

QUEENSLAND AGRICULTURAL JOURNAL

March - April 1981.

Vol. 107, No 2.





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Cover: The Royal Australian Navy is a great help in bringing possible prohibited imports to the attention of D.P.I. quarantine inspectors. Photograph by B. J. Rogers

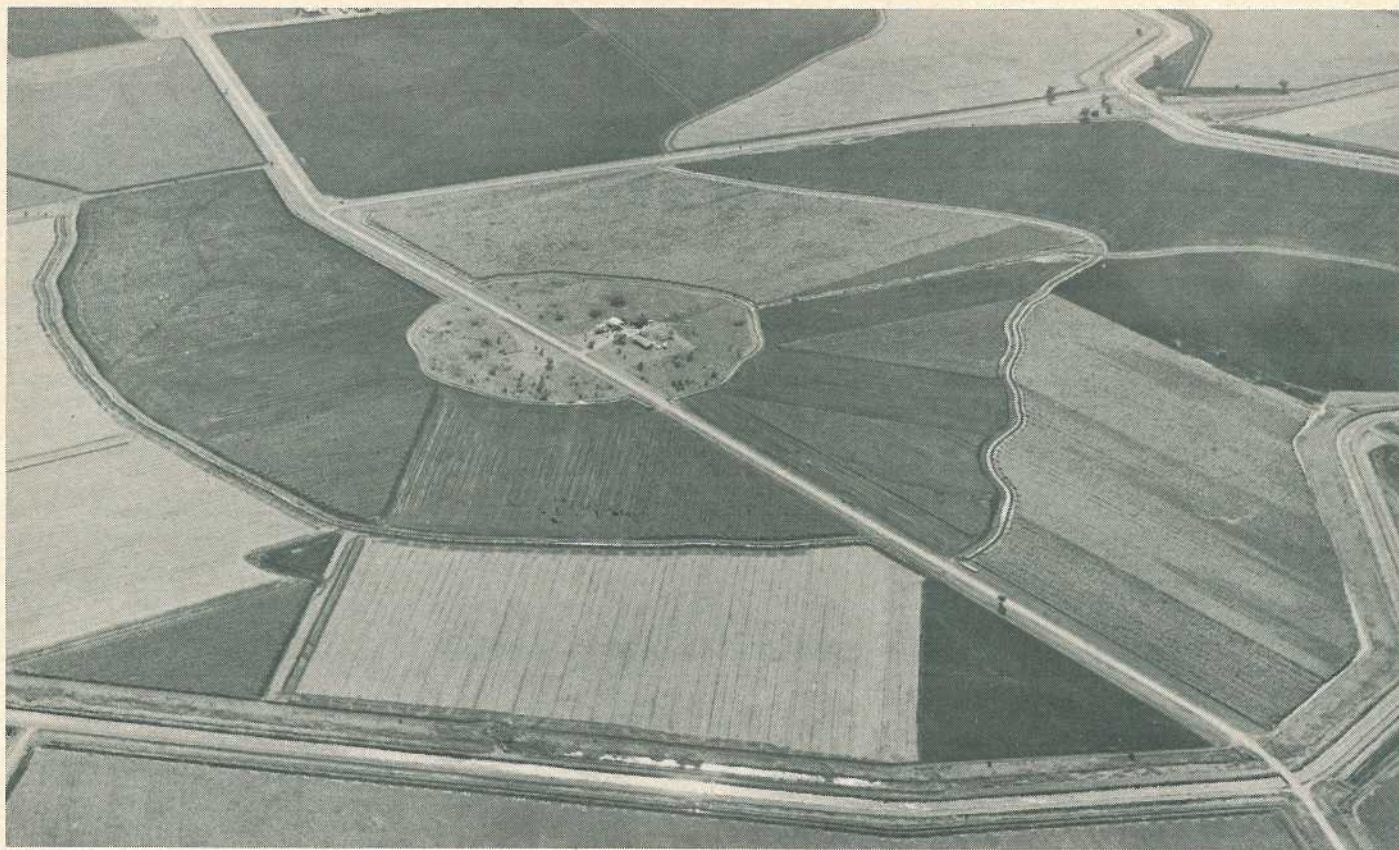
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The *Queensland Agricultural Journal* is published every second month by the Department of Primary Industries, Mineral House, George Street, Brisbane, Queensland, 4000. Telephone 224 0414.

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Irrigated soybeans at Emerald

by W. D. Hamilton, Agriculture Branch

Soybeans are an important crop in the Emerald Irrigation Area. In 1977-78, some 800 ha were grown while in excess of 2 000 ha were grown in 1979-80.

The district average yield is about 2 t per ha but yields range from 1 t per ha to 4 t per ha. The markets appear assured and most of the Emerald crop is sold to southern processors although some beans are processed in Central Queensland. Soybeans (*Glycine max*) are a summer-growing annual legume.

Choosing a variety

Most soybean varieties flower in response to changing day length. Suitable varieties must be chosen and a variety that performs well in southern Queensland may be unsuitable for the Emerald area.

Maturity is particularly important. For example, a variety that flowers quickly can set pods close to the ground and these will be lost at harvest.

Photograph above. An aerial view of soybeans and other crops in the Emerald Irrigation Area.

The yields obtained from a number of varieties in various trials conducted at Emerald are shown in table 1. The general characteristics of important commercial varieties are shown in table 2.

Variety recommendations

Flegler and Davis are the recommended varieties for planting in December—the main planting time for Emerald crops. Both varieties have consistently produced high yields but Davis is prone to pod shattering.

Wills can also be sown at this time. It is a hardy variety, however, it did not perform consistently well in 1978-79. Both Flegler and Wills have a black hilum which makes them unsuitable for some markets.

Later plantings of these varieties may still yield well but conditions must be favourable and often pods are set too low on the plant.

Fitzroy and Canapolis are recommended for plantings in mid December to mid February. They are longer season varieties which have performed well under trial. Because

they take longer to flower than the quicker varieties, they usually set their lowest pods higher on the plant.

Fitzroy was developed and released by the University of Queensland in 1979. Canapolis was introduced from Brazil by a seed company.

Fertilizers

A 3.5 t per ha crop of soybeans removes about 220 to 240 kg nitrogen per ha, 20 to 25 kg phosphorus per ha, 60 to 70 kg potassium per ha as well as other minor trace elements.

NITROGEN

Nitrogen fertilizer is not recommended for soybeans in Emerald except when the plants fail to nodulate.

Although much of the nitrogen requirement of the crop is met through symbiotic nitrogen fixation in the root nodules, a proportion is supplied from the soil.

Generally, in the Emerald district, soil nitrogen supplies are low. There is a suggestion locally that low rates

TABLE 1

Grain Yields (kg/ha) from Variety Trials Conducted at Emerald

Variety	Planting Date								No. trials
	22-1-74	4-3-74	6-1-76	7-12-78	21-12-79	20-12-79	11-12-79	Average	
Fitzroy	..	..	3 739	2 986	3 775	3 977	4 366	3 769	5
Flegler.....	3 953	2 741	3 639	4 104	3 630	4 070	3 805	3 706	7
Davis.....	4 250	2 724	3 698	3 955	3 727	4 081	3 490	3 704	7
Canapolis.....	..	..	4 082	2 870	3 701	3 453	4 097	3 641	5
Bragg.....	2 955	2 437	3 479	4 143	3 392	4 351	3 654	3 487	7
Semstar.....	3 253	2 532	3 580	3 653	3 313	3 955	3 988	3 468	7
Wills.....	3 710	2 687	3 483	3 010	3 114	3 862	4 093	3 423	7
Hill.....	3 180	2 304	3 184	3 484	3 613	..	..	3 153	5
Collee.....	3 316	2 600	2 626	3 734	3 338	..	..	3 123	5
Hampton.....	2 408	2 453	3 406	..	..	..	..	2 756	3

TABLE 2

Soybean Varietal Characteristics

Variety	Maturity* rating	Lodging resistance	Average height (cm)	Average height to lowest pods (cm)	Flower colour	Pod Hair colour	Hilum† colour	Pod shattering	Approx. no. seeds per kg
Davis.....	6	good	75	12	white	grey	buff	yes	5 500
Bragg.....	6	very good	75	10	white	twany	black	no	5 200
Wills.....	8	fair	85	16	purple	tawny	black	no	6 100
Semstar.....	7	poor	90	13	white	grey	buff	no	5 900
Collee.....	5	very good	70	8	purple	tawny	black	no	5 700
Flegler.....	7	good	75	12	purple	tawny	black	no	5 200
Hill.....	5	good	70	10	white	tawny	brown	yes	6 000
Fitzroy.....	8-9	fair	100	12	purple	grey	imperfect black brown	no	5 700
Canapolis.....	9	very good	90	12	white	tawny	black brown	no	6 000

* 5—quick maturing.

10—slow maturing.

† The hilum is the place on the seed where it attaches to the pod.

of nitrogen fertilizer (less than 40 kg N per ha) are beneficial, particularly to provide a supply to the plant before the nodules become productive.

However, even low rates of nitrogen fertilizer reduce the effectiveness of the nodules. Both nodule number and nodule size are usually reduced when the supply of soil or fertilizer nitrogen is increased. Only rarely has the addition of nitrogen fertilizers proven profitable when the soybean crop is well nodulated.

PHOSPHORUS

Soybeans respond to phosphorus fertilizers and most soils in the Emerald area are deficient in phosphorus. Soil analysis is a useful guide to the level of phosphate fertilizer to be applied.

POTASSIUM

Soybeans require moderate amounts of potassium but most soils in the Emerald area have sufficient

quantities available for plants. Some soils are deficient and 40 kg K per ha is recommended for these areas.

OTHER NUTRIENTS

Sulphur responses have not been recorded in the field although deficiency symptoms have been observed in some crops growing in the area. In pot trials, significant yield responses to sulphur have been recorded on soils from the area. Test strips of fertilizer containing sulphur are recommended.

Field responses to zinc fertilizer have not been observed in the Emerald Irrigation Area. Some soils have only marginally sufficient

quantities of available zinc. Test strips of 5 kg Zn per ha banded at, or before, planting are recommended. This rate is equivalent to 23 kg zinc sulphate heptahydrate or 14 kg zinc sulphate monohydrate per ha.

Responses to other trace elements have not been recorded in the Emerald area.

Planting

Seed should be planted into a moist, firm seed bed at a depth of 4 to 5 cm. Sufficient seed to achieve a plant stand of 250 000 plants per ha is recommended. Plant populations should be increased for late plantings.

TABLE 3
Phosphate Fertilizer Recommendations

Soil analysis ppm P (bicarbonate extraction)	Comment	Fertilizer recommendation
0-10	response likely	20 to 30 kg P per ha
10-20	response probable	10 kg P per ha
20-30	response possible	test strip
30	response doubtful	no fertilizer



Field days enable soybean growers to study soybean varietal performance at Emerald.

Rows should be 50 cm apart or twin rows on beds 1 m apart. Some growers use 1 m rows because this fits equipment used for cotton and facilitates weed control. Little yield is lost at this row spacing but wider row spacing will depress yields. Table 4 shows plants per m of row at various row spacings and plant populations.

Seed inoculation

Inoculation of seed with the correct strain of *Rhizobium* is important. This strain is usually absent in soils that have not

previously grown soybeans and nodulation will not occur. These crops yield poorly unless soil nitrogen fertility is very high.

Seed inoculation may not be necessary in areas which have had several crops of soybeans, but the relatively low cost of inoculant makes it inexpensive insurance.

Soybean inoculant can be purchased in peat-based mixtures and should be carefully applied to the seed. The inoculant should not be exposed to heat or sunlight and the seed should be planted shortly after the inoculant is applied.

Irrigation

Soybeans are sensitive to drought stress and respond well to irrigation. Crop water use in the Emerald environment depends on seasonal conditions but usually is about 500 mm. In some hot, dry seasons in excess of 650 mm of water is required by the crop.

Moisture stress should be avoided throughout the growth of the crop but flowering and pod filling are critical stages of crop development when the crop must not be moisture stressed. Stress at flowering can severely reduce yields. Moisture stress during pod filling will reduce seed size and consequently reduce crop yield. Moisture stress during the vegetative phase usually has the least effect on yield.

Pre-planting irrigation is recommended. This facilitates weed control and provides adequate moisture for the early vegetative growth of the crop. The first post-planting irrigation is usually required 30 to 40 days after planting. Flowering occurs 40 to 50 days after planting and at this stage the crop should be regularly irrigated. In the absence of rain, an irrigation may be required every 10 days depending on soil type and weather conditions. An average irrigation schedule for Emerald is shown in table 5.

TABLE 5
Irrigation for Soybeans at Emerald

early December	pre-planting irrigation
mid December	plant
mid January	irrigate
early February	irrigate
mid February	irrigate
mid March	irrigate

One useful method of calculating when to irrigate is based on a crop factor and measurements of pan evaporation. The crop factor has been calculated by measuring actual water use of a crop at various growth stages. When the crop has full canopy cover, water use by the crop is similar to the pan evaporation—crop factor is 1. When plants are smaller, the crop factor is less than 1.

If the daily pan evaporation is multiplied by the crop factor, the daily water use is calculated. This can be accumulated until the easily available soil moisture is used. An irrigation is then required. If more than 10 mm of rain falls, this can be subtracted from the accumulated water use and irrigation delayed accordingly.



A well-grown crop of Davis soybeans approaching harvest.

TABLE 4
Plants per Metre of Row

Plant population plants/ha	Row spacing (cm)		
	30	50	100
200 000	6	10	20
250 000	7.5	12.5	25
300 000	9	15	30
350 000	10.5	17.5	35

Table 6 gives an example using 10-day average pan evaporation figures for Emerald.

