the major sheep breeds in the State was established, using sheep provided by the studs.
ABRI continues to run as a field station and has a full experimental program. Today part of this program involves cropping-related activities. Departmental activities at Katanning have been progressively centralised at a new office/laboratory facility in the town. The new office/laboratory complex was opened 1999/2000 when it became known as the Great Southern Agricultural Research Institute. The original Katanning District Office was sold in 2003/04.

The Metropolitan Area stations

Medina Pig Research Station
The Pig Research Station was opened in 1967. There was some initial criticism of the facilities but these were progressively improved. By 1970 the role of the station had been confirmed as a minimum disease facility and it was stocked accordingly. It was proposed that three separate herds be maintained—Berkshire, Large White and Landrace. Research has continued there to the end of this review. By 2008 it was the only such government-owned facility in Australia.

Poultry Research Station
Development of the Poultry Research Station began in 1952 but with delays due to shortage of funds it did not become operative until 1954/55. Initially it examined issues such as bird density, the impact of hatching dates of pullets on production, the effect of 'step down' lighting on egg size and different food sources. Interestingly in one instance, a higher death rate was experienced when a South African fish meal and Cheynes Beach whale meal were used in a ration. Research on feeds and feed mixtures for both layers and meat birds were important work of the station over a number of years.

The station was closed in the early 1980s as part of a rationalisation of the department's research stations and the work was transferred to Medina, where the Intensive Industries Centre was established.

The Vegetable Research Station at Herdsman Lake and Medina
This station was in the development stage in 1955/56. Initially no work was done by the Vegetable Branch and the vegetable plantings were used by other branches. The 1958/59 report states that “the property is now reaching a stage where it will prove its value to the industry”. By 1960/61 the station was already under threat of being moved to allow for the area of the adjoining Churchlands High School to be expanded. In 1962/63 five acres were released to the Education Department for use by the new high school, and a site was selected north of Medina for the Intensive Industries Research Centre. By 1963/64 the Medina site was being prepared for planting and in 1964/65 the station had moved to Medina and the Herdsman land was transferred to the Education Department.

The high rainfall stations

Brunswick State Farm
In his 1904/05 report the Under Secretary asked for land and funds to establish a Dairy Industry Experiment Farm. He pointed out that horse breeding was a potential source of income for the State with the Indian army needing 3000 to 4000 horses annually. Early in the 1906/07 financial year a portion of land in the Brunswick area was vested in the department “for the purpose of creating a Dairy Farm”. The farm was to have a mainly demonstration role with limited experimentation. The area, which included some deep alluvial soils associated with the Brunswick River, was considered very suitable for dairying. It was intended that the farm be stocked with pure-bred dairy cows and pigs. The cows would be herd-tested so that the potential value of any surplus stock would be known at the time of sale. In addition the government was providing financial assistance to farmers by selling
cows to them on two-year terms and endeavours to provide suitable bulls to maintain or improve the quality of the stock. In 1907/08 the first successful sales of stock from the farm were reported. Despite the care taken, some complaints were received about the quality of the cows supplied to farmers. The reports state that when returned to good feed and good management the cows almost always recovered their capacity to produce. Milking machines were also offered to farmers on two-year terms. The Irrigation Expert reported that interest in irrigation due to the success of a small area on the Brunswick farm.

In general the station filled a gap during the period of its operation. It was taken over after World War I for returned servicemen to obtain experience, and never returned to the department.

**Denmark Research Station**

In 1913 the government instructed the department to establish a model dairy farm at Denmark. The government planned to encourage dairying by making finance available to farmers at liberal rates through the Agricultural Bank. A dairy factory and bacon factory were later added as part of the farm operations. Brunswick and Denmark were to have a primarily demonstration role with limited experimentation. Denmark also provided both the butter factory and an additional option for farmers to market their pigs through the bacon factory.

In 1921 there was a report from the Denmark Stud Farm, that a paddock had been planted to subterranean clover at 2 pounds per acre without manure as a green manure crop, to be ploughed in to save expenditure on expensive nitrogen fertiliser. At the time the main pasture was based on perennial ryegrass, cocksfoot, paspalum and ‘mixed clovers’.

In 1925 the Denmark farm was reorganised. The butter factory was turned over to the farmers to be run as a cooperative factory. Since the farm was in the Guernsey zone, the Jersey cattle which had been on the farm were replaced by a part-stud and part-‘grade’ Guernsey herd. The pig herd was also enlarged with a stud of Berkshire pigs. Two Guernsey bulls and two stud Berkshire boars were held for the use of settlers wishing to improve their herds. A stud Clydesdale stallion was placed on the farm for the use of settlers wishing to breed horses. The farm was then titled the Denmark Stud Farm.

In 1940/41 Denmark started research into the use of poorer quality soils carrying bottlebrush and stunted jarrah. Various aspects of this work continued over the next 25 years. This included experiments on the Plantagenet Peaty Sand which showed that copper and potash were important, in addition to lime and phosphate. Important plant introduction work was also carried out there over a period of years along pig management, farm-scale trials of pastures and fodder crops, and determination of fertiliser regimes.

The station was almost totally pastured by the early 1940s. It was also reported that during the year a milking machine was installed as a labour saving device! During the war it was largely on a maintenance basis because of labour shortages. After the war it continued largely as a stud stock and demonstration farm. An experiment on viral pneumonia eradication from the pig herd was carried out there and there was ongoing work on pasture establishment on poorer land, and some plant introduction. By 1970 the work had expanded to study stocking rates on particular pastures, the productivity of perennial pastures on suitable soil types in the Denmark area, pig feeding trials, and trials of the trace element requirements for livestock, together with a range of other detailed work on fertiliser use. This level of work continued through to 1982, when the station was transferred to the Denmark Agricultural College as part of the research station rationalisation at that time. Useful equipment was transferred to the new experimental block at the Mt Barker Research Station.
Wokalup Research Station
In 1942 the department took over a farm at Wokalup, just south of Harvey. It would later become Wokalup Research Station. As it was developed work on animal management and plant introduction was carried out there. In 1955/56 it was decided to centre an artificial insemination program at Wokalup and the appropriate infrastructure was built and technicians were trained. Action was taken to purchase bulls for all the breeds used in the industry (Guernsey, Jersey, AIS, and Friesian). While suitable bulls were obtained of the Guernsey and Jersey breeds it was difficult to get suitable bulls from the other groups. By March 1956 commercial operation began, with 1500 cows being inseminated in the first year. The program was managed by the department until early 1967 when it was taken over by the independent Artificial Breeding Board, which was established under legislation.

In 1961/62 artificial breeding was used to develop two herds (one Jersey and one Friesian) for comparison. Milk composition was compared as this was a real concern at the time. Time of calving and weight at birth was also followed for sale stock to determine the influence on weight at birth on sale value. This work was in addition to the continuing plant introduction and nutrition program.

In 1965/66 pasture research included time of closing for hay, plant introductions, nitrogen fertiliser on early oats, and the use of chemicals in the establishment of pasture. By 1970 the station was milking 100 cows and carrying out extensive work on stocking rates and other animal management issues as well as continuing its pasture establishment and management work. At this time a very large beef cattle experiment was established, to compare the productivity of different breeds of beef cattle. The work on nitrogen use, stocking rates and plant introduction continued through the 1980s.

Wokalup was handed to the industry in 1992/93 to become an industry-run dairy farm testing modern dairy practices and for demonstration. The industry was not able to make the necessary arrangements and the station was finally transferred to the Harvey Agricultural School.

Bramley Research Station
Bramley Research Station was purchased to continue experimental work on the role of phosphorus in the fertility and productivity of dairy cows. This work is reported in Chapter 6.

It was also demonstrated that the paddocks at Bramley were deficient in cobalt for developing calves. In 1961/62 a range of experiments continued despite the limitations imposed by the small size of the property. The phosphate feeding trial continued, copper residual availability was investigated, cobalt availability was studied, and heavier stocking rates were investigated. Throughout its life the focus continued to be on carrying capacity, phosphorus nutrition of milkers, calf rearing, parasitology, cobalt nutrition and some unique pasture nutrition and management trials. In 1982/83 Bramley was sold as part of the research station review. All dairy work was transferred to Vasse when Wokalup was closed in 1992/93.

Vasse Research Station
The Vasse property was purchased as part of the research station rationalisation in 1982/83. The focus was to be on animal nutrition in an overall study of issues related to beef and dairy cattle. It replaced facilities at Northam, Denmark and Bramley Research Stations. The original aim was to maximise production from the available paddock feed, particularly the spring flush. In a review of research station facilities in the 1990s it was decided to centralise all dairy and beef work at this station. In 2003/04 refurbishment and extension of the facilities began. These include a centre pivot irrigation system and an ultra-modern computerised dairy, which was opened in 2008.

In 2009 there were two major experiments, both focused on production per unit of feed energy.
In the beef herd, the focus was on the energy cost of the mother. Angus cattle selected for high energy and low energy conversions or high and low feed efficiencies were used. This is part of the Cooperative Research Centre on Beef Production centred on New England University.

The challenge for the beef industry remained its ability to receive reasonable on-farm prices, permitting the adoption of much of the technology adopted in the dairy industry. The feed production systems can be the same but affordability in an uncertain market situation is difficult.

The second experiment was testing the production from dairy cattle at five stocking rates and five rates of nitrogen fertilisation of the pasture. The rates of nitrogen were nil, 1, 1.5 and 2 kilograms per hectare per day applied as urea. The five stocking rates were 1.25, 1.5, 1.75, 2.0 and 2.25 cows per hectare. There was no evidence of trace elements affecting plant growth but the cows required selenium and may have required cobalt. In wet years additional sulphur was needed late in the season. On-farm the nitrogen application and stocking rate were determined by the amount of ground cover. A leaf area index of 2.5 seemed about right for maximum production.

The station is also experimenting with wheat cut at the early dough stage as a potential source of silage. The plant material is produced on a ‘hill block’ off the main station. Experiments are planned in consultation with farmers.

When the feed in the experimental farms dries off, the herds are run on the pivot sprinkler-irrigated pasture of perennial ryegrass and white clover. The animals are supplemented with high quality silage made by rolling pasture at 40 to 50 per cent moisture and wrapping it in plastic to produce anaerobic conditions.

This could be the shape of the future dairy farming but the areas of uncertainty are:

- price of nitrogen versus the price of milk
- price of land, which for the Busselton area, is running at from $10 000 to $15 000 per hectare
- the availability of irrigation water. If water allowances are very low there may be a case for transfer of water rights from Harvey to the area south of Capel. The available area would stretch from Capel to the south coast.

Mount Barker Research Station

Mt Barker was purchased in 1967/68 as a basic research facility for the margin between the high rainfall livestock-based beef and dairy industries to the west and the cropping industries to the east. By 1982 it was clear that more work on crops and pastures was needed in this environment. The station was expanded by the purchase of an additional block at Manurup north of the station. Initially, the cropping work focused on the performance of cereals in the area but as the station developed it became the key site for the work on rapeseed. This outstanding work which produced the foundations of the modern canola crop is reported elsewhere but was made possible by the Mt Barker facility. By 2008 work on sheep and cropping was reduced.

The horticultural research stations

Manjimup Research Station

In the early days of the tobacco industry, trials were carried out on farmers’ properties but this proved to be unsatisfactory. By 1939/40 the department had established two experimental sites, one at Jardee (west of Manjimup) and the other at West Donnelly. In 1942/43 the experimental program continued at West Donnelly but the department had decided to establish a research station nearer Manjimup. At Manjimup in that year the work was focused on developing the new station and transferring equipment from Jardee.

In 1944/45 a research station was opened and all experimental work on tobacco was transferred from Jardee and West Donnelly.
In 1953 this work was transferred to another new area 8 miles (15 km) west of the town. While it came under the control of the Horticulture Division, in 1956 it was primarily used for tobacco research. In 1955/56 an extensive experimental program was carried out investigating fertilisers and their placement, varieties and irrigation. Fertiliser trials were continued showing the value of nitrogen and phosphorus and sorting out the rates for particular circumstances.

While the work showed clear benefits in production with the use of irrigation it aggravated the chlorine level which became the big quality issue. When the industry collapsed after poor sales in 1961 and an abortive attempt to sell in Melbourne in 1962, an area was used for experimental work for potatoes and other annual and short-term crops.

During 1966/67 this station was closed and a new site purchased in the Middlesex district 23 km south of Manjimup. The land consisted primarily of Karri loam and there was a frontage to a permanent stream, Smith’s Brook. Sixty-four hectares of 259 ha was cleared. Some experiments investigating internal parasites in sheep, and barley yellow dwarf disease of oats were started. Extensive horticultural research was carried out on the property. This included trials on the processing crops, beans, peas, asparagus and peaches. New varieties of apples were also tested, particularly red varieties. In the late 1970s a variety and irrigation trial with wine grapes was started. The result stimulated the rapid development of the industry in the district.

However, the site was distant from Manjimup, making it difficult to integrate its activities with those of the district office. In the spring of 1985 a new site was selected 7 km south of Manjimup. In 1986 the Minister for Agriculture opened the new centre at the 107 ha site. It had good water supplies and soil typical of the district’s quality horticultural crops. Development was in two phases—relocation of the staff and relevant work from the old station, and moving the district office from the town.

Phase 2 was completed with the erection of an office block, laboratories and conference rooms, opened in September 2000. The new facility was known as the Manjimup Horticultural Research Institute. In 2009 a third of the station’s resources were taken up by the apple breeding program, with the remainder divided between the grains program, viticulture and vegetables. Testing new crops such as green tea, cool climate citrus, and avocados was in progress.

Manjimup Horticultural Research Centre opened in September 2000.

Stoneville Fruit Research Station

Stoneville was the major research station for the fruit industry from the mid-1950s until the 1990s. Development work started in 1955/56 and continued through to the late 1950s. This included extensive plantings for trials of rootstocks and pruning techniques, and small-scale work on hormone and weedicide use. Jarrah sawdust was used successfully as a mulching and hilling material. In 1958/59 progress in planting material for rootstock trials was reported. In spring 1959 the first trial with orange rootstocks was planted, followed by an apple rootstock trial in 1960. The 1965/66 report refers to a very successful year, with 10 years of development completed.

From 1970 an active development and research program was undertaken. Stoneville produced very valuable information on rootstocks, particularly for apples and oranges. It also had a major role in the breeding and selection of apple
varieties. The magnitude of this work and the time scales involved make this a major undertaking for any facility. This is reflected in the decision to make this the National Apple Breeding Program. It produced the Lady Williams, and later Cripps Pink and Cripps Red varieties. In the late 1980s it was decided to centralise horticultural research at Manjimup, and Stoneville was sold in 2000/01.

The Swan Viticultural Research Station
The government purchased a 92-acre property in mid-1954 to develop as a viticultural research station. Initially work was done on cover crops and their impact on vigour and yield of vines. Later it was reported that 11.5 acres were planted to experiments dealing with rootstocks, long-term fertiliser use, and replanting. Rootstock trials were started in 1960/61. Development work continued in 1961/62 and by 1965/66 the station had an active research program, with 24 experiments underway.

The northern research stations

The Ord River
In 1941/42 the Department of Agriculture and the Public Works Department established an experimental site at Carlton Reach on the Ord River. Irrigation equipment was installed and an officer appointed. Mitchell, buffel, Birdwood grass, paspalum, Phalaris tuberosa and lucerne were planted. The Public Works Department had shown that there was adequate water and a good dam site and was interested in the possibilities of irrigation. By 1942/43 the experimental areas were largely established and providing useful information.

In 1945/46, following an agreement between the State and Federal Governments for a joint investigation of the agricultural potential of the area, a comprehensive plan was prepared by CSIRO for investigational work. The development of the necessary infrastructure was a State responsibility and expected to cost $50 000. The State would provide the farm staff and CSIRO would provide the professional staff.

The site chosen was further down river from the Carlton Reach site which was upstream from where a diversion dam was planned. This was built later. By 1948/49, 450 acres of the Kimberley Research Station had been cleared and some graded ready for planting of the wide range of crops to be tested.

In 1950/51 work started in earnest after CSIRO appointed a research officer to implement the program. Over the next decade the station was fully developed and became an independent but isolated research institute. It was well staffed and managed. On the basis of the work carried out there and the extensive soil survey of the plain area by the department, a decision was taken to build a dam on the Ord River and develop an irrigation area. The staffing and management of a research institute in an isolated location with significant social problems associated with that isolation is a story in its own right, which should be written.

As the first step in developing an irrigation area a diversion dam was built upstream from the research station. Water was pumped from this dam into a major irrigation channel and irrigation was started.

In 1961/62 some very good rice yields were reported. Cotton and oilseeds were also tested. There was some uncertainty as to the potential effect rice could have on the water-table and by 1962/63 it had been decided that cotton would be the commercial crop. Because it was desirable to harvest in low humidity, the best harvesting period was identified as from mid-June to late August. High quality defoliation was shown to be vital in achieving high quality fibre. Rotation work showed that if annual cropping with cotton was to be practised it was best not to irrigate the area during the uncropped period.

Experimental work also showed nitrogen level and time of application were important determinants of yield. Insect control and chemical weed control in cotton were also important.
Chapter 8 – Extension, education and other services

Over the rest of the decade wide-ranging investigations covering cotton, sorghum and rice crops, cotton and sorghum rotations, irrigated forage crops, dry season lot feeding, entomology and soil chemistry was carried out at the station.

Sugar showed as a highly suitable crop in the work at the station. Some commercial trials were carried out by the CSR company in the mid-1960s. These did not give good results, which was surprising in view of the excellent results obtained a decade later.

The nature of its work at Kimberley Research Station, which dealt with underlying principles more than immediate issues, reduced its capacity to address the day-to-day problems of the developing agriculture of the area. For this reason the department decided to establish an independent experimental area.

In the late 1980s CSIRO decided to cease work at Kununurra and the Kimberley Research Station reverted to the State. It is now the Frank Wise Research Centre.

