Kimberley Research Station review of progress, 1968-71

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An aerial view of Kimberley Research Station looking east, showing the Ord River and Station buildings in the foreground and the main experimental area beyond. Extending across the upper left of the photograph are a series of 50 acre, cattle grazing plots.

The potential for harnessing northern rivers flowing to the Gulf of Carpentaria and the Timor Sea was realised many years ago. These rivers together are estimated to carry about three times the water transported annually over the Murray drainage system and the South Eastern slopes, which comprise the closely settled agricultural areas of South Eastern Australia.

The Kimberley Research Station was established in 1946 to investigate the potential for irrigated agriculture in the Ord River valley. This is a review of the Station’s sixth progress report which is being published as Department of Agriculture Bulletin No. 3861.

With the completion of the main Ord Dam in October, 1971 and the storage of water during the 1971-72 wet season, the way is open to develop a total of 178,000 acres for irrigation in Western Australia and the Northern Territory. Initially, water will be released from the main dam to keep the level in the Diversion Dam, 30 miles downstream, high enough to allow gravity feed to the 22,000 acres already allocated on Ivanhoe Plain.

The Kununurra Diversion Dam at Bandicoot Bar and associated works were completed in 1963 at a cost of about $20 million and have since supported commercial irrigated farming, mainly cotton. The maximum area that could be irrigated from the annual storage in the Diversion Dam was about 15,000 acres, and did not allow much water for dry season crops.

The Ord River Dam will impound 4,600,000 acre feet of water to form Australia’s largest man-made lake covering 286 square miles at normal full supply level. To control the peak flood flows during the November to March wet season, the main dam is designed to hold a maximum of 23,400,000 acre feet of water. If this maximum volume is ever reached, the storage behind the dam, to be known as Lake Argyle, will cover 800 square miles. Once the dam is full it is expected that the overflow will run continuously for nine years out of 10.

Climate

The climate in the Kimberleys consists of well-defined dry and wet seasons. At the Kimberley Research Station, virtually all the average annual rainfall of 31 inches is received between October and April.

Evaporation outstrips rainfall in all months except January and February and makes irrigation necessary for continuous agricultural production. Relative humidity is highest in February (average 74 per cent.) and lowest in August (average 34 per cent).

June, July and August are the coldest months, with the minimum temperature likely to be below 50°F on one day in 10. Highest maximum temperatures are recorded between October and January, with one day in five having a maximum above 104°F. Plant growth is likely to be affected by these extreme maximum and minimum temperatures.

Actual daylength varies from 11.1 hours in June to 12.9 hours in December, but daily hours of sunshine are reduced by cloud cover during the wet season and range from 7.5 hours per day in February to 10.5 hours during July and August.

Soils

The main soil on the station is Cununurra Clay, which is also the main soil available for irrigated farming in the Ord River valley. Most soils are about neutral in reaction on the surface, increasing to strongly alkaline below about 1 ft. Some of the properties of the clay soils on the Station cause problems in irrigated cropping. Water moves very slowly into the soil and down the profile when the soil is already moist, resulting in waterlogging from heavy rainfall, particularly in level areas where land has not been graded to allow surface drainage. Also, good quality irrigation water must be used in order to prevent salt accumulation.
Nitrogen

A large number of experiments have been carried out on cotton, wheat, sorghum, and rice to determine the best source, rates, times and methods of application of nitrogen.

Urea, anhydrous ammonia and ammonium sulphate are equally effective on dry and wet season cotton when applied in the most effective manner.

Anhydrous ammonia nitrifies slowly, but has been sufficiently retained in Cununurra Clay to sustain a sorghum crop and its ratoon on 300 lb. nitrogen per acre applied at sowing.

The efficiency of urea, the most commonly used fertiliser, is greatly affected by the method of application. By far the best method with cotton is to band the urea at depth. Urea applied in irrigation water is less effective than banding, and surface broadcast is least effective. With 200 lb. nitrogen per acre, the yields of seed cotton per acre were 4,700, 3,700 and 2,600 lb. respectively.