Daily measurements of pan evaporation and rainfall are needed to estimate when irrigations are required. However, these estimated 10 days average pan evaporation figures give a guide to seasonal water use. If the easily available soil water was 100 mm, the crop would need irrigating at:

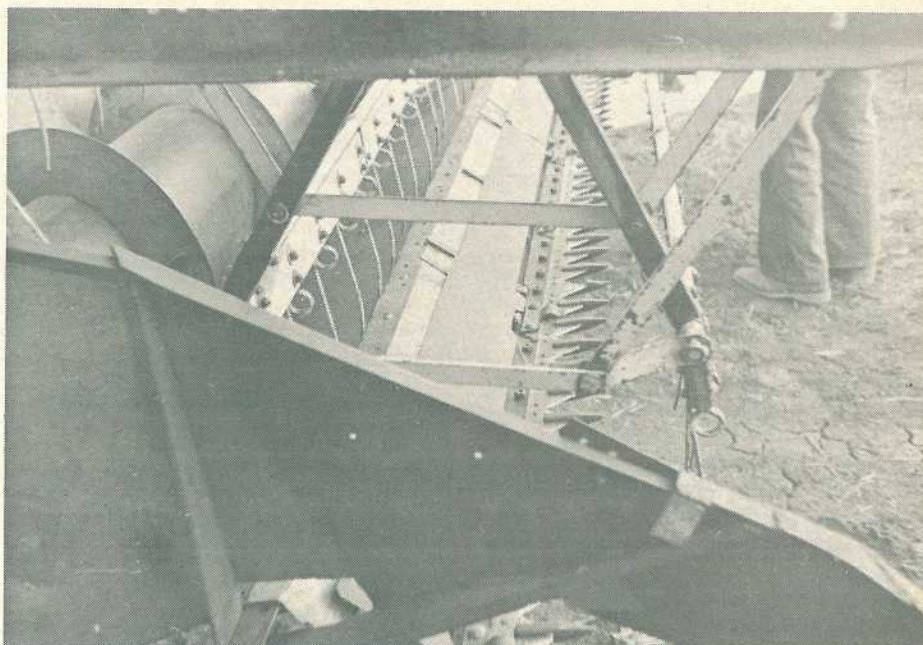
- pre-planting;
- day 40;
- day 60;
- day 75;
- day 95.

Insect pests

Insect pests seldom cause widespread losses in soybeans grown in the Emerald area. However, regular crop inspections are necessary to ensure timely control measures are undertaken should numbers reach damaging levels.

Budworms (*Heliothis* spp.) attack the soft growing tissue on the soybean plant. They also eat holes in the pods and consume the growing seeds usually soybean plants suffer only a slight setback if leaves and terminals are damaged. Damage to the seeds growing in the pods is more important. If this damage is occurring and pest numbers exceed two per m of row, methomyl at 1.5 to 2.0 L of the 225 g/L product per ha or endosulphan at 2.1 L of the 350 g/L production per ha should be applied.

The green vegetable bug (*Nezara viridula*) can cause serious losses in soybeans. This insect feeds by sucking juices from the growing beans inside the pod. Damaged beans are small and are often shrivelled. Relatively few green vegetable bugs need to be present in a crop to cause yield losses.



Floating cutter bars assist the harvest.



Hay made from soybean stubble is of low quality, but when fed with urea is a useful drought fodder.

TABLE 6
Estimation of Water Use Using Pan Evaporation

	Days from planting	Crop factor	Estimated 10 day average pan evaporation	Estimated water use (mm)	Cumulative water use
Late Dec.	0-10	0.2	83	16.6	16.6
	10-20	0.2	76	15.2	31.8
Jan.	20-30	0.3	76	22.8	54.6
	30-40	0.5	76	38.0	92.6
	40-50	0.75	62	46.5	139.1
Feb.	50-60	0.92	62	58.9	198.0
	60-70	1.0	62	62.0	260.0
	70-80	1.0	56	56.0	316.0
Mar.	80-90	1.0	56	56.0	372.0
	90-100	0.95	56	53.2	425.2
Early Apr.	100-110	0.85	51	43.35	468.55

If numbers build up to one adult or juvenile per m of row from pod set to commencement of haying off, insecticide applications will be required. This pest is not easy to detect and a careful watch needs to be maintained in the pod development stages.

Both green vegetable bug and budworm can be controlled by applying endosulphan at 1.5 L of the 350 g/L product per ha.

Spur-throated locust (*Austracris guttulosa*) infestations have caused damage to soybean crops in some seasons. They mainly feed on developing pods, although damage to leaves and terminals can occur. Both adults and nymphs can cause crop damage.

Because infestations of this pest are usually patchy, it is difficult to decide when insecticide treatments are warranted. If pod damage is occurring and more than one locust per m² is present in the crop, treatment with diazinon or monocrotophos is usually worthwhile.

Several other pests have been observed on soybeans at Emerald but have not caused severe losses. They include the lucerne crown borer (*Zygrita diva*), spider mites (*Tetranychus* spp.), green loopers (*Plusia*

spp.), red-banded shield bugs (*Piezodorus* sp.), jassids and thrips. Seedlings are sometimes damaged by false wireworms and cutworms.

Regular and thorough crop scouting is essential to ensure that pests are controlled before serious damage occurs. Green vegetable bugs in particular can build up without being easily observed.

Diseases

To date, soybean diseases have not caused severe losses in soybeans at Emerald. Charcoal rot (*Macrophomina phaseoli*) commonly causes isolated plants to die prematurely. It usually only occurs in plants that have suffered heat or moisture stress as seedlings.

Bacterial blight, bacterial pustule and wildfire have also been identified in crops at Emerald.

Weeds

Soybeans are competitive with most weed species. Planting in moisture into a weed-free seed bed and obtaining good plant cover usually controls most weeds.

Inter-row cultivation is effective at controlling weed seedlings that germinate between the rows. Two

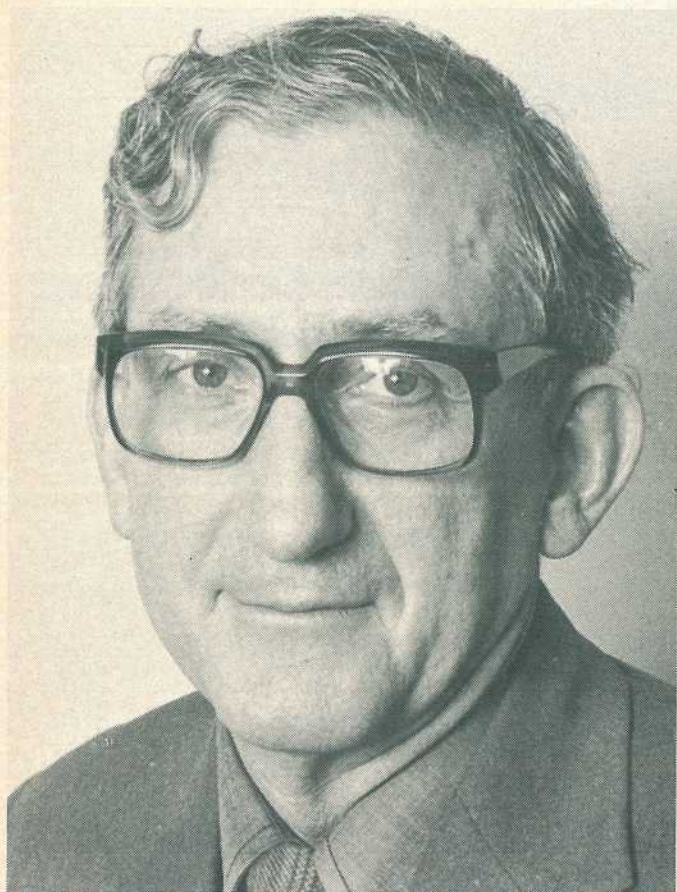
cultivations are often carried out, before and after the first post-planting irrigation.

Several herbicides are registered for use in soybeans in Queensland. Trifluralin at 1.4 to 2.8 L of product per ha depending on soil type gives good control of grass species and some broadleaf weeds. Bentazone, sold as Basagran, is an effective post-emergence herbicide. Applied at 1.5 L of product per ha, it is particularly useful for controlling noogoora burr (*Xanthium pungens*) and thornapples (*Datura* spp.).

Harvesting

Heavy yield losses are often recorded at harvest time. Losses from shattering and poor machinery adjustment can be in excess of 10%. Some hints towards improving harvest efficiency are:

- Plant a variety that sets its lowest pods higher than 10 cm from the ground.
- Ensure adequate plant populations are achieved. Poor plant stands result in pods being set low to the ground.
- Commence harvest when moisture in the pods reaches 13%. Shatter losses increase when moisture levels drop below 11.5%.



The Journal for 1981

As you will already have noticed, 1981 has brought some changes to the *Queensland Agricultural Journal*.

The changeover to offset printing has given us the opportunity to modernize the Journal. A larger page size and a better layout should make the articles more appealing and easier to read. The quicker printing process may also help overcome printing delays.

The basic information contained in the articles, however, will not change. In this, its eighty-fourth year of publication, the Journal will continue to offer its readers practical information on a wide variety of agricultural topics. It will also keep primary producers, scientists and consumers abreast of recent developments in the Department's research programmes.

For the future, the aim will be to widen the range of topics and, at the same time, continue to improve readability and presentation.

Dr G. I. Alexander,
Director-General,
Queensland Department of Primary Industries.

Breeding home-bred bulls

by J. J. Daly, Beef Cattle Husbandry Branch

Many commercial beef breeders use 'home-bred' bulls selected from within their own herd.

In a lot of cases the home-bred bulls would be as good as any purchased bulls. However, some additional work is required to see that superior types are selected. This article outlines some simple procedures that can be adopted to select better home-bred bulls.

The promotion of selecting home-bred bulls is not intended to reduce the market for bulls provided by studs or to denigrate the status of studs in the industry. Studs are the custodians and preservers of the various breeds in perpetuity. This is an important function but their scale of operation is too small to provide all the needs of the commercial beef breeding industry.

With approximately 5 million breeders in the State herd and bulls used at 4% of breeders mated, the potential annual replacement requirements for bulls in Queensland could be around 50 000 bulls per year. If all of these were supplied by the stud sector and half the bull calf drop was culled so that only above average bulls were sold, the stud sector would need to mate about 250 000 breeders. According to Australian Bureau of Statistics (ABS) census data, the stud sector only has one-tenth of these numbers and so a large proportion of bulls have to be home-bred.

In fact, ABS data shows that registered bulls represent only 4% of all bulls in service on Queensland properties. This understates the total number of bulls produced by studs as herd bulls are not recorded in the census.

Justification for using home-bred bulls

Apart from the cost and difficulty of getting bulls from other sources, the use of home-bred bulls can be made more acceptable to commercial breeders if they are seen to be as good as those available from other sources.

Any apparent differences in the looks of stud and commercial cattle are due in most cases to feeding not



Provided the herd is big enough, replacement heifers can be used to breed replacement bulls. Photograph courtesy of *Queensland Country Life*.

breeding. The stud breeder is more conscious of the appearance of his cattle because that is what sells them. Stud cattle are better fed and off-types are culled. When they are presented to potential buyers they always look good for these reasons.

Appearances can be misleading and give no indication of genetic differences between herds. The genes determine what an animal itself can do and how its progeny will perform. As you cannot examine an animal's genes to see what it can do, the only way of seeing the influence of the genes is through making comparisons between animals under uniform conditions.

Because conditions are not uniform on different properties, the genetic differences between herds can only be determined using complex procedures. Genetic theory shows that because of the exchange of genetic material between studs and commercial herds over the last 200 years, there is little or no genetic

difference between studs as a group and commercial breeders.

If there were marked differences between a bull selling herd and a bull buying herd it would take only four generations (20 years) to eliminate over 90% of the genetic difference. The operation of this transfer of genes is seen when you grade up to a new breed. In the first generation, you eliminate half the difference, in the second generation three-quarters of the difference, in the third generation seven-eighths of the difference and so on. The operation of this process is depicted graphically in Figure 1.

What this means is that under identical conditions there is no difference between the average performance of the whole stud sector and the commercial sector. Within each sector there will be individual herd differences due to different selection policies. Some stud herds will be superior to a lot of commercial herds and some commercial

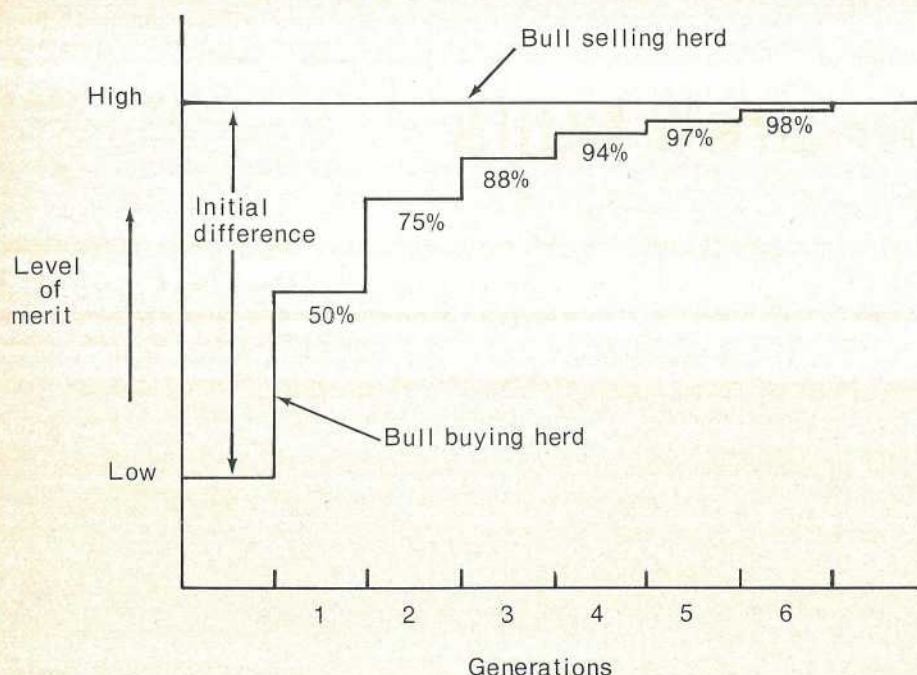


Figure 1. The elimination of genetic difference between herds.

herds will be superior to a lot of stud herds. A representation of the relative ranking of stud and commercial herds is shown in Figure 2.