Kununurra Experimental Area

In 1969 the department took up an area of the black soil plain to carry out more farm-focused trials. An area of 40 acres of cotton was planted. The area continued to be used for trials on issues such as time of planting, fertiliser rates, crop management and levels of insect control. Sorghum varieties were tested for yield and the suitability of the stubble as cattle feed. Areas of rice and sugar were planted. In 1969/70 a full-time cotton agronomist was stationed at Kununurra. Insect control management work was started, to determine the best insect management strategies. The development of resistance of the cotton bollworm to insecticides eventually caused the collapse of the cotton industry and the area became important in biological control work. Work continued, seeking alternative crops. A sugar pilot farm was also established.

Abydos Woodstock

Abydos and Woodstock pastoral properties were taken over for experimental purposes. They had been abandoned and much of the fencing had been burnt and none of the mills worked. It was hoped to develop and demonstrate methods of land management to make the country productive again. A large amount of work had to be done to renew fences, repair the mills and to control wild dogs and euros.

It was planned to put 5000 breeding ewes on the property in 1948. However, further fencing was needed and further water points repaired and problems with wild dogs needed to be solved before experimental work could be undertaken. Dogs were being trapped or poisoned at a rate of five per week during the year.

In 1951/52 it was reported that improvements were continuing and sheep had been put on the area. The dog problems had been reduced. Work began at Abydos on spinifex management, the potential of buffel and Birdwood grasses and vermin control. There was a heavy population of euros and a CSIRO officer was stationed at Woodstock to study this problem.

Surprisingly, despite the continued dog problems it was 1964 before a 400 ha paddock was enclosed by dog-proof fencing. In 1965 another 200 ha area was ‘almost completed’. A considerable amount of useful research was done after the problems were
reduced to a manageable level. This work is described elsewhere. Work continued from 1954/55 through to mid-1976, when it was finally closed.

**Gascoyne Research Station**

The decade from 1941 to 1950 was one of mixed fortunes for Carnarvon growers. The long drought of the mid to late 1930s finally broke in 1941. The years that followed featured variable climatic conditions, difficulties with transport during the war and some serious effects from cyclones, disease and insect pests. The department started to develop a research station but after reaching an operational level in 1942 it had to put it on ‘care and maintenance’ for most of the war.

Between 1945 and 1947 the Gascoyne Research Station was refurbished, a new program developed and research was resumed. Many plants had to be brought in for experimental work, including a large number of pineapple varieties. Trials were initiated on varieties of bananas, papayas and a suite of vegetables. Studies of plant propagation and planting methods were started with bananas. By 1948/49 the research station was fully functional.

Over the decades which followed, experimental work covered fertiliser trials, soil amendment, rates of irrigation, plant spacing and other issues related to the crops being grown in the area. The soil amendment trials were initiated because there was concern about the deterioration of the structure on some station soils.

Conservation of water supplies was important and research was undertaken to determine the actual needs of the banana plant. Crops such as beans and other vegetables with lower water requirements were important to the town over dry periods. Work was also carried out on fertiliser rates and times of planting for a range of other vegetables and melons. At times this work became central to the research station as producers switched to vegetables in response to the shortage of water.

In the early 1960s work was in progress with passionfruit, bananas, papaya, beans, tropical apples, custard apples, dates, onions, strawberries, grapes, avocados and mangoes. However, bananas continued as an important crop. Watering trials on the parent plant and followers were very important.

Some work was also done to select strains of buffel grass and kapok bush which would germinate in winter, in order to improve the protein level of pastures at that time of the year.

Later research was directed mainly towards irrigation techniques aimed at gaining the most value from a relatively limited water supply. It was shown that the water required for a tomato crop could be reduced from 8.5 megalitres per hectare to 3.3 ML/ha without drop in yield.

There was also some work on rangeland, examining the opportunity for ponding to conserve water to encourage seed to germinate and assist the revegetation of scalded land, and use of medic species adapted to pastoral conditions, as an alternative pasture species.

In the reviews of the 1980s Gascoyne was transferred to the Horticulture Division and became part of the Horticulture Program. A limited amount of research was carried out in 2008. It also served as an out-station for the cereal breeding program, aimed at shortening the generation time.

**The Ground Water Station at Wiluna**

Wiluna station was established in the late 1950s to test the possibility of developing a horticultural industry based on underground water resources in the area. However, studies showed total volume to be relatively restricted with uncertain recharge rates. Development work was completed in the early 1960s and experimental work initiated. By 1964/65 an extensive trial program covering cotton, lucerne, citrus and other fruit was being undertaken.
Over the period to the early 1970s the mining industry expanded dramatically in the area; it was decided that the limited water resources should be reserved for that industry's use and the station was closed. It was taken over by a grower who tested commercial crops. While these were successful there were high marketing costs and the project did not continue.

**Fitzroy Pastoral Research Station**

The Fitzroy Pastoral Research Station was established in 1966 on 85,000 acres, which was excised from a pastoral lease for studying the impact of grazing systems on native pasture. The work was intended to cover both sheep and cattle but with sheep rapidly disappearing from the Kimberley, the focus shifted to cattle. This area was selected to encompass all the important soil types in the area. It was planned to continue work in another area known as the Collins Yard trial area, as an adjunct to the station to include alluvial soils.

However, it was 1970 before the facilities were in place and the first experimental animals were brought in. The early work showed responses of weaners to mineral supplements of phosphorus and non-protein nitrogen in both winter and summer. The station was closed in 1978 when better facilities became available at the Ord River Regeneration Area.

In 1982/83, following a report on the condition of the Fitzroy frontage area, a soil conservation district was declared in the west Kimberley and a major regeneration program commenced. This project was under the direction of a Soil Conservation Advisory Committee, which included pastoralists. It resulted in a dramatic refurbishment of the grasslands along the Fitzroy River frontage. The investment in infrastructure to achieve stock control and other features of the program was $15 million. One estimate was that in its degraded state there was a loss of turn-off of at least 6000 animals a year.

**Ord River Regeneration Area Research Station**

The Ord River Regeneration Station was initiated when it became possible to carry out the most important cattle management studies on the regenerated pastures. The principles of grazing management of native grasses had already been demonstrated at Collins Yard and elsewhere and the station at the Ord focused on herd management issues as they affected herd structure and potential profitability. The work provided information on which development of proposals for restructuring the Kimberley cattle industry depended.

**Camballin Experimental Area**

The Camballin area was established to test the possibilities of irrigation on the flood plains of the lower Fitzroy River. A number of summer crops, including sorghum, were tested on the area. Three legumes were also tried. Problems of bird damage ruined experimental work on rice and sorghum. However, the major problem was control of flooding. Attempts to achieve this proved ineffective because of the magnitude of the flooding. Further work was not undertaken and various attempts to establish commercial cropping in the area failed. Any future development of the Fitzroy would require the floods being controlled with dams on the tributaries upstream.

**Pastoral Research, 1964/65**

The 1965/66 report details a series of experiments involving pasture establishment on the Pindan near both Broome and Derby, and exclosures through the Gascoyne and Murchison. There were some trials with *Sorghum almum* on Mt Hart station in the north Kimberley raising the possibility of establishment under dryland conditions where the rainfall was over 35 inches a year. This work was continued to the end of the decade. Although important, it was done outside any formal facility.
Chapter 9

Some significant people of the department

Perhaps this was the hardest chapter to write. While many of the officers listed present themselves as automatic entries, others, to a degree, are representatives of a wider group of officers, all of whom were vital cogs in the organisation.

Some 50 people are listed for their special contribution to the Department of Agriculture and the agricultural industries. The list is not in any way exhaustive because a large organisation like the department works through the efforts of many people. They are the administrative staff at all levels, the support staff of technicians, field and laboratory assistants, the inspectors, the instructors and others.

A selection of professional staff

Only a small selection of the staff has been included yet those not included were or are also important people. The chapter aims to both record the work of those included and to record the quality of the staff of the department over many years.

Lancelot Lindley-Cowen

Lancelot Lindley-Cowen was born in Virginia, USA, and arrived in WA in 1889 at age 31. When the Bureau of Agriculture was formed he was appointed as Secretary. He had been an officer in the US Navy, serving on the USS Enterprise on the China Station. After arriving in Australia he ran a newspaper and wrote on agricultural matters for the Melbourne Leader. On arriving in WA he took up a position as manager of Palinup Station east of Broomehill.

He became connected to the WA Land Company and for some time produced the Albany Observer newspaper. He then worked as a travelling commissioner with interests in vine and fruit growing and agriculture generally. He travelled extensively in the South West, giving lectures on the industry and forming vine and fruit growers’ associations. He contributed a series of articles to The West Australian on fruit and vine growing and dairying. He also wrote humorous literature for the paper under a nom de plume.

As Secretary of the bureau he established the Journal of Agriculture immediately after its formation. This was the vehicle for presentation of existing knowledge on all aspects of agriculture. With his journalistic background he was doubtless a major player in the publication and the success of the Journal. The bureau was also very active in obtaining and implementing legislation for the prevention of entry and the eradication of insects and weeds.

He sought its creation as an independent department but lost this battle and from 1898 to 1903 the department was a division of the
Lands Department. He was also one of the proprietors of the Santa Rosa Vineyard near Guildford. He died suddenly in March 1902 at the age of 44.

Alexander Crawford
Alexander Crawford was born in Belfast in 1857. He was educated at Queen’s College and at the Albert Agricultural College in Dublin. He came to Australia, possibly visiting Queensland but later prospecting for gold, surveying possible routes through WA for a transcontinental railway and for a time managing a butter factory at Ballan, Victoria. In 1881 he became part-owner of a sheep run inland from Geraldton but poor prospects made him go to Perth in 1882. He returned to Victoria where he married his cousin Eliza Jane Mathews in 1885. He extended a trip home to Ireland to visit the dairy districts of Sweden, Norway and Denmark. He then travelled to the USA spending almost a year visiting agricultural colleges.

With this background he took a position as a travelling dairy adviser in Victoria in 1888. Over the next two or three years he travelled widely in Victoria giving lectures and practical demonstrations on butter and cheese production. In 1891 he took a position as manager of the Victorian Creamery and Butter Company. This company failed in 1895 but Crawford had come to WA before then.

In 1896 he joined the Bureau of Agriculture as a dairy consultant. He continued in that position until 1902 when he was promoted to the position of Land Officer for the Victoria District (Geraldton). Shortly after his appointment he conducted members of the Agricultural Advisory Board on a tour through the land districts near Geraldton. Their duty was to report on the agricultural possibilities and to advise the Agricultural Bank whether it would be justified in advancing money on properties in the district. Their report was decidedly condemnatory, a view with which Crawford did not agree. As outlined in Chapter 8, he was instrumental in having Chapman Research Station established and was its first manager, where he proved the board’s report to be wrong.

He became Acting Director of the Department of Agriculture in 1903 and Acting Under Secretary in 1905. Meantime in 1905 he was subject to investigation by a Royal Commission looking into the failure of the Victorian Butter Company. This may have affected his career although no charges were laid. He took charge of the Rabbit Branch in March 1908 and continued in that role until 1920.

Crawford became a Councillor of the Royal Agricultural Society in 1909 and President in 1916.

George Lowe Sutton
George Sutton was born in Liverpool, England, in October 1872. His father died when he was only six months old. His mother migrated to New South Wales with George in 1882. Sutton attended Sydney’s Fort Street School. After leaving school he worked on a dairy farm with his uncle near Liverpool on the outskirts of Sydney. He attended Sydney Technical College and was awarded a Diploma of Agriculture with first class honours. He was appointed experimentalist and lecturer at Hawkesbury Agricultural College in 1900. There he met William Farrer and cared for Farrer’s wheat breeding plots. In 1905 he was appointed to manage and open the Cowra experiment farm for the NSW Department of Agriculture. His tasks included looking after Farrer’s wheat breeding plots. When Farrer died in 1906 Sutton was appointed experimentalist in charge of wheat breeding and manager of the Cowra and Coolabah government farms.

In 1911 he was appointed Commissioner for the Wheat Belt by the WA Minister for Agriculture, Mr (later Sir) James Mitchell. He shared Mitchell’s desire for development to “settle landless people on a peopleless land”. He was responsible for changing the role of the ‘state farms’ from being demonstration farms for current best practice to being primarily experimental and plant breeding farms with no aspirations to be the
best farms in their districts. He showed great energy and considerable vision and in mid-1921 was appointed Director of the Department of Agriculture.

Sutton set out to develop the department as a professional organisation providing research and information services to the farming community. He immediately looked to employ graduates from the University of WA and in his first year he was able to employ two young graduates, then two more in his second year. However, he realised that direct action would be necessary if he was to obtain the professional staff he wanted. He introduced a cadetship scheme where young men could be trained while working during their vacations in the department. In 1922 he appointed six cadets who later became departmental officers and this carried on through the 1920s with two to four cadets being appointed on an annual basis. He also employed young veterinarians who had been trained in eastern states universities. Two of the early appointments were Bill Bennetts and Claude Toop.

Sutton’s vision was for the department to be an organisation which worked closely with the farming community, extending to it the latest information and being made aware of its problems. He saw knowledge of its problems as the driving force behind the department’s research and demonstration program. He retired in 1937.

In his 16 years as Director he had changed the department into a highly professional organisation on which his successors were able to build. He left a legacy of professionalism which has been the basis of its operation ever since. He was one of the early inductees into the Royal Agricultural Society’s Hall of Fame.

George Kingston Baron Hay MC

George Baron Hay was born in Kingston, Jamaica, educated in England and arrived at Albany at age 18. He joined the Narrogin Farm School. In 1915 he was one of only two students enrolled in the Faculty of Agriculture at the University of WA. That year he joined the 51st Battalion AIF. He gained commissioned rank and was awarded the Military Cross in France in 1917. He was demobilised with the rank of lieutenant. He resumed his studies and graduated with a BSc in Agriculture in 1922 and was one of the first two agricultural graduates appointed by Sutton in 1922.

He worked as an adviser for seven years, initially in the wheatbelt and then in dairying areas. He was appointed as Superintendent of Dairying when Hampshire retired in 1931. He followed L StJ Jones as Under Secretary of the Department of Agriculture in 1941. He was seconded to the position of Chairman of the War Service Land Settlement Board in 1948, returning to the position of Director of Agriculture in 1951. He oversaw the department’s contribution to the war effort and after World War II managed the settlement of many returned soldiers onto properties.

After rejoining the department in 1951 and recognising the importance of agriculture to the State, he developed the department from a small organisation of limited resources into a potentially major applied research and extension agency. The period from 1951 to 1961 was one of major expansion, increasing professionalism and capacity to
contribute to the developing agriculture of the State. He also encouraged the farming community and marketers to work together for the promotion of research and orderly marketing. As part of this service he revived the cadetship scheme which saw the training of the cadre of officers who made the department such an effective organisation after the late 1950s. Two subsequent Directors of the department, Mike Carroll and Graeme Robertson, were products of that scheme. Baron Hay retired in 1961 and is remembered by Baron-Hay Court, the site of the current head office.

**Thomas Charles (Tom) Dunne**

Tom Dunne was an outstanding student and a good sportsman. He joined the department in 1922 as a cadre and was appointed an adviser in the Wheat Branch in 1926. Later that year he was awarded a scholarship to study at the University of California, Berkeley. He remained there to the end of 1930. During that time he studied plant physiology, plant nutrition and plant pathology. At the end of the four years he was awarded an MSc degree and a PhD for his research into the control of acidity in plants. This was a watershed paper in the thinking about the way plants controlled their internal acidity. On his return he was appointed as Government Agrostologist and seconded to work for the Merchant’s Agricultural Research Fund at Muresk College. He published numerous papers including the 1934 paper co-authored by Leo Shier entitled *A Modified Rotation for the Wheat Belt*. This was the first recommendation for what became known as ‘ley’ farming.

In 1937 he was appointed horticultural research officer and subsequently acted as technical adviser on fruit and vegetable dehydration. As a result of this work he was appointed as an Honorary Food Technologist for the Commonwealth Department of Commerce and Agriculture. This was part of the emergency arrangements associated with World War II.

As part of his horticultural research he identified ‘wither tip’ of apples as being due to copper deficiency.

In 1947 he was appointed Officer-in-Charge of the Plant Nutrition Branch, which later became the Plant Research Division. This period saw him working on a wide range of nutrition problems across an equally wide range of species.

As Plant Nutrition Officer Dunne focused on the issues of light land development and, with Shier, made a major contribution. As his role widened he took a strong personal interest in the Ord River development. He recognised it was important to provide a viable broadscale cropping system if the area was to be developed successfully, and chose cotton as the crop.

He developed the Plant Nutrition Branch by recruiting qualified staff with good academic records. When he was appointed Deputy Director of Agriculture (1956) and Director (1960) he applied the same standards across the department during a major period of expansion. He retired in 1971, leaving a much larger and highly professional department to his successors.

Edgar Noel (Noel) Fitzpatrick AM

Noel Fitzpatrick was born in 1929 and educated at Northam High School and the University of WA. He graduated with a BSc(Agric) in 1951 and completed an external MSc(Agric) in 1958. He joined the Plant Nutrition Branch and was given responsibility for research on the nutritional problems of pastures in the higher rainfall districts.

In his first 12 years of service he worked on the nutrition of established pastures, the nutrition and establishment problems of legumes being established on previously uncleared areas, and later the interaction of stocking rates and nutrition in an area stretching east as far as Esperance. In 1963 he was appointed as the first Scientific Liaison Officer and in 1968 returned to the Plant Research Division as its chief. In 1969 he was appointed Deputy Director and in 1971 Director of the Department of Agriculture. He was seconded in 1984 to the Commonwealth Government as Deputy Secretary of the Department of Primary Industry. He subsequently resigned from the Public Service in 1985. In 1988 he was appointed first President of the Murray-Darling Basin Commission, a position from which he retired in 1994.