The proportion of applied nitrogen used by the cotton crop can be as high as 88 per cent. for dry season crops, but is generally about 40 to 60 per cent., depending on the rate of application.

Cotton agronomy

Previous research at the Station helped to establish the cotton farming practices now used in the Ord area. In recent years, research has been mainly on the relationship of farming practices to cotton quality, on which the future of the local cotton industry now largely depends.

Cotton quality must be judged in terms of the quality of the yarn and fabrics as well as the ease of processing of the raw material. Fibre quality is determined by varieties and by environmental conditions between flowering and boll ripening, and can be altered by the amount of pre-harvest weathering of cotton in open bolls and by harvesting and ginning practices.

Cotton bolls can develop at any time under the climate of the Ord area. The practices that determine when most of the bolls develop are sowing time, time of nitrogen fertiliser application and insect control.

The first commercial crops in the area were generally sown in November or early December and harvested from April to June. Now, crops are sown or stubbed a month or six weeks later, part of the nitrogen application is often delayed and intensive insect control is usually delayed until after the wet season. These practices result in the loss of the early fruiting forms and most bolls are set when temperatures are falling.

Experiments on the Station have shown that later boll setting reduces staple length slightly but has no effect on fibre uniformity or short fibre content. Other effects are finer fibres and, sometimes, a slight reduction in fibre strength.

The slower rate of boll setting and ripening under lower temperatures leads to longer pre-harvest exposure of early opened bolls. Pre-harvest exposure is further prolonged by the general practice of
“once-over” harvesting when nearly all bolls are mature, by planned delays in harvesting to obtain better grades, and by extended harvesting and ginning operations in order to reduce costs.

Experiments on the Station between 1968 and 1970 have shown that pre-harvest exposure is harmful to cotton quality. The main agent causing damage was direct sunlight.

A concurrent series of experiments on the effects of delayed harvesting was carried out on farms. The results confirmed those obtained on the Station: highest fibre quality and best yield were obtained from cotton harvested twice.

The present commercial cotton growing system, with insect control delayed until the dry season and labour and equipment costs reduced by prolonged harvesting, has obvious economic advantages, but the system must be modified to reduce pre-harvest exposure. Research on this aspect is currently in progress.

Cotton breeding
A wide range of varieties from the main cotton growing areas of the world have been tested and pure seed of the highest yielding ones has been produced for farmers.

New varieties have been developed by cross breeding and selection. Promising selections with Acala parentage have yielded as well as the commercial Acala variety but have much longer fibre and better yarn strength. Provided they are grown under conditions that will produce cotton of high grade, varieties developed from these crosses should enable the Ord River cotton to replace the long staple cotton now imported from East Africa.

Recent work on the Station suggests that hybrid vigour may have an application in cotton production. Lint yield increases of 20 per cent. on the plant crop and 25 to 30 per cent. in the stub (or ratoon) crop have been obtained from first generation hybrids between Stoneville and African varieties, giving yields above 2000 lb. of lint per acre. There has been no loss of lint percentage or fibre strength and yarn strength has been slightly better than the Stoneville parent.

Commercial production will be possible when the current breeding programme produces types suitable for the production of cheap hybrid seed.

Insects
Cotton. In most years insects can completely prevent the setting of a cotton crop unless it is adequately protected by insecticides. A current practice, frequently adopted, is to provide minimal protection during the wet season and to delay until March the full insecticide programme necessary for the setting of a heavy crop.

A trial carried out twice, comparing a full spray schedule started six weeks after sowing with the same schedule delayed a further four and eight weeks produced no differences in the number of bolls on any treatment.

The severity of Heliothis attack on cotton makes it very doubtful if biological control alone could be fully effective. Augmentation of biological control agents on unsprayed areas may reduce the pressure of egg laying on cotton. Work by the C.S.I.R.O. Division of Entomology on a virus pathogen of Heliothis may later be extended to the Ord.