If you are a commercial breeder who buys replacement bulls, the problem is in identifying which studs are superior so you can improve your commercial herd. Even if superior studs can be identified, nothing is gained unless the bulls being sold can also be differentiated according to their breeding value. Below-average bulls from a superior stud herd are probably inferior to the top bulls that could be bred in a commercial herd.

In the absence of records that identify either superior studs or the genetic merit of bulls offered for sale, a bull buyer usually ends up with average bulls that cannot improve his herd. Some bulls will be above average and improve the herd, but just as many will be below average and degrade the herd.

Proof of this was given when performance recorded bulls were offered for sale but buyers did not know how to use the records. In this situation, there is no relationship between breeding value and prices paid. Higher prices were paid for genetically inferior, older bulls that **appeared** to be better grown.

Because there is little difference between studs and commercial herds, many commercial herds could select replacement bulls from within their own herd. For a commercial breeder it is just as incorrect to regard studs as the source of all progress as it is for

studs to regard the country of origin of a breed as their pacesetter for progress.

Breeding requirements

Simple procedures can be adopted to identify superior home-bred bulls. The simplest procedure is to select

bulls traditionally at branding on visual appearances, but this is no better than the existing situation. To progress and ensure that replacements are above average, some additional work is required to improve the accuracy of selection and simple records have to be kept.

Aim to fit the breeding programme into the existing management system—not the converse. Over time, as management improves, more accurate selection procedures can be adopted.

When replacement bulls are being selected from within the herd, inbreeding can be a problem in herds of less than 150 cows. Inbreeding is strongly influenced by the number of bulls used. It can be minimized if the number of bulls used is increased and the duration of use is decreased. Using say 4% bulls instead of 2 to 3% and using them for two to four matings instead of five or six significantly reduces the chances of mating to close relatives.

In herds of less than 100 breeders, home-bred bulls can still be used but outside introduction should be made from time to time to reduce the amount of inbreeding.

To improve the accuracy of selecting home-bred bulls, as many bulls as possible are left entire until at least weaning when half can be culled on pre-weaning performance.

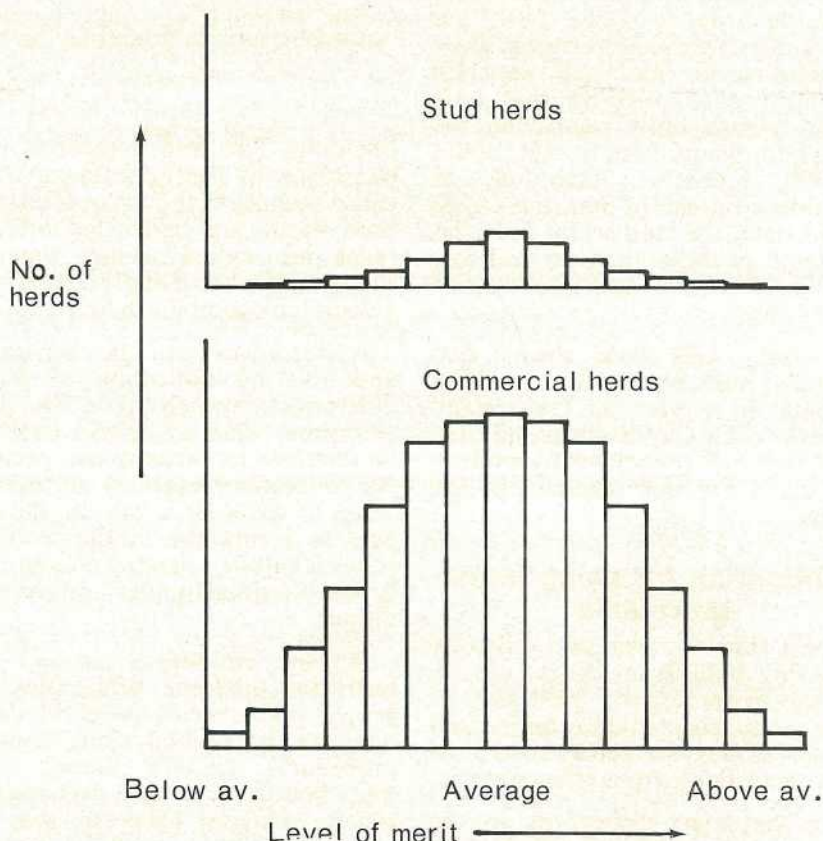


Figure 2. Distribution of stud and commercial herds on level of merit of production traits.



Progress is made through replacing good bulls with better ones. Simple techniques can be used to identify better bulls. Photograph courtesy of *Queensland Country Life*.

Castration at weaning and 18 months is practised on a number of properties and has no effect on producing 'staggy' steers.

Ideally, controlled mating is practised to reduce the spread in calving and the effects of seasonal variation on calf performance. Having a tighter calving period reduces age differences and errors in selection when ages are unknown. However, controlled mating is not an absolute requirement for the options considered here.

Actually, very little is required to improve the accuracy of selecting home-bred bulls. Some extra work is involved in collecting records at branding, weaning and as yearlings, but most of this fits in well with the usual activities on the property. While scales are not essential, they increase the accuracy of the assessment of growth.

Use of bulls

The number of bulls used on commercial herds varies between 2 to 6% of cows mated and is strongly influenced by paddock size and topography. On appearances, using fewer bulls looks good because less have to be selected as replacements and so the quality of those selected may be superior.

Any advantage gained through using less bulls has to be balanced against the disadvantages of inbreeding and chance effects, particularly in small herds. Chance effects are important in small herds and increase the risk that the rate of genetic improvement will be below

expected rates. It is better to use more bulls per year to hedge against these two problems.

Using more bulls to reduce chance affects does not mean that the average quality of the larger group of bulls is lowered. Provided bulls are replaced more frequently, genetic change is increased and overall herd improvement is accelerated.

Using 4% bulls and replacing them after two mating seasons is a sound practice. A sire's genes do not improve with age and if he is any good, some of his sons should replace him. At the extreme, bulls should not be used for more than four mating seasons. This reduces inbreeding, and as infertility disease problems increase with bull age, reproductive performance is enhanced through using younger bulls.

Identifying superior stock

Herd improvement in the characters of importance to beef production can only take place if the best animals in any calf drop can be identified as replacements. These animals can only be identified if allowances are made for all the non-genetic influences that contribute to what an animal appears to be. Through making allowances for these non-genetic environmental effects, we get a more accurate account of an animal's real value.

Some examples of environmental effects are:

At branding

The appearance of calves is strongly influenced by the age of the dam and age of the calf. Bigger calves

at branding were born earlier and are mothered by older cows that milk better. The smallest calves were born later to first calf heifers.

At weaning

Similarly, bigger calves are the oldest and were reared on older cows. Smaller calves were born later and reared on first calf heifers. Sex also influences growth and bulls grow faster than steers which grow faster than heifers.

At yearling

The influence of the dam on pre-weaning performance dissipates itself after weaning and by 18 to 24 months is negligible. Therefore, growth or weight at 18 to 24 months is a better expression of an animal's inherent ability to grow. Growth comparisons should be made within groups of similar ages, the same sex and having similar rearing conditions.

The pre-weaning performance of calves is more an indication of a cow's rearing ability than the calves' growing abilities. However, because of management problems, some selection decisions have to be made at earlier, less appropriate times. At branding, insufficient time has elapsed to judge anything and any culling should be minimal and limited to culling for gross abnormalities.

The earliest that any selection decision should be made is at weaning when dams can be evaluated on their rearing ability and a crude assessment can be made on the calf's ability to grow. These assessments

will be most accurate if the influences of sex, age of calf and age of dam are accounted for and all calves are reared under uniform conditions. Accuracy in selection is therefore increased through:

- Using scales instead of guesstimates.
- Removing known biases that influence performance—selecting within dam age groups, sex group and correcting for age of animal.
- Standardizing the environment—use short mating periods and identical rearing conditions.

For the most accurate assessment of growth rate and mothering ability, date of birth, sex of calf, and dam identification have to be recorded. In a herd of 300 breeding cows, the collection of these calving records could occupy two men for half a day every day during the calving period. With a 3-month calving period this means that one-third of a man year is used just to collect calving records.

The labour involved in this exercise is unacceptable to most commercial cattlemen. Satisfactory, simplified, less accurate alternative procedures can be used. Two possibilities are:

- Pre-weaning performance can be measured from branding to weaning and most of the confounding influences of age of dam on calf performance can be eliminated if first calf heifers calves are identified separately. Growth rates can be assessed on growth from branding to 15 to 27 months of age.
- Instead of using the branding record, month of birth can be substituted for day of birth with little loss of accuracy. So with a 3-month mating period (four heat cycles), calves are identified in three monthly groups and given a median birth date for each month so age adjustments can be made on weaning weights and yearling weights. Alternatively, the period of birth could be made to relate to two heat cycles so calving would be identified within 6-week periods—this reduces cattle handling.

In the following discussions the use of only a branding record is considered because this is the easiest record for most people to collect.

Simplified selection procedures

A range of simplified selection procedures exist. All of them are an improvement on doing nothing. Obviously, some are more accurate than others. In this exercise, only

four alternative procedures are outlined. To keep the exposition simple, only the charters of economic importance are considered. These are fertility, growth rate, mothering ability and tick resistance (for those in ticky country).

All measurements or records collected are made when stock are in hand for other activities. Observations are made at branding (around 3 months of age) and weaning (at 6 to 8 months) to measure pre-weaning performance. Yearling performance is collected at an appropriate time prior to the commencement of the first mating which could vary from 15 to 27 months of age.

It is preferable that yearling weight is collected at the end of a summer growing period rather than at the end of an extended period of weight loss or maintenance.

In describing the different options, it is helpful if the activities are related to an imagined herd of 300 breeders. The assumptions are:—

Number of breeding cows....	300 head
Number of bulls at 4%	12 head
Replacements—	
Heifers at 20% of mating and overmating by 30% .	78 head/year
Bulls mated for 4 seasons ..	3 head/year
Branding—	
Total at 80% of matings...	240 head
Bull calves	120 head
Heifer calves	120 head
Mortalities (for simplification).....	
	Nil

Option 1: the simplest and less accurate procedure

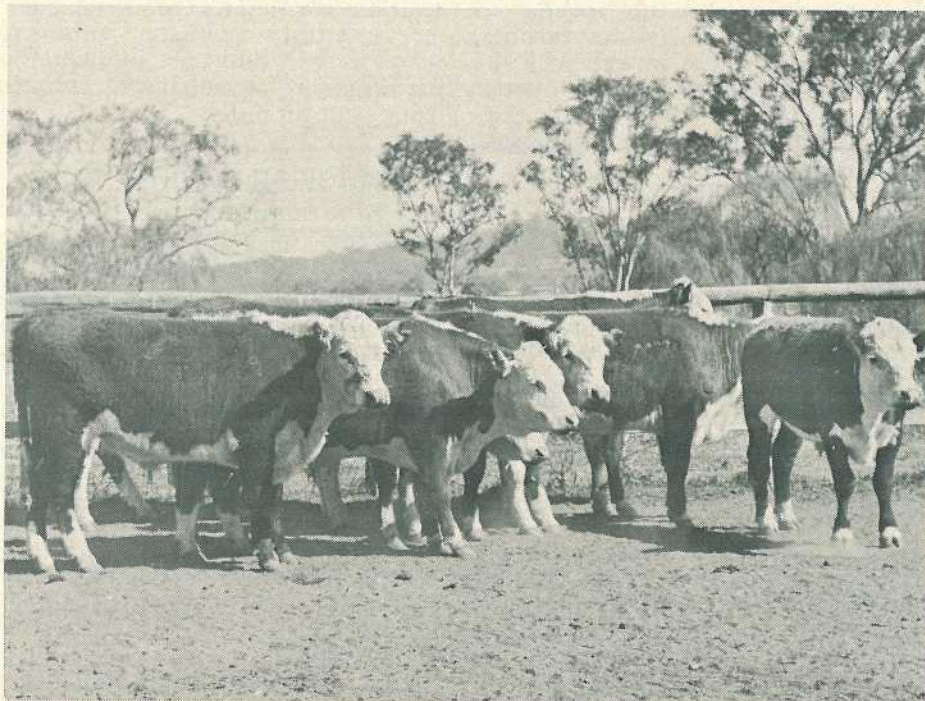
(Ignores age of dam influences)

For this exercise, scales are not necessary but they are an advantage. Controlled mating is also not necessary but it does reduce age difference errors.

Three replacement bulls are required. Allowing a selection intensity 1:10 (one bull selected from a group of 10 bulls) a total of 30 bulls (approximately the top one-third of the bull crop) are selected visually at branding. These are tagged and weighed at branding and weighed again as yearlings at 15 to 27 months of age when the best bulls are selected on growth from branding to yearling. Without scales, the best grown of the group of 30 are selected visually at 15 to 27 months of age.

Replacement heifers are selected using traditional procedures where the bottom one-third are culled on a visual assessment preferably at yearling, but it could be done at weaning. The rest are retained and mated as replacements. The procedure for the selection of bulls is as follows:

AT BRANDING. Select 30 of the best grown bull calves (30 out of 120) and tag and weigh them—castrate the remainder. Most of the selected bulls are probably older calves and from older cows.



If you breed steers that do well in your environment, the best of them will make good sires.

AT WEANING. If required, the number of bulls being carried through to yearling can be reduced by half based on their performance from branding to weaning. It is preferable if the whole group of 30 bulls can be carried through to 15 to 27 months of age.

AT YEARLING. At 15 to 27 months of age, weigh and select the top three bulls on their growth from branding to yearling. Also test for tick resistance if in ticky country.