In his first 12 years in the department he demonstrated the extensive potassium deficiency of older pastures in the higher rainfall areas. He also identified the importance of molybdenum on some soils in the South West and Great Southern. Work was also carried out on identifying suitable Rhizobia for lucerne establishment on sandy-surfaced soils, on the management of lucerne under grazing, the relative value of a range of perennial pasture grasses and the complexity of the relationship between stocking rate and nutrition.

In almost 13 years as Director of Agriculture he oversaw the revision of the legislation controlling the dairy industry and the Soil Conservation Service, the amalgamation of a range of statutory marketing legislation controlling crops and seeds into a single Act, the establishment of the independent Rural Adjustment Commission and the statutory control of lamb marketing. He also initiated the regionalisation of the department. In 1976 he was awarded the Australian Institute of Agricultural Science Medal. After retirement in 1994 he was awarded the 1995 Farrer Medal for contributions to agriculture. He was inducted into the Royal Agricultural Society Hall of Fame in 2007.

Norman James Halse AM

Norm Halse was born in 1929 and educated at Wesley College and the University of WA. He graduated with a BSc(Agric) in 1951 and completed an external MSc(Agric) in 1958. He joined the Plant Nutrition Branch in late 1950 and was given responsibility for research in the horticultural industries.

He worked on the nutrition of fruit trees in the early years and on the problems of the tobacco industry. Glasshouse work showed the detrimental effect of chloride level on burn time of the tobacco leaf and field studies proved that chloride levels in the WA environment made it impossible to reduce the chloride levels. Subsequently the buyers for the manufacturers decided not to purchase WA leaf and the industry collapsed.

He was highly regarded as a scientist. As the branch/division expanded he became the senior adviser and consultant to a raft of young officers who were joining the department in the late 1950s and through the 1960s. In this role he insisted on scientific rigour in research. During the 1960s he carried out valuable work in cereal crop physiology, which provided guidance for the plant breeding program and to agronomists, showing that early planting could be the path to higher yields.

In 1970 he was appointed Chief of the Plant Research Division and for the next 13 years guided the young staff in making it a top class research organisation. In 1983 he was appointed Deputy Director. He spent little time in this position, being seconded to the Premier’s Task Force on Land Resource
Management. This reflected his long-term interest in the environment. He was appointed Director General in 1984 and retired in 1990.

Through the 1970s the department’s contacts and involvement overseas increased substantially. There was active involvement in Libya, Nigeria, Iraq and Thailand. In all these projects he was the leader of the feasibility mission, program leader or both. He had an active involvement with the international agricultural research institutes in various countries. He was a member of the external program review committee of the International Centre for Agricultural Research in Dry Areas (ICARDA) for eight years and a member of its board of trustees. Subsequently, he was a member and the chairman of two external reviews of the International Livestock Centre for Africa (ILKA). He was also a member of scientific committees fostering cooperation with the USSR and China. One of the early post-war graduates, he had a major impact on the development of agriculture and the department over 39 years.

Michael David (Mike) Carroll

Mike Carroll was appointed to the department as a cadet in 1954 and completed his BSc(Agric) at the University of WA in 1958. He was appointed to the Plant Research Division as a research officer to study plant suitability, establishment and nutrition in the medium to low rainfall areas. In 1963 he returned to the university, where he studied zinc nutrition of plants.

On completion of his PhD he returned to the department and continued in the Plant Research Division. In 1977 he was seconded to the Premier’s Department as Executive Officer of the new Rural and Allied Industries Council. This was set up to help the development of the State’s agriculture beyond the farm gate. The role broadened his perspective of agriculture as an important contributor to the economy. He returned to the department in 1979 and was actively involved in a range of Commonwealth/State policy issues via the Standing Committee on Agriculture, including initiatives to improve interstate research coordination. He was appointed Assistant Director in charge of regional services, then Deputy Director General in 1984. He served as Deputy Director General from 1984 to 1990 and was appointed Director General in 1990. He retired in late 1994.

Like other young graduates in the Plant Research Division in the 1960s Mike Carroll was heavily involved with much of the research and fitting of information to provide the knowledge for sound land development. He was part of a team looking at the basic farming technology for development of the sandy-surfaced soils, including superphosphate responses, trace element requirements, pasture varieties and establishment techniques, rotations etc.

Highlights of his work as a scientific administrator included involvement with the management of the 1969 drought, resolution of the difficulties of the Ord River Scheme and research liaison associated with the growing importance of the funds contributed by industry to the research work of the department.

His contribution to agriculture was recognised by the Australian Institute of Agricultural Science and Technology with a Fellowship of the Institute in 1989. He served as President of both the WA Branch (1972) and the federal body (1986). He was elected as a Fellow of the Academy of Technological Science and Engineering in 1997. At the time of his death he was Chairman of the WA Committee and a member of the Council of the Crawford Fund.

After retirement from the department he continued involvement in agricultural policy, research and management as a program consultant for the Grains Research and Development Corporation (GRDC). He also undertook several reviews of GRDC programs and chaired committees for the Australian Crop Accreditation System (ACAS). This involved working with breeders, agronomists, quality testers,
farmers and others to ensure that ACAS took a consistent approach to providing sound independent information to growers. In these roles his analytical mind and constructive, polite but firm, approach made him an ideal facilitator in resolving the many inter-institutional and interpersonal issues across a range of such programs.

His untimely death, after a lengthy fight with cancer, was a sad loss to Australia’s agricultural industries, particularly the crop industries.

**Graeme Albert Robertson**

Graeme Robertson joined the department as a cadet in 1965, graduating with a BSc (Agric) in 1969. He then won a Rhodes Scholarship for study at Oxford, where he completed his PhD in plant nutrition and MSc in agricultural economics. He returned to the department in late 1974 as an adviser in the Marketing and Economics Branch. During this time he did extensive work on the situation of Ord River farmers following the collapse of the cotton industry and the options for government to provide assistance for that farming community. In 1977 he was appointed Officer-in-Charge of the Kununurra District Office. In this period he changed the attitude of farmers from despair to optimism. His influence was demonstrated by the farmers who, when learning he would be transferred to Perth, offered to pay his salary for two years if he was allowed to stay. This offer was not accepted and in mid-1981 he was transferred to Perth as Commissioner of Soil Conservation and Director of Resource Management. He revitalised the Soil Conservation Service to make it one of the best in Australia. He became a leading influence in the development of policy in resource management in Australia. He was recognised nationally with the McKell Medal in 1993 for “Outstanding Contributions to Soil and Land Conservation in Australia”.

In 1990 he was appointed Assistant Director covering research and research management. At this time he was also appointed Chairperson of the Federal Land and Water Resources Research and Development Corporation—a part-time position held until 1996 in association with his departmental responsibilities.

In March 1991 he was appointed Deputy Director General. He was acting Director General and then Director General with a major initial task of implementing the 1994 Portfolio Review. He was then Chief Executive of the total agency (Agriculture WA) comprising some 1700 staff. He effectively implemented changes required by the government following the review. This included moving the department’s focus to include marketing of products and meeting the requirements of consumers beyond the farm gate as part of its commitment to providing sound advice on production issues to the farming community.

**Ian Geoffrey Longson**

Ian Longson graduated with a BSc (Agric) from the University of WA in 1975 and obtained a Masters Degree in Marketing and Policy from the University of Guelph, Canada, in 1978. After a short period with the department (1978-1981) as an economist he moved via the Premier’s Department, the Asian Development Bank and the Dairy Industry Authority to a private economic consulting firm in 1985. In 1995 he was appointed as Executive Director, Program Coordination within the Department of Agriculture’s executive and was directly involved with the implementation of the Hussey Review. In 1998 he was appointed as Deputy Director General/Executive Director Policy and Business Services. In this role he developed strategies to reform the WA agricultural statutory marketing boards for grain, eggs and potatoes to address national competition policy compliance. He also developed strategies for the implementation of the government’s policy on gene technology research and the commercial release of modified organisms.

He administered the delivery of $27 million of dairy assistance following deregulation of the
industry. He also developed a food quality and safety (SQF) protocol and organised its sale to the Food Marketing Institute in the USA to make it available for international adoption.

He was appointed Director General in 2004. In addition to the normal role of the chief executive he continued the introduction of a market focus and value-adding approach for all products and services provided by the department. He established a food section and developed a multi-agency food strategy. He also initiated the ‘Farm Focus’ project to review and redirect the department’s extension and communication for the farming community. He retired from the department in June 2009.

**Charles Austin Gardner MBE**

Charles Gardner was born in Lancashire in 1896 and came to WA in 1909 with his family who took up farming in the Tammin district. He was a talented artist and won a prize for a flower painting at the Royal Show in 1916. He was appointed to the Forests Department as a botanical collector in 1920 and was a member of a Kimberley Exploration Expedition in 1921. He published details of his observations and collections under the title of *Botanical Notes, North Kimberley Division of Western Australia*. This comprised more than 100 pages, giving detailed descriptions of habitats and plants, including the naming of 20 new species. It was illustrated with photographs and detailed drawings which were a hallmark of his future work. He was appointed to the department as an assistant to the Plant Pathologist and Botanist in 1924.

Although he was not university-trained he already had a substantial knowledge of the plants of WA and a reputation as a collector. By 1927 Gardner had revised the material in the department’s collection. He had also made a collection visit to the eastern Goldfields and discovered a number of plants not previously reported. In 1928 the Botanical Branch was established and a small plant collection was transferred from the Forests Department and joined with the department’s collection. This became the State Herbarium and Gardner was appointed as Government Botanist and Curator. Gardner held this position until his retirement in 1960. In 1930 he published a paper giving a systematic census of the plants of WA describing a number of new plants.

The State Herbarium remained part of the department until it was transferred to the Department of Conservation and Land Management in 1986.

The department’s interest was primarily in economic botany and in his early years he published extensively on weeds and pasture plants. By the end of 1928 he had published over 60 papers on these issues. When he was appointed Government Botanist there was a significant change in the direction of his publications which then focused on the flora of WA. Progressively the economic aspects were left to staff as they joined his group.

Gardner was a committed plant collector, classifier and recorder. He travelled extensively, adding to the collections in the herbarium and producing numerous taxonomic papers. His 1930 paper on a systematic census of WA plants was intended to be a preliminary to a *Flora of WA*. However, except for a chapter on the grasses in 1952 and his joint paper with Bennetts on the poison plants, this did not proceed very far. At the time of his death he
was working on the genera Banksia and Eucalyptus but these were left to be completed by others. His series Eucalypts of Western Australia published in the Journal of Agriculture covered 117 species. These were compiled into a book, Eucalypts of Western Australia, by department botanist TEH (Ted) Aplin in 1979.

Over the years he published prolifically in the journals of the Department of Agriculture and of the Royal Society; 320 publications are listed in a bibliography held in the department's library. He developed an encyclopaedic knowledge and made a major contribution to the knowledge of the unique flora of Western Australia. Through vigorous representation he was instrumental in having five major flora reserves proclaimed by the government.

Harold William (Bill) Bennetts

Bill Bennetts graduated from the veterinary school at Melbourne University in 1920 having completed Masters and Bachelors degrees. In 1930 he was awarded a doctorate in veterinary science. He then worked with the Commonwealth Government in Cairns during an outbreak of bubonic plague. He lectured and demonstrated in the Department of Pathology at Melbourne University before coming to WA in 1925 as the first veterinary pathologist in the department. In 1947 he was appointed Principal of the Animal Health and Nutrition Laboratory at Nedlands, retiring in 1959. He worked for a short time afterwards as a consultant to the veterinary medicine group, Coopers.

Bennetts was without doubt one of the most illustrious veterinary scientists in Australia’s history. He was the principal scientist in the control of enterotoxaemia in 1930, the control of enzootic ataxia in 1937 and the control of ‘falling disease’ in cattle in 1939. He identified the cause of clover disease and wrote extensively on the toxic plants of WA. Enterotoxaemia, or Beverley disease, was a major problem to the early sheep industry in the Avon Valley. The discovery of the cause and the cure and production of a vaccine to control the disease had a very large impact on animal husbandry throughout the world where sheep grazing was important.

Enzootic ataxia was found to be caused by copper deficiency. This was one of the first records of a trace element deficiency causing an animal health problem in the field. It led to a large amount of experimentation to determine the extent of copper deficiency in WA. This in turn led to the development of the large areas of light land for agriculture.

Botulism: Sheep in the medium rainfall areas were affected by botulism due to poor diet causing them to develop depraved appetites and consuming the carcases of rabbits. Feeding trials had shown that the problem was due to a protein deficiency. Investigation by Bennetts and others identified the organism responsible and a vaccine was developed to overcome the immediate problem. The botulism problem was overcome later through the development of higher protein pastures through the planting of subterranean clover and the control of rabbits. Details of this and Bennetts’ other work are in Chapter 6.

Clover disease: The identification of the cause of this problem by Bennetts and his colleagues focused subsequent research and pasture management and plant breeding which provided the low isoflavone clovers which solved the problem.

These major disease conditions seriously affected sheep farming over wide areas of agricultural land in Western Australia. The research was largely completed by the mid-1940s and made possible the development of a major sheep industry. Despite a lack of resources, Bennetts achieved world recognition. Such was his reputation that while he was at the Hollywood laboratory hardly a week went by without notable scientists from overseas or interstate calling to see him.
Eric John Underwood CBE, AO, FRS

Eric Underwood joined the department as a cadet in 1924 and was appointed to the staff on graduation in 1928. He was awarded a scholarship to study at Cambridge University, where he was awarded a PhD in 1931. He rejoined the department and held the position of Animal Nutrition Officer. He resigned in early 1946 to take up appointment as Professor of Agriculture at the University of WA.

Underwood won worldwide recognition for his contribution to the solution of a number of animal nutrition problems, the outstanding one being the demonstration that Denmark wasting disease of young cattle was due to cobalt deficiency. He worked on this problem with veterinarian JF Filmer. Underwood was credited with being the first to demonstrate a field response to cobalt. He also worked on issues such as pregnancy toxaemia and fat lamb production. He was part of the team assembled to determine the cause of ‘clover disease’ in the early 1940s, and subsequently as Professor of Agriculture he supervised a program which saw the solution develop through plant breeding.

As Professor of Agriculture he earned a major international reputation as an animal scientist, particularly through publication of his book Trace Elements in Human and Animal Nutrition.

He was the major force in persuading wheat farmers to make a direct financial contribution to agricultural research and persuading the WA Government to match those funds to establish a Soil Fertility Fund. This was subsequently taken up nationally by the wheat industry and the Commonwealth Government to form the Wheat Industry Research Fund. The current Rural Industry Trust Funds grew out of this initiative. These funds have been a huge benefit to all State departments of agriculture.

Underwood’s work was recognised through numerous national and international honours, including Fellowship of the Royal Society. He was one of the first inductees into the Royal Agricultural Society’s Hall of Fame.

Laurence John Hartley (Hartley) Teakle

LJH Teakle was appointed to the department on his university graduation in 1923. In 1924 he took up a scholarship to study at the University of California, Berkeley, and completed his PhD. In 1928 he was appointed as Plant Nutrition Officer in the Department of Agriculture. On the instruction of the Director, he carried out an extensive survey of the forest and mallee soils within the triangle of Salmon Gums, Southern Cross and Lake King. This preliminary survey identified salinity as a potential cause of the problem of an estimated 40 per cent of these soils. He recommended more detailed surveys before further settlement of these areas. This report, coupled with the onset of the Depression, resulted in the area largely between Lake King and Salmon Gums, known as the 3500 farm scheme, never being developed although much of it had been surveyed ready for release. This advice extended to the Lake Brown and Lake King areas which had been settled. As a result of Teakle’s report soils of these areas were surveyed and the farms were reconstructed with some potential farmers losing their properties. This resulted in Teakle being very unpopular with some farmers and he was forbidden by the Director to go back to the area for a period. He continued to oversee this extensive soil surveying program, which was carried out in the early to mid-1930s.

As Plant Nutrition Officer he was also involved in a lot of the early work on phosphate use on various soils. He also took a major part in the early days of the trace element studies which followed on from the demonstration of copper deficiency at Gingin. In 1946 he was appointed the first Commissioner of Soil Conservation. He resigned to take up the position of Professor of Agriculture at Queensland University at the end of 1947. His departure was a big loss.
Clee Francis Howard Jenkins

Clee Jenkins originally joined the Western Australian Museum on graduation with a Bachelor of Arts from the University of WA in 1929. He transferred to the department in 1933 as an assistant entomologist and was appointed as Government Entomologist in 1939. In 1964 he was appointed Chief of the Biological Services Division which contained the Plant Pathology, Entomology, Botany and Weeds and Seeds Branches.

Among his first challenges were the grasshopper problems of the 1930s and early 1940s when plagues were common in the dry years. Swarms developed on the thousands of acres of abandoned cleared country of the eastern wheatbelt. He told of coming to work in the morning in the mid-1930s to be ordered to catch the Kalgoorlie Express that evening to travel to the grasshopper-infested areas so the Minister could say in Parliament that night that he had an officer en route to the area “at this moment”. Outbreaks of codlin moth, oriental fruit moth and sirex wasp were also dealt with effectively under his direction.

He oversaw the development of the Entomology Group from very small beginnings to an effective research and advisory unit. He was responsible for the implementation of the Argentine ant eradication campaign and advising on methods of spreading myxomatosis in WA. He was in charge of the Entomology Branch during the introduction of the new synthetic pesticides, with the benefits and problems these new tools brought to insect control.

He was awarded an Honorary Doctorate of Science in Agriculture in 1995 in recognition of his contributions to the industry and science. One of the sidelines of his period as Chief Entomologist was the continued development of the insect collection which was kept in a room protected by fire prevention equipment based on carbon dioxide flooding in the event of fire. In 1986 the collection held 160,000 insect specimens.