Sorghum. Significant sorghum yield losses have been caused by Heliothis. Insecticides applied to con-
control Heliothis upset a natural enemy balance and resulted in an increase in aphids. Harvesting machinery was seriously clogged with honeydew resulting from an attack of the aphid Rhopalosiphum maidis.

Three species of locusts are becoming a hazard to the economical production of sorghum in the area.

Sorghum agronomy

Winter temperatures in the Ord River valley are sufficient to maintain sorghum growth, so that three crops can be produced in one year. The high yields obtained are near those required for sorghum to be profitable with the high costs of handling through the port of Wyndham.

This implies that at least one crop may mature during the December-March wet season with the risk of heavy losses in yield and quality from head moulds. Harvesting may not be possible if the wet season is late finishing.

No commercial or experimental hybrid has so far consistently out-yielded Texas RS-610. Some tropical types have given higher yields, but they are commercially unsuitable in their present form as they reach a height of over 12 ft. and cannot be harvested with conventional equipment. Also, their grain colour is unacceptable to present markets.

Some tropical types are daylength sensitive and will not initiate flowers between late August and early January when the daylength exceeds 12 hours. Daylength sensitive dwarf varieties with acceptable grain colour are being sought. These would result in all plantings between late August and mid January maturing in early June, giving flexibility in planting date and avoiding the hazards of planting or harvesting in the wet season.

Investigations have shown that the optimum row spacing is 20 in. or less and optimum plant population about 200,000 plants per acre. Depending on seed quality, this would be equivalent to a seeding rate of 20 to 25 lb. per acre. Over a wide range of conditions and seasons the optimum nitrogen dressing appears to be 150 lb. per acre, both at planting and re-cycling.

Reasonable first cycle yields can be expected without nitrogen from land left to clean fallow for at least two years.

Recently, studies have begun into the effect on plant growth and grain yield of water stress at different stages of crop development.

Temperate cereals

The temperate cereals, wheat, oats and barley have been grown successfully under irrigation in the dry winter months.

Wheat. Studies of pre-flowering water stress showed that the number of ears and grain number per ear were reduced, but yields were unaffected due to the compensating effect of grain size. Post-flowering water stress reduced grain yields substantially by reducing grain size. Various varieties have been tested for yield and baking quality with various water and nitrogen treatments.

Barley. Of 20 varieties planted at three times, the best overall performance was given by Arivat.

Oats. Oats have given hay yields of up to 4 tons per acre, but grain yields have been low due to low weight per volume.

Maize. The Dekalb experimental hybrid G1 gave the best yield of the hybrids planted in the 1968 dry season. In the 1969/70 wet season, 34 Australian commercial and experimental varieties yielded over 5350 lb. per acre. The varieties G1, GM211 and C6 yielded over 6245 lb. per acre.

Culinary peanuts

Peanuts were tested extensively in the early years of the Station but trials were discontinued in 1954 because of harvesting and disease problems. Varieties better adapted to heavier soils have since been bred. Harvesting machinery has also improved.

These newer varieties remain dormant after maturity provided the soil is kept moist, allowing digging to be carried out at a moisture content which will enable the nuts to be free from soil particles.

Two varieties tested during the 1968/69 wet season yielded up to 1 ton of kernels per acre and were satisfactory for the oil trade but they did not have the quality required for the Japanese culinary market.

Eight new U.S. varieties planted in March 1970 gave yields of 1784 to 2676 lb. per acre, and four were of culinary quality. Seed of these varieties is in a multiplication programme in which encouraging yields have been obtained.

Over 100 introductions were planted in March 1971 to test oil and culinary potential and to assess varieties for spreading the planting time throughout the wet and early dry seasons. Present varieties are unsuited to planting later than the end of March.

Oilseed crops

Experimental work at the Station has been renewed on safflower as a dry season crop and soya bean and sesame as potential wet season crops. Emphasis is on importation and testing of improved varieties.

Rice

Work on rice since 1965 has been complicated by the appearance of a "disorder", symptoms of which have been observed on most rice varieties including those grown before the disorder appeared.