Option 2: bulls selected from replacement heifer's calves

(No age of dam correction required)

Replacement heifers and first calf heifers are mated and retained in a separate paddock until they wean their first calf. Heifers are mated for 3 months and the calving pattern established through the first two matings will tend to remain in phase for subsequent pregnancies under uncontrolled mating in the main herd. Replacement bulls are selected only from the first calf heifers' calves and replacement heifers are selected from the whole herd using the method presently in use.

This approach is similar to the operation of an open nucleus herd where a small separate herd is established to provide replacement bulls (see option 4). Inbreeding is not a problem in the example given here but would be in much smaller herds.

For this option, two breeder paddocks are required. The replacement heifer and first calf heifer paddock is approximately one-third the size of the main breeder herd. The segregation of replacement heifers and first calf heifers in one paddock has much to commend it as a management tool.

These animals are the most valuable breeders in the herd. Their whole breeding life is ahead of them and their lifetime productivity is strongly influenced by what happens during the first 2 years of breeding. Segregation and preferential treatment of these animals increase calving and survival rates. It also in effect provides a means of selecting the whole herd on two traits with reasonable repeatability—fertility and mothering ability.

The procedure in the heifer paddock is as follows:

AT MATING. Overmate heifers by 30%. For the 300 breeder herd this means mating 78 replacement heifers and round 60 heifers with first calves at foot for a 3 month period to the six youngest replacement bulls (three 2-year-old and three 3-year-old bulls). In total, six bulls are mated to 138 replacement and first calf heifers.

AT CALVING. As soon as 80% of those mated have calved, identify the 20% of heifers that are either calving later or failing to calve. Of these 20%, those that fail to calve are culled and those that calve late are identified as potential culls. Because of the overmating, up to 20% of the heifers mated can be culled for failing to calve or a combination of calving late and/or rearing poor calves. Fertility is repeatable and heifers that fail to calve after a normal mating tend to be poor conceivers in future years.

AT BRANDING. The entire calf crop of approximately 30 bulls and 30 heifers' calves in the heifer paddock is tagged and weighed. Leave the bulls entire.

AT WEANING. The calf crop is again weighed and within sex groups, growth from branding to weaning is calculated so the poorest performers are identified. Within the bull calf group, up to half can be culled and castrated on their performance from branding to weaning.

The ability to rear a good calf each year (mothering ability) is reasonably repeatable. Because of this, the ability of a cow to rear its first calf provides a reasonably accurate indication of future rearing ability and can be used as a once and forever evaluation of mothering ability. At the extremes, the repeatability of very poor and very good mothers could be quite high.

Poor mothers can be identified if the poorest performing calves within each sex group are identified and mothered up. The numbers culled on mothering ability have to be balanced against culling for late calving and other miscellaneous culling so that no more than 20% of the first calf heifers are culled.

After weaning, the selected first calf heifers (60 head) are transferred to the main herd and subsequent culling limited to culling for failing to calve and physical defects. They remain in the main herd until culled for age round 8 to 10 years of age when they still have some salvage value.

AT YEARLING. At 15 to 27 months of age, all bulls are weighed and the top three replacement bulls selected on their performance from branding to yearling. If in ticky country, a tick test is also carried out. The selected bulls are mated to the replacement heifers together with the three other youngest bulls selected in the previous year.



A group of home-bred performance-recorded yearling bulls on a commercial herd in the Brisbane Valley.

Option 3: all replacements selected objectively-surplus bulls sold

(Age of dam influence accommodated)

Objective selection is extended to the whole herd and bigger populations are assessed. Controlled mating is practised in the whole herd and replacement heifers and first calf heifers are mated in a separate paddock and held there until they wean their first calf.

With the separate identification of first calf heifers' progeny, most of the confounding influence of age of dam on calf performance is eliminated and the accuracy of selection and rate of herd improvement are increased. In this situation, good quality bulls that are surplus to requirements are available for sale.

At least two separate breeder paddocks are required and all calves are tagged and weighed at branding. Bull calves are left entire until weaning when half can be castrated. More work is involved in this option but the rewards are also greater.

AT MATING. Control mate in both paddocks for 3 months.

AT CALVING. In the replacement heifer paddock as soon as 80% have calved, identify late calvers and non-calvers as possible and definite culls respectively.

AT BRANDING. In both paddocks, tag and weigh all calves of both sexes and cull lightly for gross abnormalities. Bull calves are left entire.

AT WEANING. In the heifer paddock, weigh all calves and within sex groups identify poor performers and mother up. Mothers of poor calves are culled. This means that up to 20% of the replacement heifers are culled on a combination of failing to calve, calving late or being poor mothers. Cull and castrate the bottom half of the bull calf group.

Main herd—Weigh only the bull calves and cull and castrate the bottom half on their performance from branding to weaning.

At the completion of weaning, 60 bulls and 120 heifers remain available for further assessment as yearlings.

AT YEARLING. At 15 to 27 months, weigh and select the top replacements on their performance from branding to yearling. Tick test where applicable. Only three bulls and 78 heifers are required as replacements. Surplus bulls could be sold as herd bulls.

Changes in the number of stock available for selection are shown in Table 1.

Option 4: for large herds—establish a nucleus herd

This procedure is suitable for large herds in extensive areas where even simple selection procedures are difficult to implement. In these areas, what is difficult in the main herd is manageable in a small nucleus elite bull breeding unit. This unit would supply all the replacement bull requirements for the whole property and could have some spares available for sale.

NUCLEUS HERD SIZE. The size of the nucleus is determined by the number of replacement bulls required each year, the amount of selection pressure required and the amount of inbreeding tolerated. With

the nucleus herd closed to outside introductions, a minimum herd size of 150 cows mated to five or six bulls is required to avoid a high rate of inbreeding. If bulls of merit are available outside the herd, one in every five or ten bulls used in the nucleus could be introduced from outside.

With a bull selection intensity of 1:10 (one replacement bull selected from every ten bulls) a nucleus herd of 150 cows can supply six bulls out of a 60 bull calf drop. This supplies all the replacement bulls needed for a 600 cow herd. With a selection intensity of 1:5, a 1 200 cow herd can be serviced.

RECORDING PROCEDURES. The recording procedure in a nucleus herd is similar to that outlined in option 3 with one difference. In a nucleus herd it is an advantage if half the nucleus herds replacement heifers are introduced from the main herd. This procedure reduces inbreeding and increases genetic variation. As a result, overall performance increases.

For a 150 cow nucleus, approximately 20 replacement heifers would be introduced to the nucleus from the main herd. These could simply be selected by eye on weight for age at 15 to 27 months of age.

The options discussed here provide some idea of the possibilities for improving the accuracy of selection with quite simple programmes. They can all be modified to suit particular needs.

TABLE 1
Change in Calf Drop Numbers Due to Selection

	Number on hand at branding	Number available after weaning	Number of Yearlings	
			selected	surplus
Bulls	120	60	3	57
Heifers	120	120	78	42

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Smallholder dairy development in Malaysia

By Dato' Dr Osman bin Din, Director-General, Veterinary Services, Malaysia

This article describes a dairy development programme in Malaysia based on cross-breeding of local cattle and importation of cross-bred cattle from overseas countries.

The Department of Primary Industries, The CSIRO, and other Queensland and Australian organizations are playing important roles in this development.

The programme conveys an important message concerning the transplanting of technology from developed to developing countries, and the use of agricultural programmes as an instrument of social change.

This Department is proud to be associated in a scheme which will directly benefit 15 000 farmers and the much wider group to whom this economic increase will flow in an indirect way.

Since 1972, the Department's Wacol Centre has been favoured by the Malaysian Government as its major semen supplier. Regular shipments of Australian Milking Zebu, Australian Friesian Sahiwal and Friesian semen have been sent during these 8 years.

This association has also provided the opportunity for significant technical exchanges between officers from the Malaysian and Queensland Departments in a wide range of animal husbandry matters.

To implement this programme, the Malaysian Government has placed firm orders for approximately 25 000 Sahiwal-Friesian heifers bred from cows in Australia and New Zealand and further orders are likely. Almost all of the Sahiwal semen for this programme has been produced at the Department's semen production centres. Two major private Queensland stock organizations have been involved in these contract breeding arrangements, both in Australia and New Zealand.

The CSIRO and the Australian Milking Zebu Society have also played a significant role in the introduction to Malaysia of A.M.Z. dairy cattle. More recently, substantial amounts of semen from the Department's A.F.S. bulls have been used in follow-up breeding in this programme.

The article was sent by Dato' Dr Osman bin Din, Director-General of Veterinary Services, Malaysia, in recognition of the Silver Jubilee of Herd Improvement in Queensland celebrated during 1980.

I thank him and his colleagues for their collaboration and look forward to continued association in these important breed development programmes.

G. I. Alexander,
Director-General,
Queensland Department of Primary Industries



The author—Dato' Dr Osman bin Din.

The Third Malaysian Development Plan (1975–1980) marked the firmer beginning of smallholder dairy development in Malaysia.

Although attempts at dairy development had been made for the previous 10 to 15 years, they were mainly just experiments in trying to establish a suitable cross breed cattle for milk production rather than programmes to upgrade the local 'dairy' animals. (LD).

These local dairy animals were of the *Bos indicus* type, which were brought by the early settlers from Southern India. Over the years, the Government took an active role in the importation programme, and as a result more animals were brought in from the Indian subcontinent. These were mainly of the Sahiwal and Sindhi breeds.

The idea was to improve the quality of the already available animals and to promote milk production. Most of the cows were kept at Government stations, but the bulls were distributed to farmers under the bull loan scheme.

More recently (15 years ago) various *Bos taurus* dairy breeds were introduced into the country from Australia. These were Friesian, Jersey, Australian Illawara Short-horn (A.I.S.) and later Australian Milking Zebu (A.M.Z.) animals. Frozen semen from North America and from Wacol was used simultaneously on the LD's and the native cattle (KK). In 1979, about 18 000 inseminations were carried out.

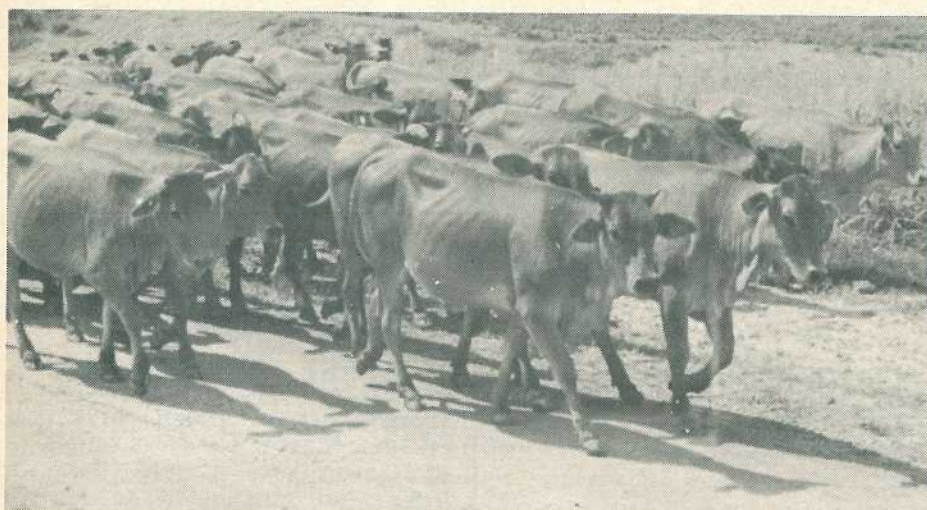
The present base cattle population of all ages is:

Native cattle (KK)	360 000	(150 000)
Local dairy cattle (LD) ..	70 000	(30 300)
Cross breeds (various)	28 000	(12 000)
Total	458 000	

(figures in parenthesis denote breeding females)



An imported Friesian Sahiwal purebred on a smallholder dairy farm.



A herd of Australian Friesian Sahiwal in Malaysia.

TABLE 1

Breed	Total yield kg	Lactation length days
(1) Native Cattle KK*	642	180
(2) Local Dairy LD*	940	230
(3) LD Jersey*	1 100	250
(4) LD/Friesian*	1 723	240
(5) Sindhi/Friesian*	2 337	275
(6) Sindhi	935	243
(7) A.M.Z.	1 248	276
(8) A.I.S.	1 437	260
(9) Friesian	1 583	260
(10) Friesian*	810	189
(11) KK/Sindhi*	838	218

*Locally born animals. (The rest are imported.)

The guiding principle in our dairy development planning strategy is the new economic policy of the Government which dictates a two-pronged attack on poverty. The policy consists of:

- Economic uplifting and restructuring of everyone in the country.
- Narrowing the income gap between the rich and the poor.

With this policy in mind, dairy development plans are drawn up and executed. Basically, the plan calls for the importation of breedable cross-bred cattle and the establishment of Milk Collection Centres M.C.C. with a network of collecting points in villages and agriculture areas.

The M.C.C. will provide the following services for small landholders:

- Dairy extension.
- Health coverage and compensation scheme.
- Training of farmers.
- Milk collection and processing.
- Arrangement of bank loans.
- Artificial insemination.
- Cattle distribution.
- Milk Marketing.

Each M.C.C. will serve about 500 farmers, each with a daily production target of about 6 500 L. Each farmer would keep two to three dairy cows, with a maximum of five animals. Twenty-four M.C.C.s are being established during the Third Development Plan, and about 34 more such centres are being planned for the next 5 years (1981-1985).

Based on the above figures, the requirement for dairy cross-bred cows would be in the region of 80 000 head, not including replacement stock.

Currently, the amount of milk produced locally is only about 22.5 million L, and the actual demand is 391.5 million L (milk equivalent). The targeted local production is 20% of the total demand by 1990.

It is estimated that only about 25 000 head of milking cross-bred cows can be made available by 1985 through our own artificial insemination programmes. The remaining 55 000 head have to be met through importation. Australia and New Zealand appear to be the main sources of supply of these cross-breds. By July 1980 more than

10 000 Sahiwal/Friesian heifers had been landed from these two countries.