Claude Roderick Toop

Claude Toop retired from the position of Chief Veterinary Officer in 1966. He had joined the department in 1926 after two years in private practice, having graduated from the University of Melbourne. He began work on TB problems of dairy herds and was then appointed as the first Government Veterinary Officer stationed in the Kimberley. He worked initially on cattle tick and buffalo fly, and later pleuro-pneumonia. He then spent five years as quarantine officer at Fremantle and for a further 10 years undertook general veterinary work in the south of the State. During this period he became familiar with the disease problems and well-known among farmers.

He became acting Chief Veterinary Officer in 1948 and was confirmed in the position in 1951. In this role he oversaw the development of the departmental veterinary service in the post-war years and also fostered and developed a strong inspection service. The inspection service had the dual role of managing the eradication programs.
and relevant legislation for stock management and managing the border controls which successfully excluded weeds and exotic diseases.

Toop is credited with developing the protocols which contained the buffalo fly and pleuro-pneumonia in the Kimberley. He was involved with the eradication of swine fever in 1942 which was introduced in food for US troops stationed in WA during World War II. It reached the pig herd through swill feeding, which was subsequently banned. He introduced Strain 19 vaccination against brucellosis in dairy cattle and organised the campaign to eradicate TB from dairy herds. This had been almost achieved when the national program started in the State.

In the early 1960s he oversaw the early stages of the national program which finally eliminated TB from all cattle herds in WA. He organised the footrot eradication campaign. This was regarded one of his great successes as he adopted a rigorous quarantine and slaughter campaign which was at first quite unpopular. However, results led to widespread support for the program. While it was not fully successful, it reduced the incidence of chronic footrot from a major to a minor problem. He was also involved with the control of the pullorum disease of poultry when it was introduced.

He is also credited with the introduction of the cadetship scheme to train young men as veterinarians in eastern states universities, before the establishment of a veterinary school in WA. Toop was an outstanding officer who was inducted into the Royal Agricultural Society's Hall of Fame.

In 1934 he was transferred to Perth as a specialist export lamb market adviser. He was the original State member on the Commonwealth Technical Committee on Fat Lamb Production. In 1941 he was appointed Assistant Superintendent of Wheat Farming and was associated with the major development of what became the Wheat and Sheep Division. His major contributions as Assistant Chief of the division were to develop the agricultural advisory services for the wheat and sheep areas, particularly in the period after World War II, and through his collaboration with TC Dunne on the development of a suitable cropping rotation for the wheatbelt; he was co-author in their 1934 paper *A Modified Rotation for the Wheat Belt*. He also worked with Dunne on the development of the sandy-surfaced soils for agriculture from 1950 to 1956; particularly through Wongan Hills and Esperance research stations.

In 1953 he was appointed Chief of the Wheat and Sheep Division and continued the development of advisory services. In 1955-56 he took leave of absence to work in Syria and nearby Arab countries for the Food and Agriculture Organisation.

He established a reputation for his capacity to cooperate with, bring practical knowledge to, and marshal resources for teams of specialist researchers. Underwood, Bennetts and Reg Rossiter, a CSIRO scientist, were among his colleagues in the solution of a range of management issues with livestock. In studies of botulism in the 1930s he was an integral part of the investigation team working on feeding regimes. In the 1930s he published a number of papers on management of fat lambs. He was also part of the team that first investigated the breeding problems of sheep on subterranean clover pastures—the problem which became known as ‘clover disease’.

He became Deputy Director of Agriculture in 1961 and in that role proved to be an outstanding administrator, taking a particular interest in the development of younger members of the staff.

**Francis Leonard (Leo) Shier**

Leo Shier joined the Public Service as a cadet in 1922. On completion of his Agricultural Science degree he was appointed to Geraldton as an adviser in 1926. During his time there he was involved with the experimental program at Chapman Research Station and carried out active extension and practical research over a wide area of the wheatbelt.
Chapter 9 – Significant people of the department

George Henry Burvill

George Burvill joined the Department of Agriculture as a cadet in 1927 and was appointed as an agricultural adviser in 1930. He became Assistant Plant Nutrition Officer in 1937 and was appointed Commissioner of Soil Conservation in 1947. In 1956 he was appointed as Chief of the Plant Research Division and in 1969 as Assistant Director. He retired in 1971.

Burvill graduated from the University of WA with a BSc(Agric) with first-class honours. He had distinctions in all subjects during his degree, an achievement only matched by one other graduate. From 1930 to 1935 he worked on the soil surveys in the Lake Brown district, Lake Carmody and Lake Camm areas west of Lake King and then the Salmon Gums district which followed Teakle’s report. In 1937/38 he spent a period with CSIR Soils Division and the Waite Institute in Adelaide on study of the salinity problems of the Kerang area in Victoria. For this work he was awarded a Master’s degree.

His main work after return to WA in 1938 until appointment as Commissioner of Soil Conservation in 1947 was in a team looking into the nutritional problems of sandy-surfaced soils. This followed the identification of copper deficiency at Gingin which triggered a widespread interest in trace element deficiency. This work provided the basis for the development of the 1950s and 1960s.

In 1944 he led a soil survey of the Ord River Valley which was the basis of the establishment and subsequent management of the Ord River irrigation scheme.

In 1947 he took over the infant Soil Conservation Service which had been established under Teakle in 1946. In the following nine years he worked with limited resources and limited support from the community to establish an ethos of conservation of the State’s soils. It was almost 30 years before the community in general started to give strong support for conservation of soils as part of the growing commitment to conservation of natural resources. In 1956 he took over the Plant Research Division from Dunne and oversaw its expansion into a potent research unit within the department. The division worked on a range of issues over the next 50 or more years making a major contribution to the successful development of both existing agricultural and the light land areas.

After early retirement in 1971 he edited the book *Agriculture in Western Australia—150 years of development and achievement 1829–1879* which was part of the State’s sesquicentennial celebrations in 1979. He also prepared a final report on the Salmon Gums soil survey which due to other pressures had not been completed. The Salmon Gums survey remains one of the largest detailed soil surveys ever carried out in Australia.

Burvill was inducted into the Royal Agricultural Society’s Hall of Fame for his contribution to agriculture in WA.

He became renowned for his encyclopaedic knowledge of Western Australian soils, vegetation, and geography. While this was not his main contribution to agriculture he was an important reference point on many issues for professional colleagues of all ages with whom he shared his knowledge generously. When he died in 1992 the comment was made that “a library of information had died with him”.

Meredith Ryers (Bill) Gardiner

Dr Gardiner was born in the USA in 1913 and obtained his BS(Chem Eng) and later VMD (Doctor of Veterinary Medicine) at the University of Pennsylvania. His early career involved several universities and in private industry, a period of war service with the US Navy in the Pacific followed by private practice in northern Queensland before returning to the USA.

In 1959 Dr Gardiner was appointed Veterinary Pathologist in the Animal Health Laboratories. Later in that year he became Chief Veterinary Pathologist following the
Bill Gardiner was recognised for his great capacity for work and his enquiring mind, and he applied both of these characteristics to a wide range of veterinary problems in Western Australia, both as a researcher and an administrator. During his time with the department he published over 85 scientific papers on a range of topics including lupinosis, selenium and nutritional myopathy, clover disease, various poisonous plants, internal parasitism, and diseases being tackled by State eradication and control programs including bovine tuberculosis, bovine brucellosis and cheesy gland in sheep. He identified the presence of a large number of diseases not previously reported.

Dr Gardiner made huge contributions to scientific knowledge on lupinosis, selenium and animal health, clover disease and cobalt nutrition in ruminants. He made the first comprehensive descriptions of the pathology of lupinosis, and his review published in 1967 is still widely referred to. He was the first person to conclusively prove that lupinosis was a mycotoxicosis (in 1966), but was beaten to publication of the identity of the causative fungus by the South Africans in 1970. He conducted extensive studies into the epidemiology and pathology of nutritional myopathy in sheep and the association with selenium, building a base of knowledge in Australia for others to build on in coming decades. His investigations and reviews of clover disease and cobalt deficiency are still considered essential reference materials. His research achievements were recognised with the award of the degree of DVSc by Melbourne University and foundation membership of the Australian College of Veterinary Scientists.

During Gardiner’s period of leadership, the Animal Health Laboratories were developed into a complete diagnostic veterinary laboratory with the full range of diagnostic disciplines, and he built up a team of well-trained scientists that formed the foundation for the excellent reputation this organisation developed. He also oversaw considerable expansion of field veterinary services and directed greatly increased animal health field activities throughout the State. Dr Gardiner was also a member of the planning board and the Veterinary School Committee during the establishment phases of Murdoch University.

Stanley Thomas (Tom) Smith
Tom Smith joined the department on graduation in early 1944. He was a farmer’s son with a sound general knowledge of agriculture and excellent interpersonal skills. He worked initially in the Plant Nutrition Branch where his first job was taking part in the first soil survey of the Ord River Valley.

In the early 1950s, he was appointed Senior Soil Research Officer with specific responsibilities to develop research programs to increase understanding of the expanding wheatbelt salinity problem and to devise practical ways of maintaining agricultural production on affected farmland. In particular, he initiated studies into the direction and movement of groundwater in wheatbelt valleys using techniques which had not previously been applied to the agricultural salinity problem. Under his direction, work on the selection and propagation of salt-tolerant plants was promoted.

Tom Smith was one of the early proponents of clearing restrictions on actual and potential water storage catchments in the South West. Although this advice was largely ignored at the time, a number of catchments were subsequently revegetated at very considerable cost.

In 1969 and for several years in the 1970s, low rainfall led to many areas in the wheatbelt encountering a serious lack of on-farm water supplies. The government organised special measures to provide relief. As part of these arrangements Tom Smith, in association with the then Rural and
Industries Bank Commissioner, Jack Gabbedy, put in place emergency supply measures. These included drilling programs, pumping water from fresh and brackish lakes, and trucking bulk water supplies into water deficient districts. Tom Smith’s appreciation of the seriousness of the situation and his empathy with farmers’ problems ensured a very rapid response. He then encouraged staff to develop new and innovative techniques to maximise run-off into farm dams and to minimise evaporation and seepage losses. They were also encouraged to design computer models to estimate optimal dam and catchment sizes for a given sheep flock size in a range of rainfall and evaporation zones.

Tom Smith’s expertise in soil matters was recognised when he was appointed in the 1960s as a soil specialist assisting a UNESCO project in the Sudan. With his sound knowledge of the soils he was heavily involved with the Ord River Scheme and served on the Kimberley Research Station technical advisory committee. He also supervised further soil survey work on the Ord and elsewhere and undertook some early studies of salt movement in the soil profile under irrigation on the Kimberley Research Station. He was appointed Chief of the Soils Division and Commissioner of Soil Conservation in 1966. He took responsibility for the general oversight of the department’s work on the Ord. He was appointed Deputy Director in 1971. The department lost a very valuable officer with his early death in 1981.

**Thomas Edward McDowell**

Tom McDowell joined the department on graduation in early 1949. His first advisory post was in Esperance but he moved to Narrogin early in his career. In Narrogin he was highly regarded for his work across a very large district. In the eastern parts large areas of light land were being developed for agriculture, requiring a lot of attention. Tom was a pasture and crop enthusiast and his work at Narrogin demonstrated both the value of topdressing pasture and the enormous advantage of applying superphosphate to pasture as close as practicable to the start of the season compared to early topdressing.

Tom also played a pivotal role in the development of the experimental area at Forrestania some 30 miles east of the rabbit-proof fence to determine its suitability for farming. This area demonstrated that agriculture could be successfully extended into that area on light land. The heavier soils carrying forest and mallee had been looked at for the 3500 farms scheme and rejected, but the combination had proved to be economically viable elsewhere. A monument to his work now exists on that site even though the government decided not to extend settlement into the area.

In 1967 he moved to Perth as Assistant Chief of the Wheat and Sheep Division and in 1969, Chief of the Division. He became an Assistant Director in 1971 and Deputy Director in 1981. His sudden death in late 1982 was a great loss to the department.

**Alfred Richard (Dick) Tomlinson**

Dick Tomlinson initially joined the clerical service of the department but was appointed as Acting Chief Inspector of Vermin in 1949. This position was later confirmed and with the creation of the Agriculture Protection Board in 1952 he became its first Chairman and Chief Executive Officer. Due to potential administrative conflict and the intention that the board would remain closely allied with the department, the Act was subsequently amended to make the Director of the Department of Agriculture the *ex officio* Chairman, and Tomlinson remained the Chief Executive Officer.

The success of the board over the next 40 years was a tribute to the energy, vision and insistence on work being a cooperative effort with farmers, local government and the board. Rabbits, which had been a plague, were controlled with innovative poison programs and warren ripping, even though
myxomitosis was not as effective in WA as elsewhere. Wild dogs in the pastoral areas were also brought under control largely through identifying their breeding areas and carrying out a targeted aerial poisoning campaign. There was some (but less) success with the fox. This was largely due to difficulty getting the same degree of cooperative action coupled with greater difficulty in getting an effective control measure.

Caged birds were also brought under control in order to avoid accidental introduction of serious pests into Western Australia. A particular success was the prevention of starlings from reaching the State as rabbits and foxes had done.

During his period of office the rabbit-proof fence was modified. The No. 2 fence was largely sold; the No. 1 and No. 3 fences were joined and with the remainder retained as a vermin-proof fence. The work on weeds was also far better managed than in other states because of the legal capacity to have action taken. A particular success was the control of skeleton weed. Independent study showed that this weed was potentially a serious problem. This has not occurred because of the farmer-funded control program.

Robert John (John) Lightfoot

John Lightfoot joined the department as a cadet and completed his agricultural science degree at the University of Western Australia and was appointed an adviser in the Sheep and Wool Branch. In the 1960s he spent three years at the University of Sydney undertaking a PhD. He resigned from the position of Executive Director of Animal Industries in 1998 to join an agricultural lime supply company, Aglime, as manager of exploration and mining.

John’s major interest was research. Much of his work was related to the reproductive physiology of the sheep. This included the impact of high isoflavone subterranean clovers, nutrition during and before mating and the management of rams during the joining period to increase the efficiency of joining, the use of deep-frozen sperm in artificial insemination and the movement of sperm in ewes following insemination. He investigated the important components of clover disease, which had returned as a major problem in the 1960s and 1970s. This research led to a range of recommendations to minimise the depression in fertility of ewes associated with grazing on clover-dominant pastures. Later work showed an effect on ewe fertility remained even on ‘balanced’ pastures. He also clarified management and production issues associated with lambing ewes at different times of the year.

The opportunity for higher stocking rates than those used traditionally by farmers had been demonstrated by the late 1950s as had the importance of measurement as a tool in selecting superior sheep in breeding programs. Lightfoot promoted both these ideas strongly to the industry. In the early 1960s he was involved in the encouragement of Merino stud breeders to use objective measurements in the selection of sires. This involved visits to many of the larger studs to demonstrate the benefits resulting from weighing rams, from weighing fleeces at shearing and having the diameter of the fibres measured rather than using visual crimp scores. Regrettably, the studs were not initially receptive to these ideas. Perhaps his most important contribution to the sheep industry was organising the importation of Awassi (a fat-tailed meat and milking breed) sheep from Cyprus through a very vigorous import and quarantine protocol. This was controversial, with concerns expressed by the conservative fringe of the wool industry about the possibility for black fibre contamination of the Australian fleece. The downturn in recent years of wool had boosted live export industry. This industry has been helped by the capacity to export the preferred fat-tailed sheep to Middle Eastern markets. This capacity developed in the 1980s.
John Lightfoot’s expertise in sheep production was widely recognised and over a 15-year period he was heavily involved in advising the sheep industries in Libya, Nigeria, Tunisia, Iraq, Saudi Arabia and China. He retired at an early age, which was a serious loss to the department.

William John (Jack) Toms

Jack Toms joined the department in 1952 after graduation from the University of WA. He was appointed to the Plant Nutrition Branch and after gaining experience, including some time on Esperance Research Station, he was given the responsibility for managing the branch’s work in the wheatbelt. This demanded a lot of cooperation with the advisers in the field. At the time the Jerramungup War Service Land Settlement Scheme was being developed. Investigating the needs of this area was a challenge in itself. All the experimental work had to be done with farmers’ or the scheme’s machinery and there was no accommodation, so camping was required.

Development of the western sandplain centred on Eneabba was also creating special problems, developing large areas of deep sand. As the development push slowed Toms became interested in the use of nitrogen across the wheatbelt and carried out the initial work on its use. He also initiated the early experimental work on continuous cropping.

With the first blocks on the Ord River Scheme about to be allocated he was sent north to supervise the planting of trial areas. He grew 30 acres of cotton as the first crop in 1961/62 and 200 acres in 1962/63. The first commercial crop was grown in 1963/64. As an indication of his energy and commitment he fertilised and weeded the first 30 acres by hand and did the same on the 200 acres with the help of a potential block owner. He was dependent on a private company for equipment for planting, spraying and harvesting but found them peculiarly uncooperative.

Later he was a vigorous research leader, described by one of his staff as “challenging, stimulating and fiercely supportive of his staff”. He oversaw the modernisation of plant breeding in the department. He was appointed Chief of the Plant Production Division and later Assistant Director in charge of the department’s research program. Overall he made a major contribution to the industry.

Barry Richards

Barry Richards joined the department as a cadet and graduated BVSc from Queensland University. On graduation he joined the veterinary pathology staff and was appointed Chief Veterinary Pathologist in 1990, retiring from that position in 2004. He returned to the role from late 2006 to early 2009.

He was involved with the establishment of the regionalised veterinary laboratory services and initiated the concept of specialist functions in regional laboratories. The success of this was reflected in the Albany Regional Laboratory being designated as the national reference laboratory for ovine footrot. This resulted from the development of a definitive test for the virulent form of the causative agent of footrot at that laboratory. This provided the means of carrying the footrot eradication campaign forward as a control program.