The typical symptoms of the disorder are death of seedlings, stunted growth, rusty brown speckling, spotting or blotching of the older leaves, and irregular maturity typically occurring in patches but sometimes widespread throughout the field.

Many suggestions have been made as to the cause, including insect transmitted disease, nutrient deficiencies or imbalance, herbicide residues (in the irrigation water or the soil), and the quality of the irrigation water (other than its possible herbicide content).

The relationship between the disorder and possible zinc deficiency remains to be tested in the field. Recent studies at the Station suggest that the level of bicarbonate may play some role in the occurrence of the disorder.

In the absence of the disorder, quadrat yields with the variety IR8 were 5,600 lb per acre, when sown in May 1969, 8,700 lb per acre when sown in August and 11,600 lb per acre when sown in December.
Hence it is important that all factors contributing to the rice disorder should be identified so that appropriate management practices can be devised.

**Irrigated forage**

The assessment of dry season grazing crops for fattening cattle started in 1969. Maximum production did not exceed 400 lb. liveweight gain per acre. Sorghum species gave low but steady gains, and oats gave very good gains for the first 10 weeks with a decline to low levels of production thereafter.

Trials on both sudax and oats failed to show any difference between weekly, fortnightly and monthly watering. The nitrogen requirements of the two crops were determined and losses of nitrogen were as high as 80 per cent. The value of production was considerably short of the cost of growing the forage and work on forage crops for the dry season has been suspended in favour of perennial grasses.

Pangola grass (*Digitaria decumbens*) has been planted as a management trial comparing a week-on, week-off rotation and continuous grazing. After eight months there appears to be no difference in productivity between the grazing systems. After seven months the pastures appeared severely nitrogen deficient despite 60 to 120 lb. nitrogen per acre as surface applied urea every 6 to 9 weeks. It is suspected that most of the urea applied broadcast on the surface is lost.

The maximum possible liveweight production per acre using steers with low capacity for compensatory gain was calculated and gave 1,170 lb. liveweight per year.

An observation area of *Leucaena leucocephala* indicated that this legume can withstand heavy stocking rates for long periods, but mimosine toxicity has been a consistent problem. Despite severe toxicity symptoms in some animals, weight gains continued.

In a period of 161 days, animals stocked at 3 beasts per acre gained an average of 1.3 lb. liveweight per day or 3.9 lb. liveweight per acre per day. During this period the

*Leucaena leucocephala* became dominant and reached a height of over 9 ft., suggesting that at 3 beasts per acre the pasture was under-stocked.

**Dry lot feeding**

Research into intensive feedlot fattening of beef cattle, particularly the local shorthorn, using products from the Ord Irrigation Area has been in progress since 1967. Despite decades of natural selection for survival under low energy, low protein range fed conditions, local shorthorn steers have been successfully fattened on various sorghum-based high energy rations.

Limited comparisons of other breeds have shown none to be markedly superior to the local cattle. As more rice might be grown on the future expanded irrigation areas, a rice-cottonseed ration was also tested, but was not quite as good as a sorghum-based ration.

**Rangeland management**

*Supplementary feeding.* Breeding females have been shown to suffer most during the annual drought in northern Australia, and the problem has been investigated in a trial started in 1967.

A supplement of whole cottonseed was fed out weekly at the rate of 0.9 lb. per breeder per day from early September through to the first effective fall of rain which was usually in late November-early December. Supplementation arrested the late dry season liveweight loss to some extent and slightly increased calf survival and liveweight at weaning.

*Improved dry-land pasture.* More than 1 million acres of grazing land near the Ord River Irrigation Area may be suitable for improved pastures such as the annual tropical legume *Townsville stylo* (*Stylosanthes humilis*). Production and persistence of ten strains is being assessed on various soil types under varying rainfall.

*Sabi grass* (*Urochloa mosambicensis*) is being tested as a companion grass to a range of *Stylosanthes* species on levee soils. With improved pastures these dry-land areas could be a valuable source of store cattle for fattening on the adjacent Ord Irrigation Area.