The first generation cross-bred cows are to be mated to cross-bred bulls to obtain 50% to 62.5% *Bos taurus* offspring. Locally born and imported bulls are selected for semen collection. However, as the demand is so high and so urgent, A.M.Z. and A.F.S. semen is also being imported from Australia. *Inter se* and criss-cross breeding systems are being adopted.

Through these importations, we are hoping to achieve the desired goals in our endeavour to promote local milk production. So far, there has been a noticeable and definite increase in the milk yield of the locally born cross-bred cows.

The figures in Table 1 should give some indication to the improvement achieved so far:

The performance of the imported Sahiwal/Friesian has yet to be determined as most of them have not completed their first lactation. However, preliminary observations indicate that milk production per day ranges from about 3.15 L to 10.8 L, with the majority of them producing about 6.75 L per day.

With improved husbandry and feeding, a minimum level of about 7 L per day could be achieved.

It must also be emphasized that one of the primary roles of the imported Sahiwal/Friesian is to increase the size of the dairy cattle breeding population in the country

as well as increasing the volume of fresh milk. An improvement in the hay supply is also proposed to ensure better feeding.

We hope to be able to provide an additional income to about 15 000 small farmers, and at the same time provide nutritious food to our local population, especially the school-age children.

We are, therefore, in no small way, very thankful to the Queensland and Australian Governments and their public and private institutions for helping and providing us the innumerable facilities we have been able to use in our dairy production programmes. In particular, we send our regards to the Wacol A.I. Centre for its past help and salute its 25th year of operation.

Funds for the family farm

Funds are available through the Rural Reconstruction Board to assist the financing of the transfer or expansion of the family farm.

Mr Mike Ahern, Minister for Primary Industries, said that the family farm was still the cornerstone of Queensland's primary industries. He considered that it would remain the most efficient unit of production.

Mr Ahern said it is important that an opportunity is available for the family farm to pass from one generation to the next while in a productive state. Also, to meet changing needs in primary industries, it may be necessary to expand the family farm. In other circumstances, some form of family partnership is desirable.

Usually, primary producers are able to make these adjustments through their own financial channels. However, where some additional finance is needed, the Government is prepared to help through the Rural Reconstruction Board. During the first few months of the Scheme's operation, the Board has approved \$300 000 in loans.

The Board acts as a lender of last resort and within the principles of the Rural Adjustment Scheme. The Board usually does not provide all the finance needed. Rather, it co-operates with commercial lenders such as banks to make up a loan package.

Mr Ahern emphasized that he appreciated the good working relationship which existed between the Board and the Banks and thanked them for their co-operation.

Interested farmers should contact the Board with a proposal setting out their intentions and how they propose to arrange finance. The farmer also nominates someone (usually a family member) who requires assistance to complete the arrangement. The nominated person was then invited to apply for assistance where the Board considered the proposal was feasible.

Proposal forms are available from the office of the Board in Perry House, Albert and Elizabeth Streets, Brisbane, 4000.

Fruit and vegetable industry will benefit

Queensland fruit and vegetable growers, transport operators, wholesalers, retailers, and consumers will all benefit from recent staff changes announced by Dr G. I. Alexander, Director-General of the Queensland Department of Primary Industries.

Dr Alexander said the realization by the industry of the importance of correct post-harvest handling has increased the demand for Departmental assistance at all stages of the marketing chain.

To meet this demand, the Department has strengthened the Fruit and Vegetable Market Extension Service by the addition of two officers from Horticulture Branch.

The Market Extension Service was established in May 1975. Initially, it functioned as a feed-back advisory service to fruit and vegetable growers. Any post-harvest problems observed at the Brisbane Markets were referred back to growers through the local extension officers.

The service was extended later to cover all aspects of post-harvest handling of fruit and vegetables from the farm to the consumer. An officer of Agricultural Standards Branch maintained liaison between Departmental technical and extension officers and persons involved in the distribution chain.

The recent increase in staff will enable post-harvest problems to be studied in detail and provide opportunities for investigating improved handling techniques. Package rationalization is one project on which emphasis will be placed, Dr Alexander said.

The Market Extension Service, while operating primarily in the Brisbane Market, will cover major provincial markets in Queensland as well. Through liaison with other State Departments, it will monitor Queensland produce in the markets in those States.

A cheap, easy to build water level indicator

By Dr. R. G. Boothroyd, Capricornia Institute of Advanced Education

Farm water tanks can easily run empty without warning because usually they are not equipped with an indicator to register the water level.

One common example of this problem is an undetected leak in the delivery pipe from a windmill pump. For some applications, such as water supply to the home or piggery, sudden failure can be a considerable nuisance.

To be really useful, any water tank level indicator needs to be readable 'at a glance' and from a distance of 500 m or so. The writer has had 18 months of very successful experience with a float-indicator as illustrated in this article.

This gadget can be made quickly and easily by any property owner. It can also be made from a wide variety of readily available scrap materials.

The float-indicator

Dimensions and materials are not critically important. The author's unit, illustrated in figure 1, consists of a vertically-floating 4.3 cm diameter rigid plastic pipe (item A) which is sealed at its lower end. A long pipe cannot float by itself in this position because it is unstable. For this reason, pipe A slides inside a larger 8 cm diameter galvanized rain-water duct (tube B).

Two small longitudinal cuts are made in the upper end of the tube B to allow a hook to be formed so that tube B can hang inside the water tank. Tube B is perforated so that it contains water to the same level as in the tank.

The lower end of the tube B is also closed and filled with stones, scrap iron etc. This makes tube B hang vertically and with high stability to the extent that it compensates for the hydrostatic instability of tube A.

Thus, tube A can float freely up and down without any friction to indicate the water level. An inverted glass jam jar is placed over the top of tube A to prevent the entry of rain. The unit has survived large storm wind loadings on the exposed tube A and has in fact functioned without any attention whatsoever since its installation 18 months ago. The indicator is adequately visible at more than 500 m.



Plate 1. Reasonably accurate measurements can be taken of a water level in a tank by using a graduated scale and a sight mark attached to a dead tree, wall or fence post.

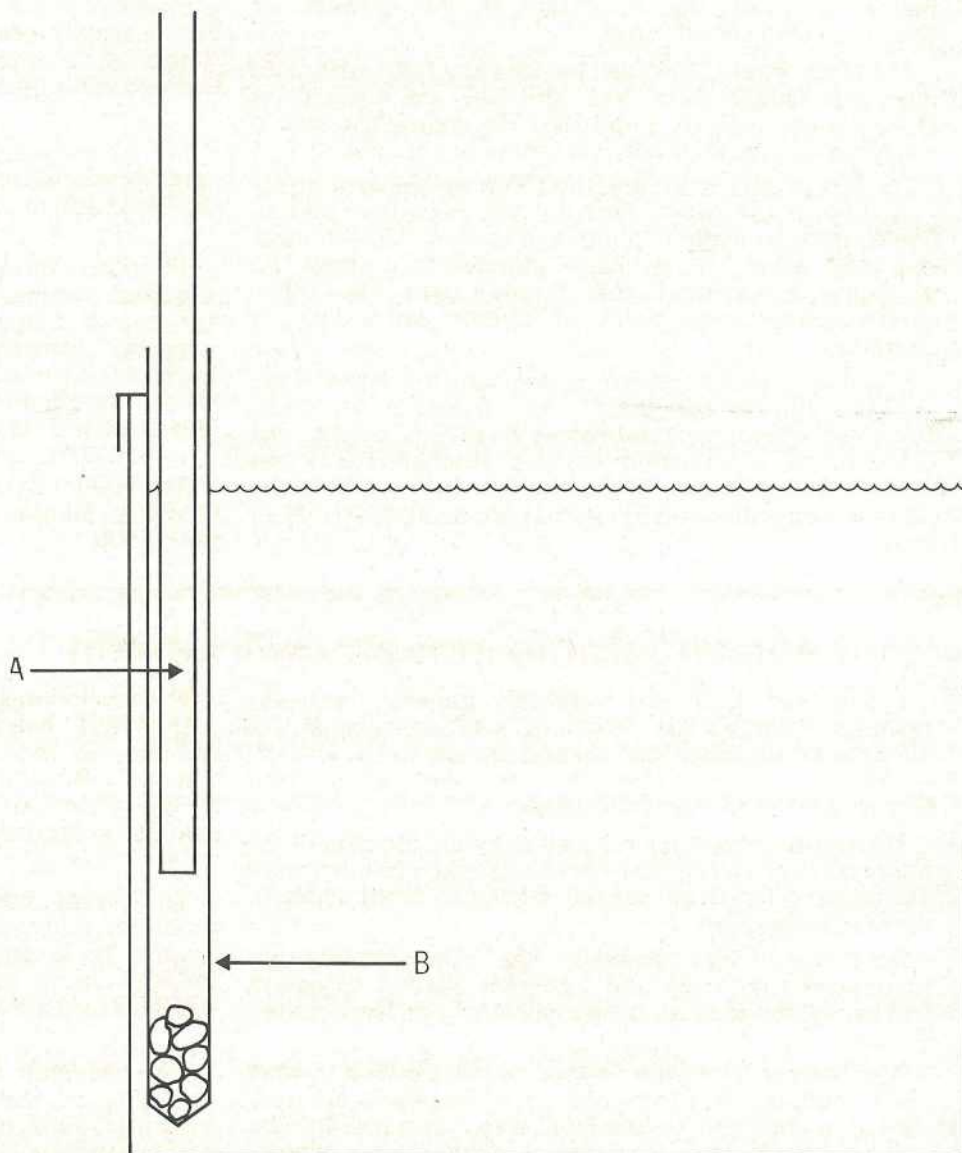


Figure 1. A water tank with a float indicator.

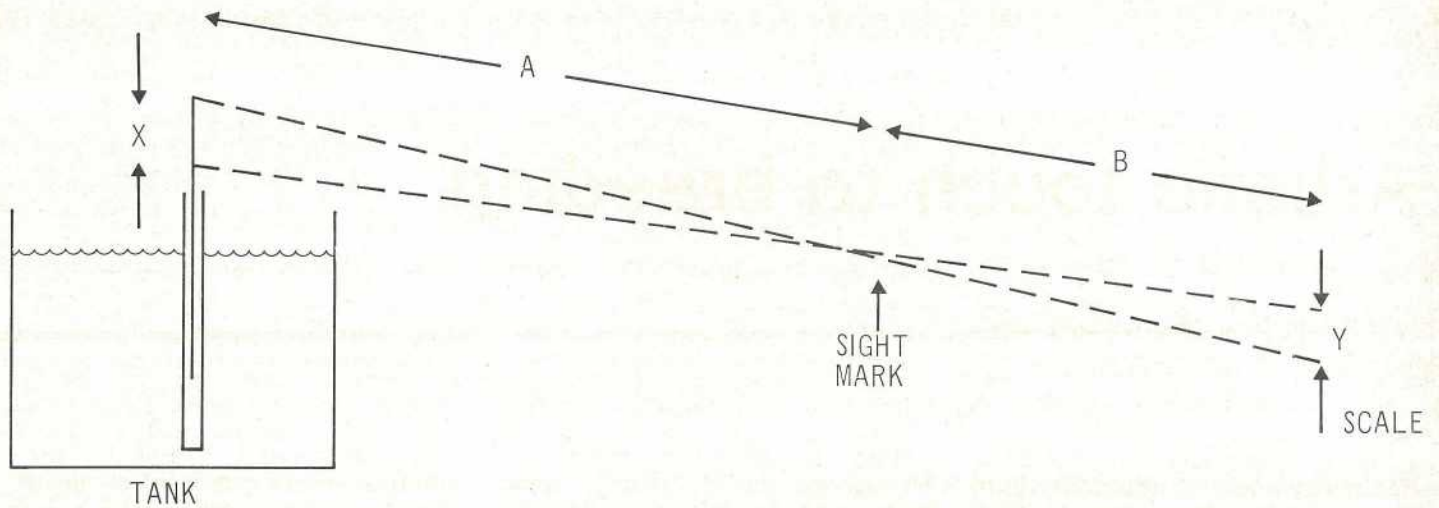


Figure 2. Measuring the water level.

Calibration

For most purposes it probably suffices to glance occasionally at the tank to see if it contains some water. However, as is illustrated in figure 2, reasonably accurate measurements can be taken of the water level in the tank using a graduated scale and a sight mark attached to a dead tree, wall or fence post.

When the water level is a distance x below the top (overflow) position, it is indicated by a corresponding rise y on the indicator scale according to:

$$x = \frac{a \times y}{b}$$

where a is the distance from the tank to the sight mark and b is the distance from the sight mark to the indicator scale. Measurement of the water level in the tank is shown in plate 1.

The immersed depth of the tube A is $\frac{1270 M}{d^2}$ cm where M is its mass in kilograms and d is its outside diameter in cm. If measurements are needed at low water levels in the tank a light, thin-wall, large-diameter tube A should be used. A light wire with indicator flag can also be attached to the tube A if desired.

It is easy to calculate the weight in tube B needed to ensure stability but, in practice, one would simply add weight until the system was stable.

The whole unit was made and installed in about half an hour from its conception, including the time taken searching for scrap materials.

Although the inverted jam jar prevents rain entering tube A, it will not prevent condensation which would influence calibration. However, in 18 months of experience no condensation effect has been observed.



Artistic touch to breeding

by G. J. Busby, Dairy Cattle Husbandry Branch.

Painting machinery and buildings has always been a necessary farm chore. But how many dairy farmers and graziers have ever thought of touching up their cows with a spot of high gloss enamel?

In New Zealand where tail painting was developed, the system has been used successfully to detect cows on heat.

Conception rates are often considered to be the main measurements of fertility in a dairy herd. But for many dairymen, extended intervals between calving and conception are also a major problem.

Failure to detect heat could cost \$30 per cow for each month that this interval is extended by the missed heat. The aim should be to produce a calf per cow per year. Extended intercalving intervals can often be traced to a heat detection problem.