A 1980 Senate Select Committee report concluded that “on welfare grounds alone, there is sufficient evidence to close the live sheep trade”. This report had to be dealt with, for this trade was a vital component of the sheep industry. Richards became actively involved in research into the causes of death in live sheep export. He was backed by considerable industry support and his team were able to identify the major causes of death and the risk factors. The recommendations from this work, adopted by the industry, halved the annual death rate and allowed exports to continue. It is almost certain that the trade would have ended in 1986 without this research.
In 1990 an administrative decision was made to charge for laboratory services deemed to be for private rather than public benefit. Following the 1994 review, the private services portion of Animal Health Laboratories was formally rolled into a business unit (AGWEST Animal Health). This meant that revenue had to cover the cost of providing the services. The business grew steadily until the end of the 1990s and has remained at about $2 million a year since. The business unit now uses export testing to hone the skills essential for maintaining the State’s ability to handle high-volume testing in the event of an exotic disease outbreak.

In the late 1990s the Commonwealth asked the states to increase the quality of their laboratory services, primarily to enhance its bargaining power in negotiating international trade protocols. The WA laboratory was the first Australian Government laboratory to obtain accreditation under the National Association of Testing Authorities of Australia (NATA) in the relevant fields of veterinary testing. Engineering the cultural shift and the funding the program was a major undertaking.

Richards also initiated an Australian-wide system, called Syndrome Surveillance, which aims to collect, collate and report the data from the testing for about 12,000 outbreaks of animal diseases annually. This activity is essentially the reason Australia knows it has no ‘exotic’ disease. Previously this valuable data sat in State laboratory IT systems and was not used to demonstrate the extent of active disease surveillance in Australia. The system is now installed in the key performance indicators of the National Animal Health Laboratory Strategy (NAHLS).

Richards also had a major role writing and workshopping the business plan (defining the deliverables and key performance indicators) for the National Animal Health Laboratory Strategy. The outcome was long overdue and required each jurisdiction to provide sufficient good quality services to make a major contribution in the event of an exotic disease outbreak.

DG (David) Wilcox AM

A request from the Pastoralists and Graziers Association led to the appointment of David Wilcox as the first agricultural adviser to the Mulga Zone, a vast area extending north from Kalgoorlie and Yalgoo, to Gascoyne Junction and to Newman and east towards Giles. In 1955 he took up residence in a disused hotel in Wiluna, where mining had ceased in 1948. He continued to work in the rangelands of WA and in Australia generally for 31 years and became Principal Rangeland Management Officer.

He combined studies with keen and accurate observations of the clear changes which had taken place in the 100 years of settlement, to develop a fundamental understanding of the natural pastures of the region. This involved identifying the relationships between trees, shrubs, grasses and herbages, the ever-changing rainfall and the grazing pressures imposed by domestic and native grazing animals. This allowed him to formulate a number of grazing management regimes and to identify the adverse impacts of unsustainable stocking rates on the multitude of distinct pasture resources in the region. In association first with JG (John) Morrissey and AA (Andrew) Mitchell, he published a definitive book *Guides to the Arid Shrubland Plants and Their Use*.

His abilities in landscape description equipped him to lead the first survey of land resources and their condition in the Gascoyne catchment, which began in 1969. Using land description methods pioneered by CSIRO and developing a methodology for land condition assessment, he was able to report on the location and severity of land degradation for each lease and to make recommendations for the future use of the leases. This innovative approach has continued to the present day. Almost all leasehold land in WA has been described and assessed in sufficient detail to allow for reports and recommendations for all leases to be prepared.
As a result Western Australia has no rival for the quality and extent of its knowledge of its pastoral resource base.

The Gascoyne catchment report was followed by the search for effective and reliable methods for measuring trends in land condition. Wilcox began, with others in 1972 to develop a method for measuring change in pastoral condition. This led eventually to the adoption of a Western Australian Rangeland Monitoring System (WARMS). It is the most reliable spatial system of recording changes in Australia. When lease-specific monitoring systems, also pioneered during this time, are included, this State has the capacity to ensure that its leasehold land is managed sustainably.

David Wilcox was appointed a Member of the Order of Australia for services to the environment and to Australian rangelands in particular. He received the Centenary Medal for services to the Western Australian pastoral industry and the Order of the Quart Pot by the Pastoralists and Graziers Association. He founded the Australian Rangeland Society, which is devoted to the science and art of using Australian rangelands in a sustainable manner, and was its first president. A rare acacia, *A. wilcoxii*, has been named after him as a token of his distinguished career in Australian rangelands.

**David Lawrence (Dave) Chatel**

David Chatel graduated from the University of WA with a BSc(Agric)-Hons in 1960, MSc(Agric) in 1964 and PhD (1968). He joined the department as a research officer in the Division of Plant Industries in 1967.

In the early years Chatel continued his university studies into the development of new strains of inoculant Rhizobia aimed at overcoming serious nodulation problems in large areas of young subclover-based pastures. The work resulted in one of his strains being used throughout Australia and overseas. It was an example of an ecological study into an agricultural problem, and its resolution was often quoted in the literature.

In subsequent years he investigated and overcame nodulation problems with lupins and medics that involved strain development and inoculation methodology. His awareness of possible specific Rhizobial requirement for legumes collected overseas resulted in seed collectors bringing back seed with nodules and soil from which the bacteria could be isolated. This resulted in acid-tolerant Rhizobia being collected with medics from Sardinia.

Early in the 1970s David Chatel became involved with research into the subclover disease, clover scorch. After the causative organism had been identified by plant pathologist Atilla Bokor, David and Clive Francis embarked on a breeding/selection program that resulted in the production of a new resistant variety of subclover, Esperance.

He also worked on the Jezira project in Iraq and produced an inoculant *Rhizobium* isolated from native Iraqi medics that proved to be very effective when introduced to Iraq for the project farms. He was the Australia-based coordinator of the project *Australian Contribution to the National Agricultural Research Project* (ACNARP) in Thailand which was funded by the World Bank.

He was an outstanding scientist with an international reputation for work from the fundamental to the applied on the vital *Rhizobium* link to the host legume. He was the author of three book chapters, 22 refereed papers, 18 conference papers and 22 technical reports and extension papers.

Much of his time from 1980 until he left in 1996 was in administrative positions, ranging from Officer-in-Charge of the Plant Pathology Branch to positions in the executive.

In 1983 he was appointed Principal Plant Pathologist, and in 1986, Chief of the Plant Research Division, and in 1987 he became Director of the Plant Industry Division. From 1992 to 1994 he was Manager of Plant Protection and Chief Quarantine Officer (Plants), and in 1994 to 1995 he was A/Executive Director Plant Industry. He retired in 1996.
Michael Leslie (Mick) Poole

Mick Poole graduated with a BSc (Agric) from the University of WA in 1965 and joined the Plant Research Division as a pasture research officer working on establishment of legumes on new land. In 1970 he transferred to crop research, investigating the competitive effects of sowing pasture under crops. With the growing importance of minimum tillage, he began working on aspects of the developing technology and providing leadership over the next 15 years. With the transfer of the Weed Research Group to the Plant Research Division he moved to the leadership of that group.

In 1987 he was appointed Director of Enterprise Development with responsibility for new industry development, overseas projects and intellectual property. In 1991 he was appointed Executive Director of Plant Industry. He resigned in 1994 and moved to CSIRO as head of the new CSIRO Centre for Mediterranean Agricultural Research.

Mick Poole published extensively on his work and the issues associated with the development of the new cropping systems. This included the competitive aspects of pasture establishment under crops, new crops for the southern wheatbelt (particularly rapeseed/canola), effects of waterlogging on crop and pasture production, aspects of weed competition and fertility build-up and rotations, and environmental impacts of the new cropping systems. He later provided overviews of the developing alternative cropping systems. He also oversaw the department’s overseas programs in Iraq and Saudi Arabia and contributed to the projects in north-western China and Iran.

He represented the department on a wide range of State and national committees and held personal appointments to a number of national committees and organisations. These included Chair of the Australian Plant Industries Committee and National Pasture Improvement Coordination Committee. He spent several years on the board of the Grains Research and Development Corporation, chairing its research committee.

Mick has been recognised by award of the Centenary Medal, Urrbrae Medal and the Farrer Medal for his contributions to agriculture. He was also elected a Fellow of the Australian Academy of Technological Sciences and Engineering and a Fellow of the Australian Institute of Agricultural Science and Technology.

Clive M Francis

Clive Francis joined the department having completed his PhD at UWA. He retired in 1999 after 33 years, of which seven years from 1992 were spent as Deputy Director of CLIMA, the jointly-funded Cooperative Research Centre (CRC). He was awarded both the Farrer Medal (1985) and Institute of Agricultural Science Medal (1982). He was perhaps Australia’s most successful pasture plant breeder. In the period 1975 to 2000 the group he led release of a large number of commercial pasture cultivars or species.

There were nine low isoflavone subterranean clover cultivars, two low isoflavone red clovers, three new medics, one Persian clover, one serradella, one bitter vetch and three high isoflavone red clovers for a drug company.

The concept of free-seeding easily-harvestable pasture varieties as an alternative to subclover and medics was a new approach which he promoted. It was brought to fruition as a phased pasture system through the efforts of other staff. This approach resulted in no less than six new pasture species for Australian farmers.

Gathering and utilising a wide range of genetic resources was an underlying part of his career. He developed strong links with the famous Vavilov Institute in Russia and was awarded the Vavilov Institute Memorial Medal in 1999. The link developed with the Vavilov Institute resulted in over 4000 accessions of grain legumes being introduced to Australian collections. He also travelled extensively on plant collection tours.

He collected plants from other parts of Australia and from Spain, Portugal, Morocco,
Ethiopia, Libya, Israel, Syria, Iraq, Iran, Sardinia, Cyprus, Greece, Crete, the Canary Islands, Madeira, Turkey, Armenia and Georgia. These missions resulted in a number of commercial releases and dramatically widened the genetic base of the breeding program.

**HG (Jack) Neil**

Jack Neil joined the department in September 1948. He was located at Moora for much of his period as an adviser. He had a special interest in sheep and sheep management and in pasture development. Jack enthusiastically applied his skills to the animal industries and in particular the scientific approach to wool improvement. He also made a valuable contribution as a trainer of young advisers in their early years of development of professional service.

In recognition of his contribution in the area of sheep management he became OIC of the Sheep and Wool Branch in 1965. There he built up the fleece testing laboratory and developed a cooperative approach with a large proportion of the State’s parent and commercial Merino studs. With the reorganisation of the department in 1977 he was appointed Chief of the Animal Production Division.

In 1971 he undertook a study tour of Middle Eastern countries to look at the live sheep industry and discuss with the purchasers and their customers the type of sheep wanted. While the exporters and importers focused on older fat wethers his investigations indicated that the customers would have preferred younger sheep. Over the years the industry moved in that direction and is now dominated by the export of younger animals. In all his roles he was an outstanding officer. But in his early years he also made a particular contribution to re-establishing the department’s country-based advisory service which had been decimated during World War II by enlistments, resignations and transfers to other duties.

**Lionel Dawson White**

Lionel White left school to work on the family farm at age 15. He then spent some years in the RAAF during World War II and trained as an agricultural scientist after being demobilised. He joined the department in 1951 and was appointed initially to Katanning. He decided to return to the family farm but after a short time returned to the department and was appointed an adviser at Northam.

Lionel was a livestock enthusiast with a passion for proper grazing management. He saw this as a keystone to successful crop rotation in minimising take-all disease in wheat and set up many grazing demonstrations to show the impact. After some years at Northam he moved to Perth as a senior adviser. When the department was reorganised in 1977, as the first step in its eventual regionalisation, he was appointed as the first Assistant Director in charge of the Regional Services Division. He acted as Deputy Director for a period before his retirement in 1983.

**Ronald John (Ron) Parkin**

Ron Parkin joined the department as a cadet and was appointed as an adviser on completion of his degree in 1962. He worked initially in Geraldton and then Esperance. After obtaining a Diploma in Agricultural Extension at Melbourne University and a short period in head office he spent four years at Albany as Officer-in-Charge and two years leading overseas projects before moving to Perth in an administrative role. He resigned to take up consultancies in overseas programs in 1991. Ron was a very able and effective extension officer, a very good field research worker and an able administrator. After he left the department he was sought after by International agencies.

At Geraldton as an adviser he also had a substantial program of applied and adaptive on-farm research. He was energetic and innovative and was involved with the development of the preparation of lime-pelleting of legume seeds in large scale
quantities, identification of the importance of cereal cyst nematode in the Geraldton district, the introduced Harbinger medic and demonstrating management options for medics, subclover and rose clover. While at Esperance he played a major role in the establishment of the Johnson Lakes experimental area to test its suitability for farming as well as continuing in extension and field research.

During his period at Albany the office was developed as one of two pilots testing the regional conduct of research and extension, as part of the developing regionalisation policy in the department. Core research staff were located at the office in animal health and production, agronomy, plant pathology, entomology and horticulture. Interdisciplinary teams were established including a regionally-based economist.

In early 1980 he accepted the role of team leader of an agricultural development project in the Jezira area of northern Iraq. This proved to be a very challenging undertaking for technical and political reasons. He followed this with a period as Principal Overseas Projects Officer with the Western Australian Overseas Projects Authority (WAOPA), responsible for the servicing/management of overseas agricultural projects in Libya and Iraq. After a brief period as Principal Extension Officer located in Perth, he took over as team leader of the Western Australian cooperation with the AusAID and World Bank-funded National Agricultural Research Project, Thailand (ACNARP) in 1983. This involved the development of 19 regional research centres along the general lines of similar organisations in Australia. In 1984 returned to the Department as Assistant Director in charge of regional services. He held this position until his resignation in 1991. Ron Parkin was an outstanding officer, which was reflected in extensive and varied career.

**Richard Frank (Dick) Buckley**

Dick Buckley joined the department as a messenger in 1934. After a short time there he was transferred to the Mines Department. In 1940 he enlisted in the Army, then rejoined the Department of Agriculture in 1946 and spent the rest of his working life there. He became a stores clerk and by the mid-1950s was in charge of the Stores Branch. He became a legend for his capacity to get things done through the complex Public Service system which existed at the time. Although not a high profile member of the organisation he was greatly appreciated by a generation of the department's employees and was a most valuable officer.

**Olga May Goss**

Having won an Exhibition to study science at the University of WA, Olga Goss graduated with a BSc with honours in zoology. After a short period as a lecturer and demonstrator at the university and working as a pathologist at the Children’s Hospital, Olga then joined the Department in 1945 as a plant pathologist. In her 35 years of service she worked on a wide range of issues, particularly in the early years when there were only two other plant pathologists.

Olga retired in 1980 as a highly respected senior plant pathologist. She took a particular interest in nematodes and published papers on eelworm infection of...
potatoes and other vegetables and also took the leading role in the investigation of eelworm problems in viticulture, orchards and cereals.

Olga pioneered the control of nematodes on bananas at Carnarvon and showed the importance of using resistant rootstocks in viticulture and orchards. She identified the existence of resistance to eelworm infection rootstocks of peach trees and also summarised the overall position of eelworm in WA and the available control measures.

Prior to the advent of commercial production, Olga also oversaw the provision of a wide range of Rhizobia to other researchers and to the farming community. Her other great interest was in nursery hygiene and she published a handbook on this subject drawing on local, interstate and overseas experience.

In recognition of Olga’s contribution in this field she was honoured with the Australian Nurseryman’s Award in 1978 and in the same year was elected Nurseryman of the Year.

Plant pathologist Olga Goss was closely involved with the early work on eelworm infestation and had a close association with the nursery industry.

Olga was also a ground breaker and was the only female member of the professional staff. Initially she was rarely allowed to make field trips because it was thought that growers would be reluctant to accept advice from a young girl. Ironically, she spent most of her working life on farms assisting growers with their problems. At first she was not permitted to spend a night away from the office. The final problem was that she was not as well paid as male graduates in comparable positions.

Laurence (Laurie) Snook

Laurie Snook graduated with a BSc(Agric) in 1932 and an Honours degree in 1935. He was awarded a Hackett studentship and studied at the Rowett Institute in Scotland. His work in Aberdeen related to pregnancy toxaemia in sheep. He demonstrated that the problem, then known as twin lamb disease, was due simply to a shortage of energy in the latter stages of pregnancy. For this ground-breaking work he was awarded a DSc. This was important in WA because of the autumn lambing practised here.

He began research at Cambridge University but with the outbreak of war returned to Australia to enlist. He saw service in North Africa and Tobruk. He was transferred to the medical corps as a pathologist and served in Palestine, New Guinea and Bougainville before discharge with a rank of Captain.

He rejoined the Department in 1946 and worked as Officer-in-Charge of the Animal Nutrition Section. He resigned in 1962 and worked until 1979 for FAO in many countries. He was awarded Fellowships of the Australian Institute of Agricultural Science in 1979 and Society of Animal Production in 1988.

His work on phosphorus deficiency in high yielding dairy cows was also very important. Phosphorus supplementation resulted in both increasing production and improved fertility. Attempts to improve the phosphorus level in pasture were not successful but he was able to demonstrate that dissolving a soluble phosphate (superphosphate) in water and sprinkling this on feed in the bail was quite effective. This work was carried out at Bramley Research Station which was purchased for the purpose.

He made a separate and important contribution through promotion of tagasaste (tree lucerne) as a fodder for cattle. As a boy
he had observed the hardiness and the preference for the shrub among farm animals in summer in the wheatbelt. Having established a small area at the Animal Health Laboratory in Nedlands, he measured its productivity. This showed it could be very productive but despite his promotion there was little professional or farmer interest until the 1980s. Eventually it was tried by farmers who developed methods of having it grazed by cattle rather than having to harvest and hand-feed it. It proved to be particularly useful on the deep sandy soils of the western sandplain. In 1988 Laurie Snook led a group to the Canary Islands, where tagasaste came from, to look for other genetic material. His resignation at an early age was a loss to the department. He has been inducted into the Royal Agriculture Society’s Hall of Fame.

