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:

- **Creation of a new Division of Animal Production.** This division absorbed research and services for beef and dairy cattle, sheep and wool, pigs, poultry and apiculture.
- **A new Animal Health Division** included veterinary services, animal inspection services, the animal health laboratories and the biochemistry section.
- **The Dairy Division** was expanded by the addition of food technology but lost its animal production and extension services.
- **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.

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 ‘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
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.

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 pedigreed 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
of choice for sandy-surfaced 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-surfaced 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-leaved 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.

A combined baiting and sterile male release campaign eradicated an outbreak of the Queensland fruit fly in WA.
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
- demonstration of the need to increase the active ingredients in the seed pickles used to protect barley against loose smut
- advances on the control of cucumber mosaic virus
- identification of the alfalfa mosaic virus as a new threat to pastures, and studies of the organism
- demonstration that covering seed with fungicide did not control take-all
- showing that barley leaf stripe disease, new to Western Australia, could be controlled by Vitavax at standard rates
- identification in 1971 of *Phomopsis* as cause of lupinosis in lupin crops in joint work with the Animal Health Division; it was also demonstrated that lupinosis spores infested lupins much earlier than previously thought
- testing fungicide sprays to control lupinosis; all were found to be ineffective
- discovery that the potato cyst nematode survived on the sour thistle, a plant outside the *Solonaceae* family, which had been thought to be the only plants affected. This increased the difficulty of control
- eradication of the 1989 outbreak of apple scab by 1993
- eradication by 1993 of an outbreak of chrysanthemum white rust, which had been introduced in 1990.

The control of loose smut in cereals was aided by the availability of modern fungicides.
**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.
**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 disinfection of citrus, opening the market for mandarins, tangelos, ruby grapefruit and lemons.

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 vigneron 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.](image)

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.

**Inspection**

While it was less conspicuous, plant inspection continued in an efficient and effective manner. Largely unnoticed, it 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.

There was a large increase in heavy haulage trucks coming across the Nullarbor as the industry and population of the State expanded. In January 1986, 941 units passed through the Norseman checkpoint. In January 1988, 1925 units passed through. In addition there were many private cars and caravans. The industry inspection group also continued to operate effectively over a wide range of intrastate responsibilities.

The department maintained a plant quarantine facility to assist with the introduction of potentially superior genetic material to aid stock and plant production. A quarantine insectary was opened in September 1981. One of its first uses was to allow a number of parasites to be introduced from overseas to assist in the control of the main caterpillar pests of agriculture.

The importance of continued vigilance was illustrated when, in 1989/90, apple scab was diagnosed in 27 orchards. Twenty-three were in the Manjimup–Pemberton area, three were at Donnybrook, and one at Dwellingup. A successful eradication program was largely executed by the inspection staff.

**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 3773 to 4690 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.

Beef industry

In the late 1970s there was a marked change in the size and distribution of the WA beef industry, with a fall in total numbers. While numbers were maintained in the pastoral areas with some increase in the Pilbara, there was a sharp decline in beef cattle in the agricultural areas, particularly in the lower rainfall regions. Two-thirds of the 990,000 cattle in the agricultural areas were carried in areas receiving more than 650 mm rainfall.

The experimental work of the Beef Cattle Branch was centred around finishing Kimberley cattle, mating young heifers, launching a computerised selling system based on carcase classification, examining the pros and cons of branding of meat and comparing direct selling with auction.

Early experiments with Kimberley cattle brought south at six, 18 and 30 months of age were disappointing. In general, the cattle only achieved a fat score of 2 while consuming a tonne of feed per head. However, the quality of the beef improved over time and the results suggested that Kimberley cattle would need closer management for longer periods, which would improve eating quality. Work was planned to examine the value of weaning as a management strategy in the pastoral industry.

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
Some pen work with sheep grazing salt-
tolerant plants showed that a mixture of half
saltbush and half chaff gave the best result.
This was to be field-tested in the coming
year. 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 carcases 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.
Chapter 4 – 1970 to 1994: the new agriculture

**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 per cent of the leases. Surveys of 80 per cent of the productive leases were completed and 40 per cent 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 back bench.

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 gazettlement with more than 80 per cent 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.

Six thousand lucerne trees (Cystisus 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.