The Queensland Department of Primary Industries and a dairy farmer at Wondai in the South Burnett, Mr P. M. Kleinschmidt, co-operated recently to evaluate tail painting as a heat detection aid under local conditions.

Mr Kleinschmidt's herd was painted, over a 5-month period, with a 50 mm by 250 mm strip at the head of the tail. The paint was rubbed off, broken or dirtied by the brisket of a riding bull or cow. After each mating, the paint colour was changed from blue to red, then green.

The changes in colour highlighted the number of cows returning for service and enabled the farmer to identify problem cows easily. During the trial, scruffing of the tail paint detected 61 out of the 70 cows that had heat periods. The other heats were determined by expectancy records and good visual observation alone. Heat detection problems were often worse in large herds as available management time was extremely limited. Depending on circumstances, farmers could spend from 1 to 1½ hours daily observing their cows for heat.

With the advent of rotary and herringbone dairies, farmers spend more time in the pit and consequently see less of their cows. Even if dairymen are experienced in the art of heat detection, tail painting still adds accuracy and makes the task that much easier.

Farmers who kept accurate stock records should find tail painting to be a most practical and sensible way to reduce intercalving intervals and improve farm profitability.

The following suggestions may be helpful when painting cows:

- Before painting, make sure the cow's coat is dry and free from loose dirt and hair.
- Apply paint to the areas most likely to be rubbed.
- To apply, first brush forward against the hair for adequate penetration, and then backwards. If the paint strip lifts after a couple of days, it should be torn off and the area repainted.
- Paint should last about 3 weeks before it needs touching up.

High gloss enamel tail paint is available commercially from the D.P.I. Wacol A.I. Centre, farm supply merchants and veterinary surgeons. Lead paints must not be used.

Tail painting is also relatively cheap as 1 L of paint, costing about \$4.30, is sufficient for 150 to 170 cows. In large dairy herds in N.S.W. and Victoria, it is one of the most inexpensive and popular aids.

It is a good idea for farmers to use tail painting before starting a breeding programme. They can then practice the detection of oestrus by observing the paint strip.

Tail paint can be applied to all dairy cows 20 days after calving. By doing this in batches, farmers could also observe any pre-mating heats. Dairy cows are usually mated 42 days after calving.

It is also useful in beef A.I. programmes where expensive estrumate injections are now used. Tail painting helps the grazer identify cycling cows.



UPPER. Paint applied to 'head' of cow's tail.

LOWER. Rubbed paint indicates cow has cycled. Paint that has been rubbed or scuffed in the previous 12 hours shows that the animal is ready to mate.

Erinose mite—a serious litchi pest

by B. Pinese, Entomology Branch

Litchi erinose mite (*Aceria litchii* (Kieffer)) is a serious pest of litchi. It causes the condition known as 'erinose' which affects both leaflets and inflorescences.

In severe cases, the growing points are destroyed and fruit setting is prevented. While older trees can recover after attack, young trees may be killed.

The mite is spread by planting infested marcots. This is caused by man, animals and birds moving through a grove, and by wind dispersal.

Life history and description

Eggs are laid on leaves when they are still in the bud. Nymphs hatch in 3 to 4 days and feeding commences immediately. The damage begins at a very early stage of leaf development. The nymph undergoes a number of moults prior to becoming an adult. The life cycle is completed in 13 days under favourable conditions.

Between growth flushes and during colder weather, adult mites survive under the protection of hairs

in infested leaves. With the advent of warm weather they begin multiplying and spread to developing buds and newly-formed leaves.

Adult mites are about 0.13 mm long and 0.034 mm wide, and cannot be seen without a high-powered microscope. Both nymph and adults are cigar-shaped, transparent or pinkish in colour with two pairs of legs at the anterior end.

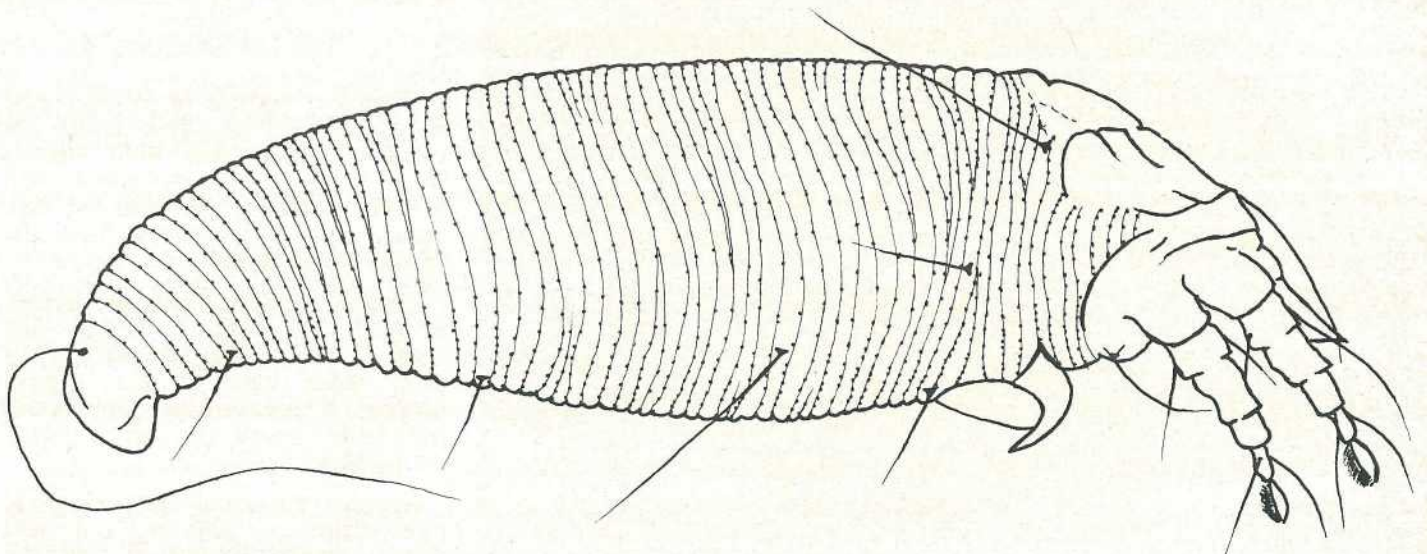
They have no wings, eyes or antennae.

Damage

The mites live among the deformed epidermal cells which are produced by the leaf as a reaction to mite feeding. Myriads of abnormal leaf 'hairs' produce the velvety erinose symptoms which are an indication of mite activity.



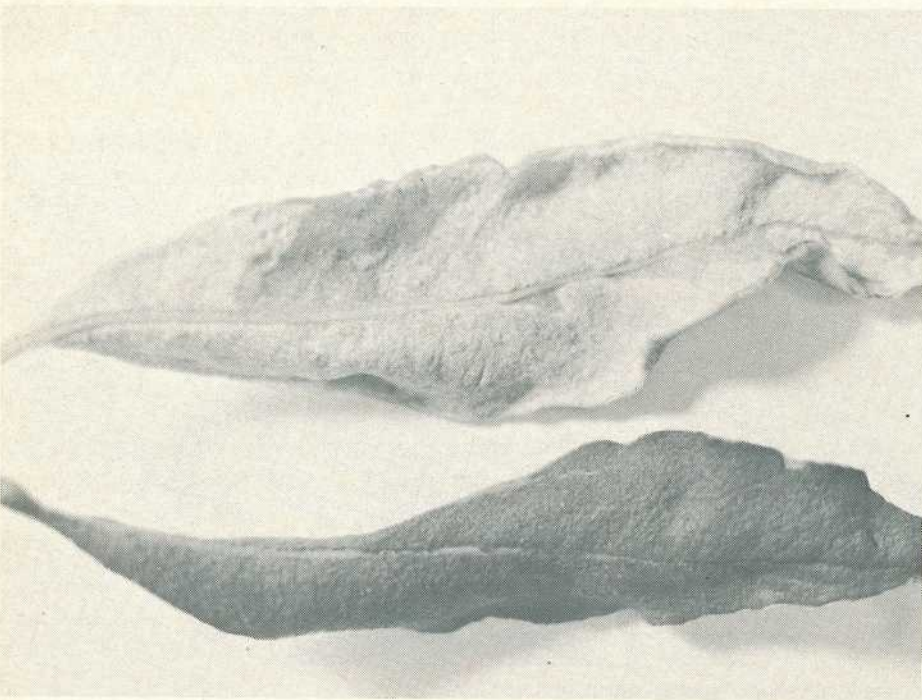
Young litchii shoot. Note deformed, blistered leaflets.



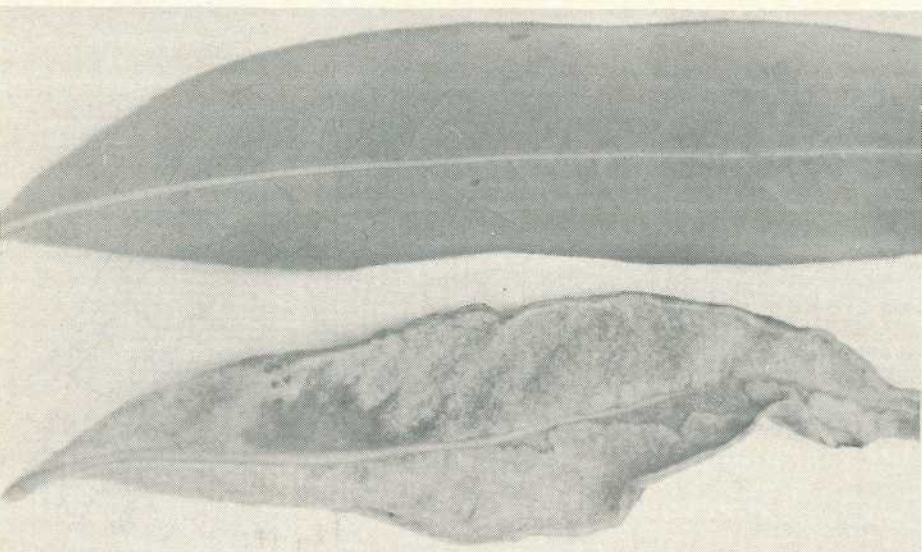
A lateral view of the litchi erinose mite (x 2 000)



Blistering evident on the top surface (above) and erinose damage on under surface of leaflets (below). Upper leaflet shows typical leaflet deformation due to heavy erinose mite pressure.



Erinose mite 'felting' on undersurface of leaflet. Old felting is shown below, young felting above. Note curling of leaflet edges.



Undersurface of young leaflets. Normal, healthy leaflet above and erinose felting on lower leaflet.



Erinose mite damage to a young fruit cluster. Note blisters on fruit and aborted fruit covered with dark brown felting.

Damage varies with leaf age. Young infested leaves show areas of transparent glistening hairs on the under surface. These hairs turn yellow then reddish-brown and finally black. As the leaf matures, infested areas become blistered. In extreme cases, the outer edges curl forming cylindrical hollow tubes.

All stages of the erinose mite are found in high numbers in young blisters where the pubescence is yellow or light brown, but as this turns dark reddish-brown the mites die or move to new buds and leaves to start new colonies. Old blistered leaves have few live mites present.

Mites from old infested leaves migrate to new areas of growth, thus restricting tree development. In extreme cases, young trees may lose most of the effective leaf area and may die unless control measures are applied.

Control

Chemical control of erinose mite is intended to be preventative not curative. Leaves and buds already showing the erinose symptoms will not be cured by spraying but new growth can be protected from the spread of the mite.

Erinose mite problems are largely avoided by planting erinose-free trees. Because young trees are taken from older trees by the marcot process, a mite-infected parent will invariably result in an infected young plant.

Dipping the aerial parts of potted trees prior to planting out will destroy most, if not all, of the erinose mites which may be present.

A dip made up of wettable sulphur or dimethoate is effective. The addition of a small quantity of wetting agent or household detergent to the dip solution will improve penetration of the chemical into any mite blisters which may be present.

Dipping is an insurance against the introduction of erinose mite and even apparently mite-free marcots should be dipped prior to planting. If possible, follow up with a second treatment 10 to 14 days later.

An understanding of the litchi growing characteristics is important.

Litchi is not a deciduous plant but periodically produces a flush of new leaves. Their colour varies with variety and can be either light to dark pink or light green. When

erinose mite is known to be present, chemical sprays should be applied just before the tree is about to flush. Enlargement of the buds should give a clear indication a flush is imminent.

Because litchi trees vary in their time of flushing due to many factors both environmental and varietal, it is important to regularly inspect trees and commence spraying when the first trees begin to show signs of flushing.

Control of erinose mite has been achieved with sprays of wettable sulphur as a thorough cover spray at the rate of 450 gms per 100 L or dimethoate 30% ec. at the rate of 100 ml per 100 L. Following the spray at the commencement of a growth flush, monthly sprays should

be continued until all new growth develops free of erinose symptoms.

The addition of a wetting agent (1 part in 1 000) improves spray penetration of the blisters.

Summary

The litchi erinose mite can adversely affect tree growth and fruit yield. The use of chemical sprays for its control is an effective means of reducing its spread, but control measures must be applied just prior to the commencement of flushing.

Growers contemplating future plantings must ensure that marcots are free of erinose because planting infested marcots is the greatest factor in the establishment of erinose mite in a once mite-free planting.

Pork for slimmers

The use of pork as an aid to slimming is recommended by Dr John Gardner, Technical Advisor to the Australian Pig Industry Research Committee.

Dr Gardner said that pork is an excellent food for people who are weight conscious. A 100 gram serving of lean pork provides 20 grams of protein, yet contains only 724 kilojoules (172 calories).

It also has a high 'satiety value', that is pork leaves the eater with a full feeling for longer than other foods and thus provides dieters with less stimulus to nibble between meals.