**Stanley Edward Hardisty**

Stan Hardisty graduated from the University of WA with a BSc(Agric) degree, joined the Horticulture Division, and worked on issues in the fruit industry for his whole career. He is listed here for the major contribution to reducing the cost of sending apples to Europe, work which he began in the 1960s. During the first 65 to 70 years of the 20th century England was a major market for WA-grown Granny Smith apples. In the late 1960s and early 1970s access became difficult. This was partly due to competition but primarily to cost.

Freight was a major component of costs. In the 1960s, Hardisty worked on the use of loose-packed bins rather than cartons. However, refrigerated containers were introduced in the early 1970s and soon became the only means of consignment. The new challenge was to ship a maximum amount of fruit in each container.

Bulk bins which Hardisty had developed earlier gave greatly increased stowage. In 1979 the next step was to consign a sea container full of ‘loose’ apples. This trial proved successful as were small shipments of a few containers consigned by South West growers (from Donnybrook and Manjimup) over the following two seasons. The loading of apples into the containers was done by a conveyor belt of half the length of the container with a false door to ensure control when unloading. On arrival at Tilbury the containers were loaded onto a truck and delivered to an importer at Canterbury and unpacked with equipment built in WA and consigned on an earlier ship. The pack-out quantity was high.

The move to container shipment was a big cost advantage and also resulted in handling being transferred away from the port workers of both countries. Packing and unpacking were in the hands of experienced staff in the orchard areas and in the importers’ warehouses. Previously, hardwood dump cases were manhandled by dock labour at both exiting and inward ports, resulting in heavy bruising. In contrast, the pack-out of the bulk containers was excellent, with no downgrading for the observed pressure points which were small and shallow, with no discolouration.

**John Ernest Cripps**

John Cripps joined the department in 1955 and was posted to the Horticulture Division in 1955 as a research officer. Biennial bearing had been a problem of the apple industry for many years. It was a particular issue for exports producing smaller fruit during the ‘on’ years and large softer fruit in the ‘off’ years. Neither was ideal for the export market. Cripps was able to demonstrate that chemical thinning of the heavy crops gave good crops in the ‘light’ years and overcame this problem. He also demonstrated that heavy super dressings overcame die back of mature trees. This was in contrast to earlier work. He was also in charge of the work at Stoneville Research Station which showed that the Malling Merton rootstocks bred in the UK were superior under WA conditions. These rootstocks are now universally used in the industry.
John Cripps' main achievement came from apple breeding. This program was reluctantly approved initially but over the years proved a great success. As in most breeding work selecting the right parents and managing a large volume of material are the secrets to success. In apple breeding it also requires a long-term commitment—20,000 plants were protected from cross-pollination each year and 108,000 seedlings were produced over three decades.

Apple breeder John Cripps bred the Pink Lady™ and Sundowner™ varieties.

In the late 1980s two new cultivars were selected and registered as Cripps Pink and Cripps Red. Both were grown commercially and high quality fruit marketed as Pink Lady™ and Sundowner™. It was reported that 20,000 Cripps Pink trees had been planted by the industry to June 1990. In 2008 Western Dawn, marketed as Enchanted®, an apple which does not brown after cutting, was released. In 2008 the Cripps Pink was grown in 15 countries and sold in 30 countries.

In 1989 Cripps was put in charge of the eradication of apple scab from WA. The campaign involved the destruction of 45,000 trees, spraying of non-infected orchards and raising the hygiene standards in the industry. It was successful and WA became the first State to eradicate the disease. Earlier, he was involved in the initial plantings of vines in the Manjimup district, which has led to the establishment of the industry in Manjimup.

He retired in 1998. In 2010 he was inducted into the Royal Agricultural Society Hall of Fame.

Clive Vincent Malcolm

Clive Malcolm graduated from the University of WA in 1955 and joined the Department of Agriculture. He later completed degrees of MSc(Agric) in 1963 and an MSc from the University of Manchester in the UK. He retired from the department in 1991. His major work with the department was on the revegetation of saltland. While this work had been started some years before, he approached it with skill and determination, recognising the extent of the salinity problem in WA and the difficulty of the work he was undertaking.

The key issues were to first identify plants which would grow in the environment and select ones which were palatable to stock. It was then necessary to find methods of establishing them across large areas and finally to determine their value to livestock. He established a major collection of salt-tolerant plants, then together with a farmer, developed the innovative Mallen seeder.

Having established good stands of saltbush and bluebush he was able to stock them and determine their carrying capacity. He promoted the value of saltbush and published the first paper on its value as a summer feed. He was instrumental in forming the Australian National Program on Productive Use and Rehabilitation of Saline Land (PURSL). This laid the foundation for the Cooperative Research Centre for Plant-based Management of Dryland Salinity based at UWA.

He was a gifted communicator, equally at home at an international conference as he was discussing issues with farmers on their properties. He inspired others to carry on his work and turned it into a mainstream activity from being a minor part of the whole saltland
management issue. He was inducted into the Royal Agricultural Society’s Hall of Fame for his work.

**John Sylvester Gladstones**

John Gladstones was an outstanding plant breeder. He set out as a young scientist to convert the bitter New Zealand blue lupin into a crop plant. It was known to be suitable for the WA climate and widely used as a green manure crop in the horticulture industry. It was also known that the New Zealand blue lupin genus was suitable for the light soils of WA.

It took nearly 25 years of meticulous breeding and selection before the first crop plant was produced. Essential features were low alkaloid content (sweetness), non-shattering pods and white flowers. While it illustrated the potential for the lupin as a crop plant, it had a number of defects and with further work over the next 20 years a range of varieties suitable for planting across a range of climates was produced. In addition, resistance to introduced diseases was bred into the varieties. This work included developing resistance to the fungus *Phomopsis*. When Phomopsis-infected lupin plants were exposed to summer rain a toxin was produced which killed sheep grazing on the dry lupin stubble. This made the grazing of lupin stubbles hazardous and the solution increased the value of the crop tremendously. The development of the lupin as a grain crop is covered in Chapter 7.

In the continuous cropping system the lupin is a legume and break crop which also provides build-up of nitrogen. The development of an important crop plant which has a range of uses in such a short period was an outstanding achievement.

As part of his research at the University of WA, Gladstones also found time for breeding and selection of subterranean clover strains. Separate from his work as a plant breeder, John Gladstones carried out intensive studies of climate and soil conditions for producing high quality table wines and had an important role in the establishment of Margaret River as a premium wine district. His work was recognised when he was among the first inductees to the Royal Agricultural Society’s Hall of Fame.

**Jeremy Allen**

Jeremy Allen studied veterinary science at Queensland University as a cadet with the department. He graduated in 1972 with first class honours and an honours degree in veterinary pathology.

He worked as a veterinary officer in the Bunbury office in 1973 and 1974, spending much of his time managing the brucellosis and tuberculosis eradication programs in the region, and conducting disease investigations. In 1975 he moved to the Animal Health Laboratories in South Perth as a veterinary pathologist.

Jeremy Allen took the lead role in studying the epidemiology and pathogenesis of lupinosis associated with sweet narrow-leaved lupins, and did so for the next 15 years. During this time he developed management techniques to significantly reduce the risk of lupinosis in sheep grazing lupin stubbles, published numerous papers in the scientific literature and gained his PhD for this work. He worked closely with the plant breeders over many years. During the period he tested the toxicity of many hundreds of lupin samples from breeding...
lines. These results guided the breeders towards their ultimate goal. He then conducted the field grazing trials that proved the success of the phomopsis-resistant lupins in preventing lupinosis.

From the mid-1990s Dr Allen directed most of his attention towards annual ryegrass toxicity (ARGT), and was a lead researcher in a four-year Australia-wide survey of the contamination of harvested grain by the bacterium that caused ARGT. This identified that this contamination could potentially devastate the grain export industry and resulted in funding of extra studies to develop answers to the problem. One of these, a five-year study of the ability of the twist fungus to reduce the prevalence of the causative organisms of ARGT, was conducted by Dr Allen. He was also funded to investigate the risk of secondary toxicity resulting from the consumption of animal products sourced from livestock consuming toxic ryegrass. The negative finding from this research gave the meat and dairy industries confidence that produce from Western Australia presented no risk to consumers.

Jeremy Allen won the Australian College of Veterinary Scientists’ Ian Clunies Ross Memorial Award for excellence in veterinary research in 1981, and the Western Australian Society of Animal Production’s RJ Moir Medal for a significant contribution towards improving the animal production industries in 1990.

He has published 157 papers, reviews and chapters in the scientific literature and a further 56 articles in general industry publications, on topics including lupinosis, ARGT, nutritional myopathy, poisoning of livestock by various metals, plants and fungi, mineral metabolism in ruminants, McArdle’s disease in sheep, nutrition of pigs and infectious and neoplastic diseases in livestock.

Jeremy Allen had an outstanding career and at 2008 continued to work in the department.

Narenda Nath Roy

Narenda Roy was born in East Bengal, India, in 1923. He graduated from the East Bengal University in science and agriculture in 1939. He was awarded a masters degree from the Indian Agriculture Research Institute in 1950 and a PhD from Cornell University after winning a Rockefeller Scholarship in 1958. He was recruited as a wheat breeder by the Department of Agriculture in 1969. He was transferred to work on rapeseed when the potential industry was wiped out by the fungus disease blackleg in 1971.

By 1977 Roy had material which had a low erucic acid content and good resistance to blackleg. These crossbreds were regarded as having early enough maturity to be suitable for a considerable part of the South Coast. The program was continued to develop further earliness and greater resistance. Lower glucosinolate content was also introduced to improve the quality of seed meal left after the oil was extracted. The aim was to produce varieties with sufficient early maturity to extend rapeseed growing into the wheatbelt proper by crossing with very early varieties obtained from India.

In 1978 a new rapeseed variety which was low in erucic acid and resistant to blackleg was released. It was named Westway and was produced from a cross between French and Canadian varieties. It was also earlier maturing and suitable for later planting or lower rainfall conditions. In 1980 two new rapeseed varieties, Wesbell and Wesroona, were released and were expected to increase sowings of the crop. In 1987/88 a gene for complete blackleg resistance was imported from the wild mustard plant (Brassica juncea). This was combined with the field resistance already present and the crossbreds inherited a high level of blackleg resistance in the field.

From 1987 he bred rapeseed varieties that were resistant to blackleg and had low erucic acid and glucosinolates. In 1991 another variety named Narendra which he had developed was released for the medium
rainfall areas. Progress was also made in developing improved oil qualities and resistance to shattering. The advances in blackleg resistance, together with the development of shattering resistant types of rapeseed, further highlighted the success of the program. It was recognised as leading the world in several lines of breeding and attracted much overseas interest. The material was in great demand from breeding programs around the world. He afterwards spent time in China as an honorary consultant and teacher. He visited Canada in 1989 and Germany in 1991. He retired from the Department of Agriculture in 1998 and joined Cornell University as an emeritus professor, finally returning to Australia after he retired.

**Peter Portmann**

Peter Portmann joined the Department of Agriculture in 1969 as barley and oat breeder, following graduation from University of Adelaide with a BAgSc. In 1980 he was appointed to manage the Plant Breeding Section. He then focused on barley breeding. In 1987 he became responsible for managing all crop breeding, grain quality testing, crop variety testing and crop seed production. In 1993 he also took over responsibility for managing all cereal and legume agronomy. He resigned in March 1997 to take up a position with the Grain Pool of WA.

On joining the department he recognised that plant breeding was a 'numbers game' and to be effective, breeders needed to be able to evaluate a large number of genotypes across a wide range of environments. In order to achieve this he concentrated his efforts on automation and computerisation of the plant breeding systems. It was also necessary to be able to manage small amounts of seed accurately at planting. This involved replacing the traditional 12-run drills with cone seeders. He also developed extruded plastic seed magazines for handling seed for plant breeding trials. These magazines became the basis for all plant breeding work throughout Australia and many other countries. He also converted small plot combine harvesters from three-person to single-person operated machines. To do this he developed a pneumatic grain transfer system to carry grain from the back of the machine to discharge alongside driver. This was then incorporated into both brands of small plot harvesters—Hege and Wintersteiger.

In conjunction with a young colleague, Arnold Rosielle, he developed software for the design of trials, printing of field books and the collation and processing of data. They also developed electronic weighing and data capture and the use of hand-held dataloggers. The net impact of these innovations allowed plant breeding to become much more efficient, with capacity increasing from 360 plots per person per year to a potential of more than 10 000.

Portmann was part of the team which saw the release of some 15 barley and 10 oat varieties, including a number of benchmark varieties. He also developed a working relationship with breeders at the University of WA to convert two competitive barley breeding programs into one collaborative program. This was a very successful partnership and was directly associated with the release of important varieties. The program focused on breeding for climatic zones. Part of the program aimed at developing shorter-strawed varieties for the southern districts. This was based on introduction of semi-dwarf genetic material from Canada and Europe. The program produced key oat and barley varieties for this region, one of which was adopted worldwide.

**Mark Sweetingham**

Mark Sweetingham joined the department in 1983 after completing his PhD at the University of Tasmania. Until 1993 he worked as a plant pathologist in the areas of biosecurity and diagnostics, disease management in the farming system and breeding for disease resistance. During the
period he determined the cause of major root diseases of the narrow-leaved lupin and researched *Rhizoctonia* diseases of wheat, barley, canola and legumes. His discoveries laid the foundation for the development of an agronomic management package for lupin diseases and for resistance breeding technologies. He also pioneered the fingerprinting of *Rhizoctonia* pathotypes explaining the nature of the host range of different pathotypes and establishing a basis for establishing crop rotation and tillage approaches.

This work was the basis for establishing the need for a detailed understanding of the epidemiology of major grain diseases in different environments. He established a national and international reputation as a result of his work on *Rhizoctonia*. Later, as a research leader, he was instrumental in developing the AGWEST Plant Laboratories. Until the time of reporting he had been the principal investigator of 23 industry-supported programs attracting over $6.5 million. He was the principal author of 50 scientific publications. He was also instrumental in establishing a number of collaborative research programs with CSIRO and the Grains Research and Development Corporation.

He moved into increasing administrative roles beyond 1999 across all grain cropping areas. In this period he contributed significantly to strategic planning and alignment of agricultural R&D to the critical needs of industry. He also contributed to the development of national policy in his areas of expertise, representing Western Australia on national research and policy committees.

**William (Bill) Bowden**

Bill Bowden joined the department as a cadet in 1969. Because of his exceptional academic performance he was released to undertake a PhD, then he rejoined the department in 1973. He developed a reputation for great “intellectual horsepower and capacity for data accumulation and organisation”. His made a major contribution in the organisation of data and the description of that data in models. In particular he focused on phosphate and nitrogen use, producing models capable of forecasting need on the basis of past history, soil type etc.

The original model was known simply as ‘Decide’ and retained that name as it was progressively improved over the years. He also became a leader, consultant and adviser to many of his colleagues, particularly young researchers seeking guidance in their careers. He set high standards for himself and expected the same from his associates. While he could have pursued a career as an academic or fundamental researcher he chose to stay at the cutting edge of applied science. The department was fortunate to retain his services for the whole of his career.

**Ron Jarvis**

Ron Jarvis joined the department as a cadet in 1963. He completed his BSc(Agric) in 1966 but was called up for National Service and served in 1967 and 1968. He worked initially as an adviser, first in Northam and then Lake Grace. He was very successful in Lake Grace from 1971 to 1980. While there, he diagnosed severe copper deficiency on crops where copper had been added with the superphosphate. He found this was due to the copper being immobilised in the granules produced by the particular fertiliser mixing technique. A spring copper spray was found to be the solution.

In mid-1980 he moved to the Plant Research Division. In 1981 he identified the advantages of cultivation to a greater depth than seed was planted. He then started work with Chamberlain John Deere, resulting in the release of a suitable combine which allowed deeper cultivation and shallow seed planting. In 1982 he identified the problem of hardpan development in some sandy soils of the wheatbelt. He successfully promoted the use of deep ripping to overcome the problem. In 1983 he also identified and did the first experiments on the use of narrow-
pointed tynes which allowed seed to be sown near the surface while fertiliser was placed deeper as a viable method of improving yield. The initial aim was to minimise the effect of the disease *Rhizoctonia*.

In 1984 he was able to demonstrate the long-term advantages of minimum tillage on the level of water-stable aggregates on heavy soils. In 1990 he demonstrated the advantage of deep banding of superphosphate on the yield of lupins. In 1992 he was awarded the Urrbrae Medal for outstanding contributions to Australian agriculture. From 1993 onward he conducted a large field experimental program investigating the extent of these issues. He retired early in 1998, shortening a career which had made a major contribution to agriculture.

**John Hamblin**

John Hamblin joined the Department of Agriculture in 1977 after completing a PhD at Adelaide University, then further studies at Cambridge. He worked on lupin breeding with John Gladstones in the Plant Production Division. The initial breeding had been focused on the major genes but with the program expanding he worked on disease resistance (mainly *Phomopsis* and brown spot) and developing mechanisation and field-testing processes.

His early experience convinced him that many of the problems of growing lupins were due to poor management rather than poor varieties. Together with an experienced adviser and farmer a new lupin management package was developed and demonstrated to farmers in the northern agricultural areas in 1979. The demonstrations involved two varieties, early versus late planting dates, use of simazine to control weeds, depth of seeding and good versus poor quality seed. Farmers were harvesting seed like wheat and not as a more sensitive dicotyledonous crop. Despite 1979 being a drought year, the correct treatments (early variety, early planted, good quality seed at the shallow depth with weed control) gave yields averaging 1.6 t/ha. The wrong combination gave yields of 0.3 t/ha—equivalent to farm yields in that year.

After a short time with the Victorian Department of Agriculture he returned to Geraldton as a research agronomist with a brief to develop the regional research effort. Observing that on the sandplain farmers were getting better lupin yields than cereals he worked on improving cereal yields, forecasting that they would double by the year 2000. This was achieved by the average farmer with good farmers achieving trebled yields.

In 1986 he left Geraldton to take up a senior appointment. The foundation he had built was developed by enthusiastic young staff. His own research efforts were severely constrained by administrative roles in the department, overseas and at UWA. He had a philosophy aimed at solving real problems that improved farming systems, rather than taking a more discipline-focus to components of systems. Hamblin made a substantial contribution to the development of lupin agronomy and the whole new cropping system which became ‘normal’ cropping practice.

**Don MacFarlane**

Don MacFarlane came to the Department of Agriculture after working as an exploration geologist in mining and completing an MSc and a PhD in hydrogeology. This was unusual at the time as most professional staff had agricultural science degrees. With the assistance of Rick Engel of the department and Greg Street of the Mines Department he applied geophysical techniques used in the mining industry to dryland salinity problems. This mainly involved using magnetometers to map dykes and electromagnetic induction to locate salt storages. Small businesses were established to provide ground-based and aerial services to farmers and catchment groups as a result of this work.
In association with CSIRO the group developed satellite remote sensing methods for mapping dryland salinity, waterlogged cereal crops and remnant vegetation condition. They also developed prediction maps for salinity. The remnant vegetation mapping was extended to mapping above-ground biomass for carbon accounting, for which they were awarded the CSIRO Chairman’s Medal—which carried a $150 000 prize. This method has been applied in other countries and was adopted as the international standard by the Clinton Climate Initiative.

The Catchment Hydrology Group which Don MacFarlane led in the Department of Agriculture was also influential in natural resource management. They divided the South West into four regions for management purposes, and these became the basis for the natural resource management regions that used Natural Heritage Trust and National Action Plan funding for the next 15 years. Don established the NRM group for the South Coast region while based at Albany for 11 years.

His work on waterlogged soils helped to resolve the conflict between the WISALTS organisation and the scientific community. The WISALTS movement advocated bulldozer-built level banks as a means of stopping the spread of salt. In practice it was shown that crop growth in saline areas could be greatly improved if waterlogging was prevented. On the original property at Brookton where benefits from building banks was first claimed this would have been the situation. Working with Tim Negus, then Narrogin OIC, Don MacFarlane used shallow seepage interceptor drains to remove waterlogging on duplex soils. This did not add recharge to the saline aquifers as the WISALTS banks had. When this was demonstrated to the chairman of WISALTS the organisation stopped advocating level banks.

**Ross Kingwell**

After a double major in agricultural economics and agronomy at the University of Western Australia, Ross Kingwell joined the Department of Agriculture in 1977. He developed an interest in farm modelling and along with David Morrison and later David Pannell, helped develop a computer-based farm model named MIDAS (Model of an Integrated Dryland Agricultural System). In 1987 Wageningen University published a seminal book that described MIDAS and its policy and research applications. It was edited by Ross Kingwell and David Pannell. During the 1980s and 1990s Ross Kingwell gained postgraduate qualifications and continued to regularly publish his research and collaborate on a wide range of projects and research issues. He developed another farm model known as MUDAS (Model of an Uncertain Dryland Agricultural System) that incorporated price and seasonal uncertainty. In the late 1990s he joined the staff of the University of Western Australia as a fractional academic appointment. There he supervised the research of scores of honours and other postgraduate students.

He was appointed as both Chief Economist in the Department of Agriculture and Food and a Professor of Agricultural Economics at the University of Western Australia. Through his efforts and those of his many colleagues, the department and its modelling staff rose to national prominence and Western Australia became regarded as a centre of excellence in farm modelling. The department's modelling work is detailed in Chapter 8.

**Key extension officers**

The following officers are dealt with as a group because they were all outstanding extension officers and were the post-war pioneers of the Department of Agriculture’s country-based services. In the early years office accommodation was poor, the department was small and the information base was just developing. At the same time major expansion was occurring in the
agricultural areas, with farmers requiring a lot of professional advice both about initial development and subsequently about the developing technology. This group represents the cadre of extension officers, most of whom are not mentioned here, who all made an important contribution to the industries they serviced and to the work of the department.

Gerald Ledsham (Gerry) Throssell
Gerry Throssell started his career with the department as a cadet and was appointed as an adviser in 1927. He was a member of GL Sutton’s second cadet intake. He joined the army in 1940 and returned in January 1944. He then spent the rest of his career as a district adviser in Geraldton.

At one time he covered the whole of the agricultural area north of Perth. It was in the very early days of legume pasture development and he strongly promoted the sowing of Dwalganup subclover which became widespread on both heavy and light land. His enthusiasm was shared by a renowned farmer of the era from the Walebing-Miling area, Sir Edward Lefroy. In the early 1950s they formed the Miling Pasture Improvement Group, the prime function of which was the development of annual legume-based pastures. This was the forerunner of an explosion of Pasture Improvement Groups (PIGs) over the next decade and by 1960 there were more than 50 groups established throughout the WA wheatbelt alone.

Gerry Throssell had a classic approach to extension. He was always careful to operate through the influential people in each recognisable community, whether they were shire officials, organisation officials (Farmers Union) or farmers who were widely respected among their peers. His modus operandi was to ensure he visited each locale not less than once a month. He always made sure he had at least one solid message each visit whether it were some recent research results or the experiences of farmers from other locations. It was this need for new, locally-focused information, and his association with farmers which led to the development of district on-farm trial programs.

In 1957 a mobile planting unit arrived in time to plant the experiment program. The unit consisted of a 12-row disc drill on loan from the Massey Ferguson Company (under persuasion from the Mendel-Wongoondy Pasture Improvement Group) and a four-wheel drive Land Rover plus a two-wheeled trailer. The Land Rover served to transport the unit and act as a tractor for the drill. Use of these units went a long way to differentiate which species and varieties were best suited to different soils and localities. It was this large expansion of on-farm trials that became the cornerstone of extension in WA over the next three decades. The mobile units are covered in Chapter 7.

Gerry Throssell retired after 37 years of service in 1965 with his unique contribution largely unrecognised at the time.

George Halpin
George Halpin joined the Department of Agriculture in January 1946. He spent most of his career in Katanning, where he was an experienced adviser and a valued member of the community. He had a special interest in animal husbandry, which was appropriate for the district at that time. At the time there was extensive development of light land to the south-east and east of Katanning and the demands on George were very heavy. He was an adviser who made a tremendous contribution in a quiet, unassuming way to the development of agriculture in the south-east of the State. Towards the end of his career he was appointed Principal Coordinator of Research Stations, a position he held until his retirement in 1982.

In the early 1970s he led the first group of farmers who went to Libya to demonstrate Western Australian farming techniques. The work was carried out on the Gefara Plain, south and south-west of Tripoli. This was a particularly challenging undertaking as
accommodation was basic and general facilities quite rudimentary. It was to the group’s credit that they managed and put the project on a sound footing from the beginning. The saga of the Libyan project probably warrants a book of its own.

**Henk Suijdendorp OAM**

Henk Suijdendorp was a deck officer on the Dutch liner *Orange*, but married a girl from Toodyay, and subsequently graduated with a degree in agricultural science from the University of Western Australia. With his family he left Perth in early 1951 to work with the recently established North West Branch at the Abydos Woodstock pastoral stations in the Pilbara about 150 km south of Port Hedland. These stations had been abandoned for some years and were purchased by the government in 1946 when the sheep industry in the Pilbara collapsed. The government’s aim was to attempt to revive the industry through improving pasture productivity and examining sheep husbandry problems.

Life in the bush did not start well. Henk’s home was to be in the old homestead on Woodstock. It was over-run by wild cats and on his arrival he found that 24 rams had also taken up residence in the abandoned building.

Henk Suijdendorp was the first research officer in the Pilbara and began his groundbreaking work on pastoral land management in this most difficult of environments—the spinifex shrub steppe. In a series of outstanding experiments he found that it was not drought or dingoes which had caused the decline in the sheep industry, but over-use of the tussock grasses within the spinifex communities. The frequent burning practices adopted by pastoralists had also reduced the amount of feed available to sheep as cool winter burns favoured spinifex at the expense of the palatable and productive edible tussock grasses. Having defined the problem he was able to show in a further series of experiments that the degraded lands could be restored to their earlier productivity through combinations of resting from use and burning in summer.

These large scale experiments were among the first rangeland grazing studies in Australia. The results revolutionised grazing practices in the Pilbara with the rapid and widespread adoption of Henk’s recommendations. In a general sense the findings also showed the sensitivity of the fragile semi-arid communities to incorrect management. In this case it had reduced the capacity of pastoral land to support domestic stock.

Following his success with grazing management Suijdendorp then began investigations into sheep reproduction and wool production in this very challenging environment. Important issues included the season and its influence on the time of mating and the interaction with the grazing system. Low lambing percentages and disappointing wool production in ewes had been important factors in the poor performance of the pastoral industry. He was quickly able to show that a deferred grazing system, and the resulting increased amount of tussock grasses available, increased lambing percentages as well as increasing wool production. In addition he showed that early mating was essential for good lambing percentages and survival. Late mating when lambs were dropped in August reduced lamb survival as the tussock grasses had dried off after mid-winter. He also showed the advantage of using locally-bred rams which had greater libido and performed better than rams introduced from the south.

His fine research work and ability to convey the essentials of management to pastoralists gained him the admiration of a whole generation of lessees in the Pilbara and over a wider area in Western Australia. He was awarded the Medal of the Order of Australia for services to agriculture in 1980.

**Raymond James (Jim) Doyle**

Jim Doyle was a Muresk Agricultural College graduate who went on to complete a degree in Agricultural Science at the University of
WA. He was posted to Geraldton in 1956 to work as an adviser with Gerry Throssell. Jim was given control of an on-farm experimental program in collaboration with Perth-based research officers. Over the next six years he pioneered the use of an experimental planting unit donated by a group of farmers, and developed a program of some 20 trials a year. In 1962 he transferred to Esperance as officer-in-charge of that district.

Two highlights of the field research program drew widespread attention: The first demonstrated highly effective lime pelleting of inoculated seed as a technique to separate seed and fertiliser. This reduced some types of 'seedling mortality' in subterranean clover sown on virgin sandplain soils.

The second was a significant wheat yield increase in 1960 resulting from the application of molybdenum—a world first which was repeated in 1962. The response was first observed by farmer Trevor Way. Both trials were carried out on Wodjil type light soils at Gutha. They resulted in the demonstration of widespread molybdenum deficiency in the eastern wheatbelt.

Jim reinforced this blend of research and extension in the rapidly developing Esperance region between 1962 and 1972 and again in head office where, among other roles, he facilitated cooperative research programs between research and extension officers. He also arranged the replacement of, and funding requirements for, field equipment including mobile planting units. He helped build a prototype cone seeder in collaboration with plant breeder Peter Portmann and workshop manager Laurie Liddell.

Jim originated the publication of the *Agricultural Memo* local newsletter (see Chapter 8). The 'AgMemo' proved so successful it became used in all the department's country offices.

**Peter Nelson**

Peter Nelson arrived from England in 1961, joined the Department of Agriculture and was stationed at Northam as an adviser to the wheat and sheep industry, mentored by Lionel White. In 1963 he transferred to Katanning with George Halpin and moved to be the first adviser at the small Lake Grace office. From 1968 to 1970 he trained in the USA as a cotton agronomist and in 1970 he moved to Kununurra. After seven years at Kununurra during which the cotton industry collapsed due to the cotton bollworm developing resistance to all available insecticides, he transferred to Geraldton. There he made a major contribution to the adoption of lupins as a crop plant and its integration into the 'new cropping system' as the key legume in the rotation.

He resigned in 1996 but continued to serve the industry, spending 14 years as the lupin and crop production specialist with the Grain Pool of WA.

Peter Nelson was an outstanding officer who made a big contribution to both the department and to the industry.

**Gillie Brown**

After graduating in the UK and migrating to Australia, Gillie Brown joined the department in 1982. She was appointed to Narrogin and was the first female general agricultural adviser appointed to work in a country office. She was there for some 12 months, moving to Moora in 1983. She spent almost five years there, proving to be very successful. In particular, she enjoyed field days, which she managed very effectively. She carried out some of the first quantitative work on the value of lupin grain as a supplementary feed for weaner sheep.

In 1988 she transferred to Perth as OIC in charge of crop variety testing. In this role she redesigned the crop variety sowing guide, making it much more user friendly and informative. From 1994 to 1996 she led a wheat marketing project aimed at bringing the wheat quality message to growers. This
followed an AWB announcement in April 1994 that it was going to pay premiums for protein, a challenge for the majority of growers who grew low protein wheat. A major information program was undertaken to give advice to growers before the crop was planted. From 1995 to 1997 she was manager for the markets of Japan and Korea. From 1997 to 1999 she was Executive Officer of the Horticulture Products Partnership Group dealing particularly with the outcomes of each project. From 1998 to 2001 she was project manager for floriculture industry development in addition to her role as executive officer of the partnership group. In 2001 she was appointed Senior Development Officer for Horticultural Intellectual Property.

Gillie Brown continues to work in the department, having had a varied and valuable career, starting as a successful field adviser.

Arthur Cyril (Cyril) Linto

Cyril Linto joined the department as a laboratory assistant in 1949 and was appointed a stock inspector in 1953. He worked for some time on the TB eradication program, the initial attempts to eradicate footrot from sheep, and on general quarantine inspections. In 1959 he was transferred to Kalgoorlie to take charge of the inspection of stock being transported into WA. He remained there until he retired in 2007. For the first 20 years he had the dual role of Stock Inspector and Regional Weed Control Officer. In 2000 he was awarded the Australian Public Service Medal for his outstanding work.

In the period from 1959 to 1969 the dramatic increase in the cleared area and sown pastures resulted in a parallel demand for livestock, particularly sheep, which could not be met from within WA. As a result, large numbers were imported from the eastern states. In one four-year period he inspected more than 1.2 million sheep. Over the 10-year period more than two million sheep came through Kalgoorlie. A major concern was weed seeds carried in the wool and it was not unusual for sheep to have to be shorn. His thoroughness and toughness in a difficult role became well known to all importers. Without doubt his work played a major role in keeping a wide range of noxious weeds out of WA.

Separately, he was responsible for developing a certification system to allow the transport of pastoral sheep into the agricultural areas, reducing the area of noxious weeds in the pastoral areas near Kalgoorlie, and undertaking the initial survey of the habitats of starlings as part of the program to keep them out of WA. Cyril is here as an outstanding example of the work done over the decades by the army of inspectors who worked in the Department of Agriculture.
Appendix 1

Department of Agriculture accommodation

**Previous offices/locations**

**Head office**
- 1894–1896: 44 St Georges Terrace, Perth
- 1896–1904: 96 St Georges Terrace, Perth
- 1904–1961: 32 St Georges Terrace, Perth

Some use of Government House Ballroom

1945–1957 Offices at 108 Adelaide Terrace, Perth
1929–1958 the Observatory Building Harvest Terrace, Perth

1945–1959: Animal Health Laboratory established at Smythe Rd, Hollywood

**Metropolitan and suburban district offices**

- Armadale District Office (closed 1980)
- Kelmscott District Office (in the Agricultural Bank) (closed 1980)
- Bicton Quarantine Centre (closed 1983)
- Woodman Point Quarantine Centre (closed 1979)
- Subiaco Viticultural Area (early years)
- Perth Cold Stores at the Markets, Barrack Street, Perth (early years)
- Butchers and Fish Shops at the Markets (early years)

**Northern and pastoral locations**

- Ord River Catchment Regeneration Project
  - Ord River Station
  - Fox River Station
- Camballin District Office/Experimental Location

**Southern Research Farms/Areas**

- 1898: Hamel Farm near Wanneroo
- 1902–1995: Chapman State Farm
  - 1982–1995 East Chapman added
- 1903–1921: Narrogin State Farm became Narrogin Agricultural School in 1921
- 1909–1920: Brunswick Demonstration Farm – Transferred for training ex servicemen in 1920
- 1913–1982: Denmark Demonstration Farm
- 1924: Avondale Experiment Farm
- 1925–2009: Wongan Hills Experiment Farm
- 1926: Salmon Gums Experiment Farm
- 1928–1939: Dampawah Experiment Farm (30 km East of Perenjori)
- 1929–1939: Yilgarn Experiment Farm (10 km East of Southern Cross)
- 1950–82: Bramley Research Station
- 1955–1964: Vegetable Research Station

*Wiluna District Office*
- 1941: Ord River Experimental Plots – Carlton Reach
- 1968: Fitzroy Research Station
- 1951: Abydos Woodstock Research Station
- The Camel Paddock – Kalgoorlie Common
Appendix 1 – Department of Agriculture accommodation

1952–1982 Poultry Research Station
1955 Stoneville Research Station
1955 Viticultural Research Station
1959–2008 Badgingarra Research Station
1982 North Badgingarra added
1942–1956 Manjimup Research Station
1956–1966 New site
1966–1985 King River site

Temporary experimental areas
1953–1957 Pingrup Plain (100 km south-east of Manjimup on Nornalup Road)
1953–1957 Northcliffe Plain (10 km south of Northcliffe on Windy Harbour Road)
1956–1959 Eneabba
1960–1965 Forrestania (approximately 60 km east of Hyden)
1963–1966 Johnson Lakes (approximately 80 km east of Lake King)

District offices
Bridgetown
Busselton
Denmark
Harvey
Margaret River
Mt Barker

Offices of the Department of Agriculture current at 2008

Head office
1961 Baron-Hay Court, South Perth
   official opening 1961
   Partly occupied in 1957, 1958 and 1959
   Director’s office, Treasury Building, St Georges Terrace
   – moved to South Perth in March 1971

Metropolitan locations
South Perth Metropolitan District Office
Forrestfield
Floreat Park
Murdoch University

Regional centres
Albany District Regional Centre
Bunbury District Regional Centre
Geraldton District Regional Centre
Kununurra District Regional Centre
Northam District Regional Centre

District offices
Broome District Office
Carnarvon District Office
Derby District Office
Esperance District Office
Jerramungup District Office
Kalgoorlie District Office
Karratha District Office
Great Southern Agricultural Research Institute Katanning
Lake Grace District Office
Manjimup Horticultural Research Institute
Meekatharra District Office
Dryland Research Institute Merredin
Moora District Office
Narrogin District Office
Three Springs District Office
Warroona District Office

In addition staff is located at another 21 country locations.