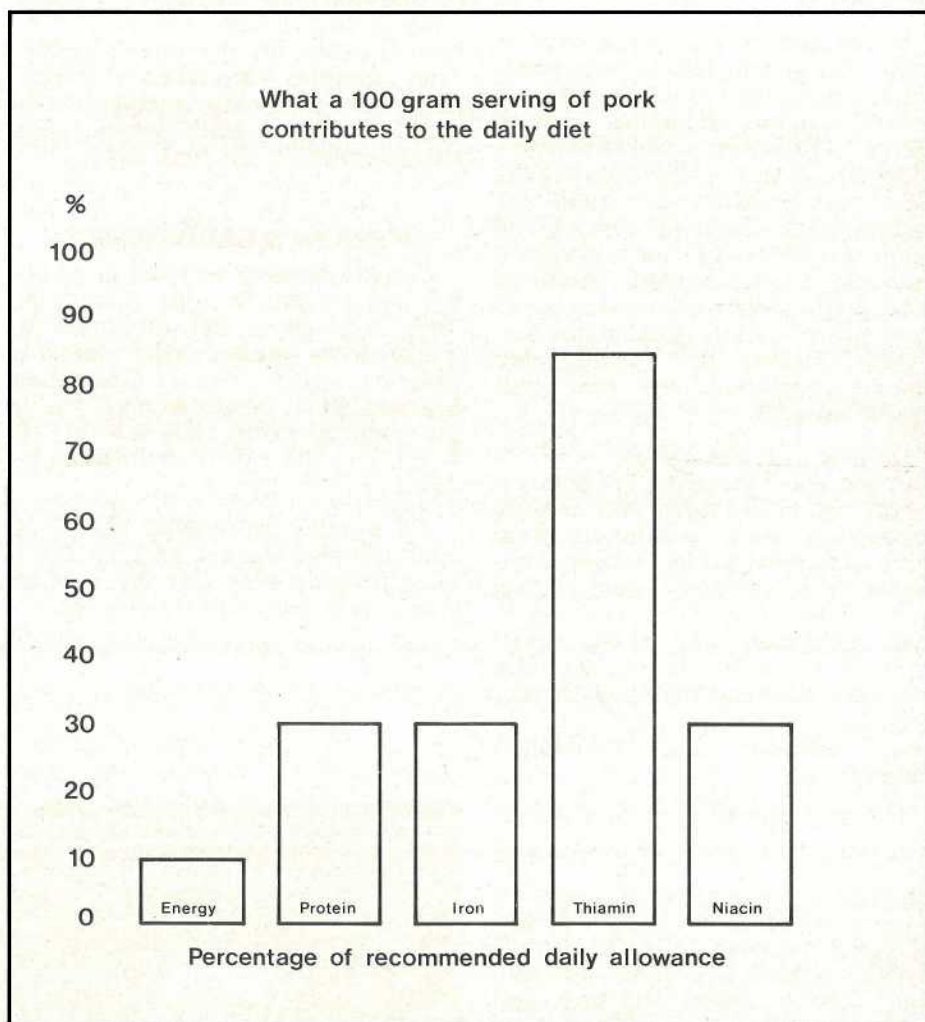
Dr Gardner said that Australia was entering an era when consumers would become more conscious of the need to have available to them accurate information about the nutritional value of the different food-stuffs on the market. The Australian pigmeat industry is confident that it has available a product which meets the closest nutritional scrutiny.

Pork is an excellent source of protein and, unlike vegetable protein, it contains all eight essential amino acids in the correct proportion for immediate use by the human body. Since the introduction of 'new-fashioned' pork, a range of pork steaks is now available—all of them leaner than traditional cuts.

In addition to its protein value, pork also supplies appreciable quantities of several important minerals such as iron, which is vital in preventing anaemia, and zinc, which is essential for growth.

Dr Gardner said that pork contains about three times the amount of the vitamin thiamine as any other food and is also a useful source of other B group vitamins.

All told, pork is more than just a good-tasting meal—it is a food with a high nutritive value worthy of a prominent place in the diet of the health and weight conscious Australian of the 1980s.



Winter milk production at Beaudesert

by G. M. Hawley, Agriculture Branch and J. Harris, Dairy Field Services Branch

Winter forage cropping for dairy production in Queensland has changed dramatically during the last 10 years with high density ryegrass largely replacing oats on irrigated lands.

In North Queensland, there has also been keen interest in both white and subterranean clovers mixed with ryegrass.

Berseem clover has recently been tried in several areas of South-east Queensland.

During the 1979 winter, a series of trials was conducted in the Beaudesert district to evaluate a range of winter legumes including berseem clover (*Trifolium alexandrinum*), CUF 101 lucerne (*Medicago sativa*), snail medic (*Medicago scutellata*), Ladino white clover (*T. repens*) and Clare sub clover (*T. subterraneum*). In these trials, berseem produced most feed, snail medic made rapid early growth, Clare good midseason growth, Ladino late growth, and lucerne performed well from mid-season onwards.

Because of the rising cost of nitrogen and the success of berseem clover in 1979, milk and pasture production were monitored from three different winter forage combinations in a large scale grazing trial in 1980. The trial was devised to seek a system of winter forage cropping which would produce milk at a lower unit cost than high density ryegrass (*Lolium* spp.) but with the same stability and production certainty.

The trial was situated on a 100 ha property with soils ranging from medium-textured loamy clay alluvials to heavy black cracking clays away from the Logan River. The trial was sited on the latter soils and the paddock was poorly drained. The farm is fully irrigated and normally milks 70 to 80 head of Friesian cattle.

The results presented in this article report the performance in one season on one farm at Beaudesert. Further research is required to confirm these results, and another trial is planned for the winter of 1981.

Trial layout

An 8.5 ha paddock, which was considered sufficient for 70 to 80 milkers, was selected. It was electric-fenced into three paddocks of 2.83 ha, each to provide 7 days' grazing for the milking herd. Each paddock was halved to simplify grazing and irrigation and each half paddock was strip grazed with a daily allocation of 0.4 ha.

Each 2.83 ha paddock was planted as indicated in figure 1. Pasture samples were taken from each mixture to determine dry matter yields. These samples were taken whenever possible on the sixth grazing day in each treatment. Milk yields were also recorded on the sixth day.

Pasture establishment

Conditions were very dry at planting and treatments were planted at 7-day intervals so that they could be irrigated to ensure establishment. The ryegrass (cv. Grasslands Manawa (H1)) was sown on 3 April, the ryegrass-clover pasture on 10 April, and the clover pasture on 16 April.

All species germinated well, but establishment was set back by flood rains in early May and the start of grazing was subsequently delayed.



Above. Treatment 3 at 50 days.



Below. Treatment 2 at 50 days.

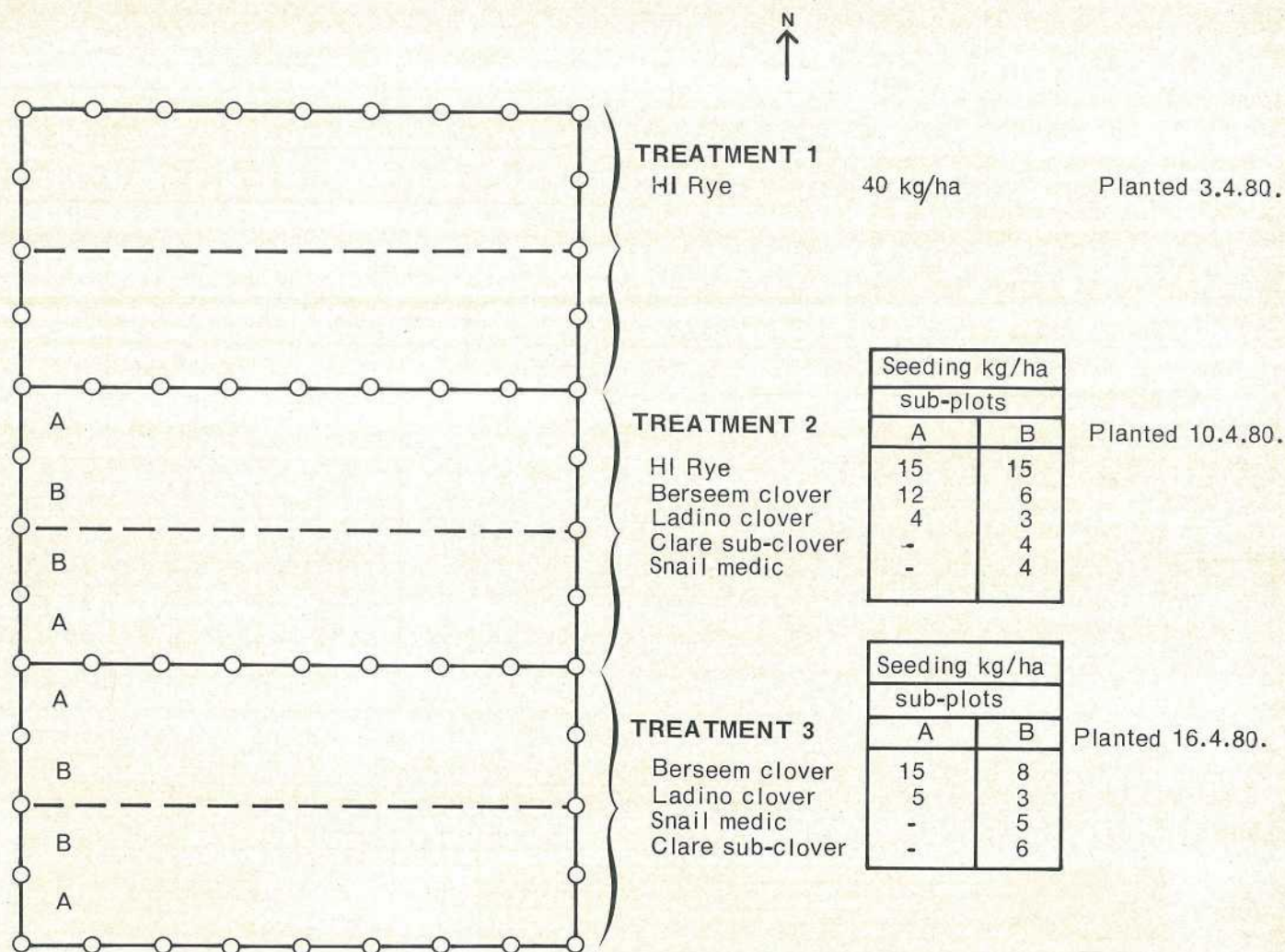


Figure 1.

Herd composition

The milking herd is a grade Friesian herd comprising 70 to 80 cows in milk throughout the year. Some dry cows close to calving also ran with the milkers on the trial area. The herd is milked twice daily in the six-unit step-up walk-through bail.

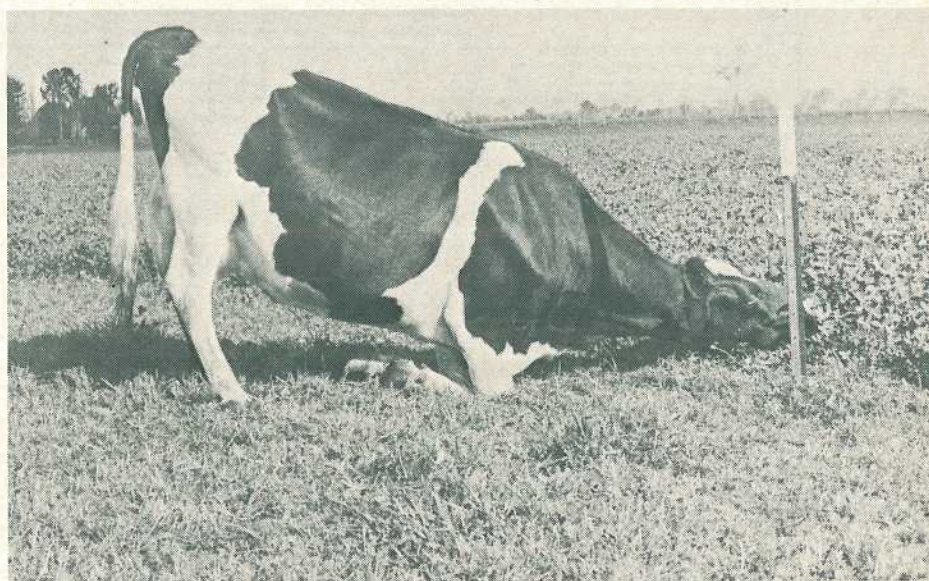
The calving pattern for 1980 is shown in Table 1.

The main calving periods occur in the winter-spring-summer period to take advantage of the winter incentives and the spring-summer flush of milk production.

During the trial, the total number of cows grazing ranged from 75 to 89 with an average of 82. The number of milkers varied from 65 to 88 and averaged 77.

Fertilizer

Soil analysis from the trial site varied slightly from paddock to paddock. Nitrate nitrogen varied from 5 to 20 p.p.m. N, bicarbonate



The clover is always greener on the other side! This photograph shows a cow grazing treatment 3.

extraction phosphorus levels were very high (in excess of 100 p.p.m.) and exchangeable potassium ranged from 0.34% to 0.50% me% K. At 6.5, pH was very slightly acid.

Previous experience with these soils has indicated responses to sulphur so sulphate of ammonia at 275 kg per ha supplied both nitrogen and sulphur at planting. 125 kg per ha of muriate of potash was also applied.

Weather conditions

Drought conditions prevailed at planting. Rain (365 mm) soaked the paddocks in early May, causing some seedling loss in paddock 3, particularly in low-lying areas which were subsequently replanted. Total rainfall during the trial excluding May was 50% below average; only 165 mm being recorded from June to November.