Research stations
Badgingarra Research Station
Esperance Downs Research Station
GSARI Katanning
Gascoyne, Carnarvon
Frank Wise Research Institute, Kununurra
Medina Research Station
Mt Barker Research Station
Newdegate Research Institute
Vasse Research Station

Quarantine office locations
Domestic and International Airports
Eucla Checkpoint
Kununurra Checkpoint

The development of departmental offices

Head offices

Summary

1894: In 1894 the Bureau of Agriculture occupied offices in the Weld Chambers at 44 St Georges Terrace. The total staff was 10.

1896: Bureau moved to the fourth floor of West Australia Chambers at 96 St Georges Terrace when the Weld Chambers proved to be too small. In 1898 it became a department within the larger Lands Department. By 1898 the total staff was 25. This new area gave it an opportunity to establish an area called ‘the Museum’ and to give the expanding library more room. The library was already becoming very useful with some 430 books on its shelves. Of these the main books were Annual Reports and Journals (66) Botany (64) Horticulture (36) and Viticulture (33). Livestock, veterinary, and dairy issues were represented but numbers were not recorded.

The Museum was the repository for ‘an expanding collection’ of insects and also housed samples of a range of soil types with attached analytical data. A Herbarium had also been started which included a large number of native plants together with introduced species of economic value including a collection of native grasses seen to be likely to have some economic importance.

From 1898 to 1904 was a department within the Lands Department and was responsible to the Commissioner for Lands.

1904: Agriculture became independent department responsible directly to a Minister. It then moved to the Government building at 32 St Georges Terrace. This building was built for the first Legislative Council. Construction commenced in 1836 and finished in 1838/39. The Council met there until 1870. The Colonial Secretary had an office in the building until 1876. It housed the Colony’s post office from 1840 to 1853 and again from 1857 to 1867. In 1890 the Legislative Council returned to the site and met there until 1904 when it moved to Harvest Terrace and handed the site over to the Department of Agriculture. The total staff was 45. During the occupancy of the building as head office the total departmental staff grew to 423. While many were in country offices the building became quite inadequate. In a decision which is difficult to understand today, this historic building was demolished in 1961 after the administrative block at South Perth was opened and the last departmental staff moved to South Perth. Council House now stands on the site.

In 1945 a purpose built Animal Health Laboratory was opened at Smythe Road, Hollywood. It provided laboratory and back-up facilities for the animal pathology and nutrition groups of the department. It became a focal point for international visitors because of Bennetts’ status. It was vacated in 1959 when the staff transferred to South Perth.

1957–1961: The department moved progressively to Jarrah Road, South Perth. In 1985 Jarrah Road was truncated and the section where the departmental offices stand was renamed Baron-Hay Court. The initial buildings consisted of four main interconnected blocks, store rooms and animal houses. These buildings were progressively occupied from 1957 with the formal opening in 1961. A fifth block was added in 1981. Earlier the State Herbarium
was built on the site together with a Virology block and other service buildings. There were also glasshouses and an area of some hectares where plant breeding lines were planted and other experimental work was carried out. This was still the department head offices in 2008.

From the mid-1930s through to the mid-1940s a number of staff were accommodated in Government House Ballroom in very temporary and unsatisfactory accommodation. An example of this was three quite senior officers Mr Clifton, Mr McGarry and Dr Dunne sharing an office in Government House Ballroom in 1942 which was equipped with only one telephone. Some relief was achieved when some sections were moved in late 1945 to 108 Adelaide Terrace into a building which had originally been built as an orphanage. Some laboratory facilities were built there and it housed the Cereal Research, Entomology, Plant Nutrition and Soil Conservation groups. There were also store rooms attached where soils and experimental equipment and materials could be handled. Originally it had been hoped that all the staff in Government House could move there, but space was allocated to the Fisheries Department and another small agency. Further relief occurred by the Veterinary Pathologist and his staff moving to the new laboratories in Smythe Road, Hollywood in 1945.

The development of a head office for the department was a long-term saga. The unsatisfactory accommodation arrangements were identified much earlier but were not addressed. In the late 1920s the Veterinary Pathologist had used laboratories at CSIR near the University Faculty of Agriculture. Also when Dr Teakle returned from completing his PhD in 1929 he worked at the University. Dr Dunne also used laboratory space at the University while doing the work on copper deficiency of apple trees in the late 1930s.

In August 1938 the Minister for Agriculture wrote to the Hon Treasurer requesting funds be provided for a new building for the department. This request was supported a year later in August 1939 by the Primary Producers’ Association seeking more adequate accommodation for the department. These representations were supported later by an announcement by the Premier that clearing was proceeding between the Government House Lodge and Christian Brother’s College (now the site of the Duxton Hotel) for the purpose of building a block of Government offices. The first of these was to be occupied by the Department of Agriculture. Discussions then proceeded during 1940 on the accommodation which would be allotted to the various groups and individuals. The planning stopped, presumably due to the complete focus on the war effort following Japan entering the conflict. Some people might remember a heap of sand which lay in the general location of the proposed buildings in the middle to late 1940s. This was the only evidence of the original intention.

In July 1944 the then Minister, Mr FJS Wise wrote to the Premier raising the issue again in quite strong terms. There were various discussions subsequent to this letter. One of the difficulties was finding a piece of land of a suitable size. There was also discussion of the desirability of having the new facilities near the Hollywood laboratories, which were being built at the time.

There appears to be a gap until the early 1950s when an area in Victoria Park was looked at. The area was a part of the reserve opposite the current departmental buildings. This was the subject of a 1952 minute from Mr MacKenzie-Clarke seeking an allocation for departmental laboratories. While the Minister favoured a site adjoining the Animal Health Laboratories he supported obtaining control over the Victoria Park land. The Town Planning Board did not raise any objection. In March 1952 the then Director and the Director of Education jointly recommended that the department move to the Victoria Park site and that 15 acres be allocated for this purpose. This went to
Appendix 1 – Department of Agriculture accommodation

Cabinet. However, this area was part of a reserve and presented special problems. Subsequent discussions with the Conservator of Forests indicated that the current site could be made available out of the Collier pine forest. This was agreed in March 1954 and detailed planning commenced.

The first building was occupied, largely by staff from Adelaide Terrace in 1957. The Administration Block was opened in 1961 and was one of the last acts performed by the then retiring Director GK Baron Hay.

In retrospect the incredible delays in providing adequate accommodation for the department were probably a good thing as over the past 50 years it has been possible to provide on the current site for many developments not thought of in 1938, nor for that matter in 1955, when serious planning started.

It is interesting that in the 1989 report of the then Director General expressed some concern that the suspension of the department's building program in the coming year meant there would be a longer than expected delay in providing new buildings at key country centres. The areas of concern were Katanning, Albany, Geraldton, Merredin and Manjimup. These buildings had priority over any further development of South Perth. Nevertheless he pointed out that the South Perth buildings remained severely overcrowded, old and in poor condition. This was probably a reflection on their original design and construction. However at the time of their completion they were an exciting addition to the department. One now retired officer who had worked at St Georges Terrace commented that moving to South Perth was the best thing that happened in his career with the department.

Post-2000 there has been a proposal that a combined universities/Department of Agriculture organisation be set up to carry out the majority of the research currently carried out by the department. As part of this change the department’s head office would move to a new location on the Murdoch University site in Murdoch. The exact plan at the time of writing was unclear.

Country accommodation

In the early days there was a policy to locate country offices as close as possible to the Agricultural Bank offices. Up until the mid-1950s country officers were largely housed in spare Government offices—often in the local court house. Occasionally a vacant shop would be rented and appropriate signage provided. In the main the officers had little equipment apart from a telephone and normal office equipment.

Sometimes even this was not very satisfactory as a young dairy adviser in Bridgetown found out. In May 1928 he was accommodated in a room in the Public Works Department. The room also had lumber in it. On one occasion he returned to find an officer of the Main Roads Department had moved in and taken his space. Later in March 1938 a room occupied in the old Court House was required for other uses and the then dairy inspector had to obtain a room in his hotel for an office. In March 1939 an office in the old Court House again became available for the dairy inspector. In 1947 the R&I Bank asked for these rooms and there was no other comment except that this was agreed, subject to other accommodation being obtained in the building.

Over time following the late 1950s the accommodation was improved with regional offices established in purpose-built buildings. These buildings accommodated a number of officers, had typing/reception staff, a reference library, post-mortem facility for veterinary staff and storerooms and garages for departmental vehicles. Later they were all equipped with a set of machinery for carrying out experiments. In the late 1970s research staff was placed at two regional offices on a trial basis. This proved to be successful and led to the establishment of large well-equipped regional centres at Bunbury, Albany, Esperance, Katanning, Merredin and Manjimup. A building of this type had been previously built at Kununurra. Although it had
a very successful agronomy program, a purpose-designed building was never built at Geraldton.
**Appendix 2**

**Staff employed over the years**

The figures below are extracted from the Public Service Lists from 1901 to 1980. In later years the figures are taken from the Department of Agriculture annual reports. The Public Service Lists do not give wages employees.

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<th>Year at June 30</th>
<th>Admin./professional</th>
<th>Temp. and short term</th>
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<th>Clerical</th>
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<th>Total</th>
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* Accounts group listed.
** No accounts section is listed as employed at the time of reporting.
*** In July 1996 as a result of the 1994 review the department, the APB and RAFCOR were combined into Agriculture WA. The FTEs of the organisations before the amalgamation were department (1613), APB (257) and RAFCOR (23) – a total of 1893. After a reduction in the total staff the total approved FTE was 1768 for 1997.

xx The temporary officers listed were obviously shortly to become permanent officers which eliminated most casual employees.

xxx Temporary officers were not listed separately and when they were identified the numbers were very small and were included in the total figures.

# This group of temporary officers were largely contract staff paid by external funds which were not recorded in this manner later.
### Appendix 3

**Budgets**

A comparison of selected budget years based on the 1980 index

*Index developed by the Bureau of Statistics Canberra (all figures in dollars)*

<table>
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<th>Year</th>
<th>Total actual</th>
<th>Revenue</th>
<th>Nett cost</th>
<th>Trust funds</th>
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<th>Total indexed</th>
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<th>Net indexed cost</th>
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<td>46</td>
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<td>778 682</td>
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<tr>
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<td>278 380</td>
<td>151 760</td>
<td>91</td>
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<td>1 542 794</td>
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<td>303 300</td>
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<td>82</td>
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### Appendix 3 – Budgets

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<th>Index</th>
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<th>Net indexed cost</th>
<th>Trust funds</th>
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From 1995/96 the Department of Agriculture, APB, RAFCOR budgets combined

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<th>Trust funds</th>
<th>Total indexed</th>
<th>Indexed revenue</th>
<th>Net indexed cost</th>
<th>Trust funds</th>
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<table>
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Long-term linked series

To provide an approximate long-term measure of consumer price change for the period since the first Australian retail price index was compiled, the ABS has constructed a single series of index numbers by linking together selected retail and consumer price index series from amongst those described above (see table below). The index numbers are expressed with a reference base of 1945 equals 100.0 which was the end of a period of price stability during World War II. The successive series linked together to produce this long-term series of index numbers are:

- from 1901 to 1914, the A Series Retail Price Index
- from 1914 to 1946–47, the C Series Retail Price Index
- from 1946–47 to 1948–49, a combination of the C Series Index, excluding rent, and the housing group of the CPI, and
- from 1948–49 onwards, the CPI.

This long-term series of index numbers is updated each year.

Retail/Consumer Price Index numbers

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[a] Base: Calendar year 1945 = 100.0
[b] The index numbers relate to the weighted average of six state capital cities from 1981. Index numbers are of calendar years.
## Appendix 4

### Legislation over the years

The Acts and the years when they were first referred to are given below. Items before 1894 preceded the Bureau but were subsequently administered by it:

<table>
<thead>
<tr>
<th>Year</th>
<th>Act</th>
<th>Year</th>
<th>Act</th>
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<tr>
<td>1871</td>
<td>The Wild Cattle Nuisance Act</td>
<td>1894/15</td>
<td>The Grain and Foodstuff Act which established the G &amp; F Board*</td>
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<td>1890</td>
<td>The Destructive Insect and Substances Act (1890)</td>
<td>1890</td>
<td>The Industries Assistance Act – both a result of the 1914 drought**</td>
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<tr>
<td>1892/93</td>
<td>The Scab Act (1893)</td>
<td>1894/95</td>
<td>A Wheat Marketing Advisory Committee was appointed to ‘advise’ on marketing the 1915 harvest under a Government scheme</td>
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<tr>
<td>1894/95</td>
<td>The Stock Diseases Act (1895)</td>
<td>1904</td>
<td>The Plant Diseases Act (1914)</td>
</tr>
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<td>1894/95</td>
<td>The Brands Act</td>
<td>1905/06</td>
<td>The Cattle Trespass etc. Acts</td>
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<td></td>
<td>The Fertiliser and Feedstuffs Act</td>
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<td>The Diseases in Bees Act</td>
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<td>The Noxious Weeds Act (1904)</td>
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<td>The Rabbits, Wild Dogs Vermin Act</td>
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<td>The Commerce Act (a Commonwealth Act under which Agricultural exports were dealt with by the Department)</td>
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<td>1904</td>
<td>The Brands Act previously managed by the Registrars Office was transferred to the Department</td>
<td>1909/10</td>
<td>The Vermin Boards Act</td>
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<td>The Abattoir Act</td>
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<td>The Insect Pests Act and the Insect Pests Amendment Act (1898)</td>
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<td>The Agricultural Seeds Act</td>
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<td>The Plant Diseases (Amendment) Act</td>
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<td>The Vermin Boards Act</td>
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<td>The Vermin (Amendment) Act</td>
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<tr>
<td>1911/12</td>
<td>The Veterinary Act which provided inter alia for the appointment of a Board</td>
<td>1922/23</td>
<td>The Royal Agricultural Society Act (1926)</td>
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* Enacted in December 1914. Expired in September 1915.

** Was not administered by the Department.
Appendix 4 – Legislation

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<td>The Alsatian Dog Amendment Act</td>
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<td>1931/32</td>
<td>The Wheat Pool Act (1932)</td>
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<td>The Dairy Products Marketing Regulation Act (1934)</td>
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<td>The Bulk Handling Act (1935)</td>
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<td>The Marketing of Onions Act (1938)</td>
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<td>1944/45</td>
<td>The Feeding Stuffs Act (1928–42)</td>
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<td>1945/46</td>
<td>The Soil Conservation Act (1945)</td>
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<td>1945/46</td>
<td>The Marketing of Eggs Act (1945)</td>
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<td>The Milk Act (1946)</td>
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<td>1945/46</td>
<td>The Marketing of Potatoes Act (1946)</td>
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<td>The Feeding Stuffs Act (1928–46)</td>
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<td>1946/47</td>
<td>The Potato Industry (Trust Fund) Act (1941)</td>
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<td>1947/48</td>
<td>The Wheat Marketing Act (1947)</td>
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<td>1947/48</td>
<td>The Dried Fruits Act (1947)</td>
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<td>1947/48</td>
<td>The Poultry Industry (Trust Fund) Act (1948)</td>
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<td>1950/51</td>
<td>The Agricultural Protection Act (1950)</td>
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<td>1950/51</td>
<td>The Noxious Weeds (Amendment) Act (1950)</td>
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<td>1952/53</td>
<td>The Bee Industry Compensation Act (1953)</td>
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<td>1952/53</td>
<td>The Veterinary Medicines Act (1953)</td>
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<td>1952/53</td>
<td>Referenda on Proposals for the Marketing of Wheat, Oats and Barley Act (1952)</td>
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<td>1954/55</td>
<td>The Argentine Ant Act (1954)</td>
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<td>The Honey Pool Act (1955)</td>
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<td>The Wheat Industry Stabilisation Act (1953)</td>
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<td>1959–1965</td>
<td>The Foot and Mouth Disease Eradication Fund Act (1959)</td>
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<td>The Filled Milk Act (1959)</td>
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<td>Aerial Spraying Control Act (1960)</td>
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<td>1959–1965</td>
<td>The Veterinary Surgeons Act (1960)</td>
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<td>1962</td>
<td>Alsatian Dog Act (1962)</td>
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<td>1963</td>
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<td>1965</td>
<td>The Artificial Breeding Board Act (1965)</td>
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<td>1965</td>
<td>The Cattle Industry Compensation Fund Act (1965)</td>
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<tr>
<td>1967</td>
<td>Ord River Dam Catchment (Cattle Straying) Act</td>
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<td>The Argentine Ant Act</td>
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<td>Stock Diseases (Regulations) Act</td>
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<td>The Wheat Delivery Quotas Act</td>
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<td>Stock (Identification and Movement) Act</td>
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<td>Plant Pests and Diseases (Eradication Funds) Act</td>
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<td>Agricultural Products (Chemical Residues) Act</td>
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<td>Herd Improvement Service Act</td>
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<td>Biological Control Act</td>
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<td>1988–2000 Agricultural Products (Disputes) Act</td>
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<td>Agricultural and Veterinary Chemicals (Taxing) Act</td>
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<td>1997–1998 Exotic Diseases of Animals Act</td>
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<td>2001–2008 Gene Materials Proposed Declared areas Act</td>
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<td>2004–2005 Industrial Hemp Act</td>
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<td>2006–2007 Tree Plantations Agreement Act</td>
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<td>2008–2009 Wild Cattle Nuisance Act Repealed</td>
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<td>– Chicken Meat Industry Act</td>
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<td>– Agricultural and Related Resources Act</td>
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<td>Biosecurity and Agricultural Management Act</td>
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Note: Repealed acts are marked with "repealed".