TABLE 1
Calving Pattern for 1980

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
No. of cows calved	6	6	8	15	8	5	12	9	7	21

TABLE 2
Maintenance Fertilizer

Date	Treatments		
	Urea (kg/ha)		
	1	2	3
Jun.	125	125	125
Jun./Jul.	175	175	Nil
Jul.	140	Nil	Nil
Aug.	100	140	Nil
Sep.	140	140	Nil
Oct.			
Total	680	580	125

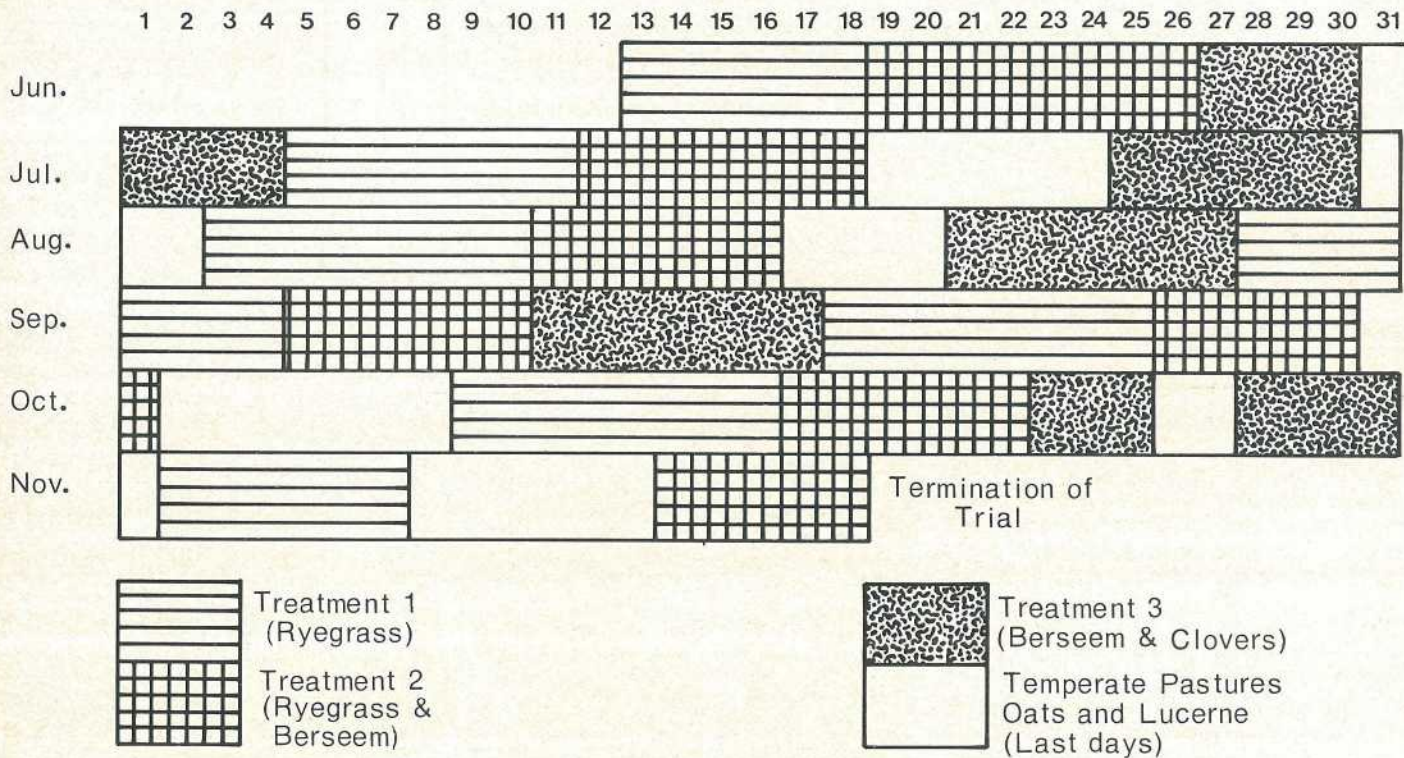


Figure 2. Grazing days per treatment.

TABLE 3
Grazing Details

Treatment	No. of grazings	Days		Hours average per day	Average no. of cattle grazed	Total grazing hours
		Average grazing interval	Grazing			
1. Ryegrass.....	7	23.3	49	6	86	25 300
2. Ryegrass + berseem and clovers	7	24.5	47	6	81	22 800
3. Berseem + other clovers.....	5	29.75	35	5	81	14 200

Pasture management

Fertilizer

A top dressing with 125 kg/ha of urea was applied after the first grazing to all three treatments. Treatment 3 received no further fertilizer.

Treatments 1 and 2 were top-dressed with urea after each grazing (table 2), although the August application on treatment 2 was omitted.

Originally, nitrogen applications were to cease in treatment 2 after August as the clovers were expected to provide sufficient fodder. This did not occur, so nitrogen applications were continued.

Irrigation

After each fertilizer application, all treatments were irrigated if required. Further irrigation was applied when necessary and approximately 3 ML/ha of irrigation

water was applied to each of the three treatments.

Grazing

Due to waterlogged conditions, the first grazing for each treatment commenced 74 days after planting, although the ryegrass was ready to graze in 49 days. As the trial progressed, it became obvious that a strict 21 day grazing sequence could not be maintained due to periods of waterlogging after rain, slow growth

TABLE 4

Ryegrass Treatment
(kg/ha D.M.)

Planted 3 April, 1980

Harvest date	Days	Ryegrass	Weeds	Total presentation forage
17 June	74	2 450	365	2 815
8 July.....	21	1 853	33	1 886
5 August.....	28	1 934	Trace	1 934
2 September	28	2 219	Trace	2 219
23 September	21	2 020	55	2 075
14 October.....	21	2 079	52	2 131
4 November	21	1 159	121	1 280
Total.....	214	13 714	626	14 340
Percentage of total		95.63	4.37	100

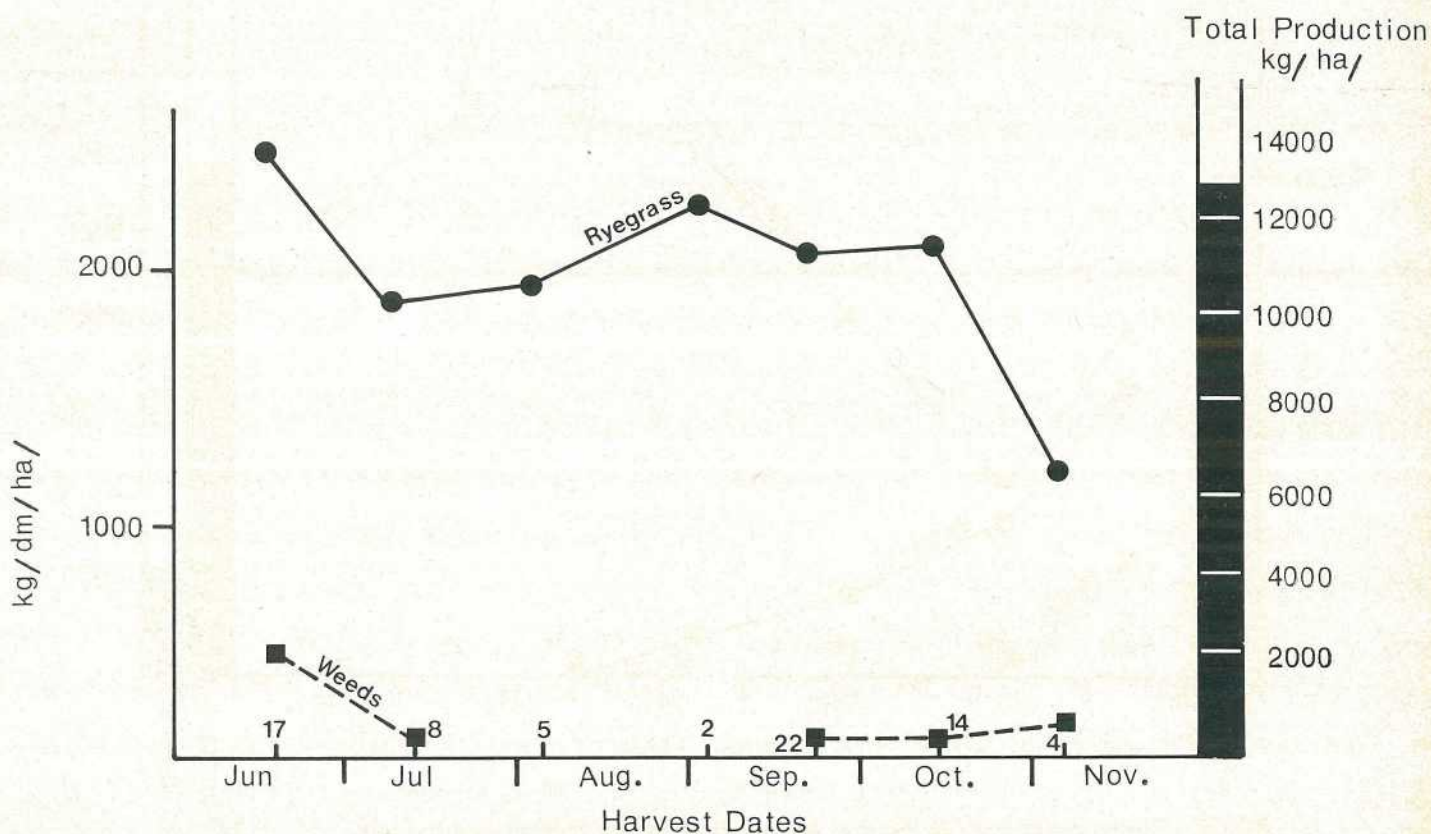


Figure 3. Ryegrass treatment.

in mid winter, and slow regrowth in treatment 3. This delayed start of grazing reduced the total number of grazings on all three treatments during the trial.

The herd grazed the trial between milkings and also utilized common grazing land adjacent to water troughs and farm buildings. Pasture on the common grazing land consisted of paspalum (*Paspalum dilatatum*) blue couch (*Digitaria didactyla*) and some white clover.

The grazing pattern is illustrated in figure 2 and further grazing details given in table 3.

Treatments 1 and 2 produced the same amount of grazing in terms of the number of grazing days and total number of cow-grazing-hours achieved.

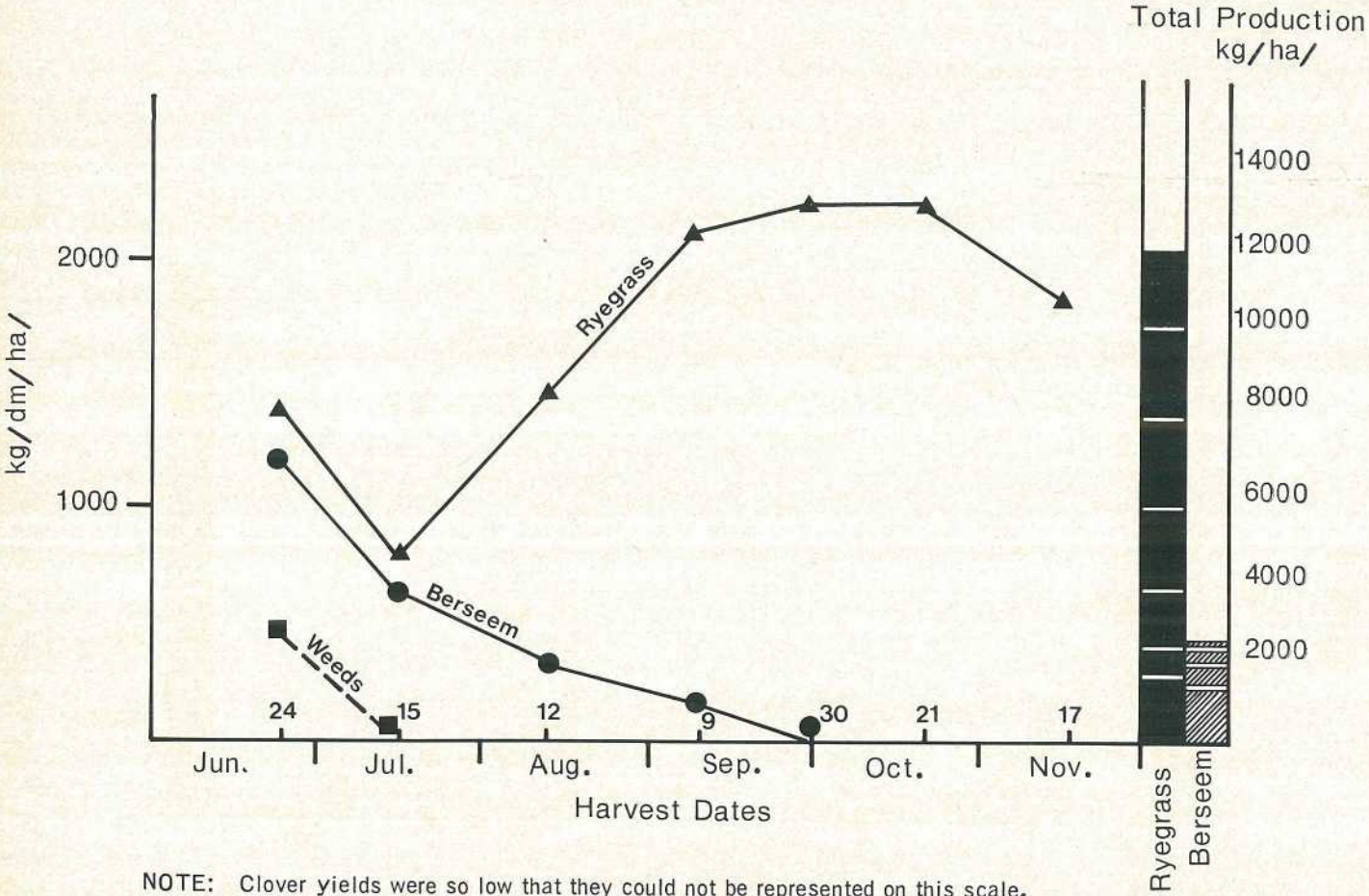
Treatment 3 did not provide as many grazings as other treatments, neither was it capable of as much time on the pasture as treatments 1 and 2.

This shorter grazing time was due to bloat problems and insufficient feed. The reduced number of grazing days was due to slow regrowth between grazing which extended the grazing frequency to an average of 30 days.

Temperate pastures, oats and lucerne were used to fill in for those lost days and the common grazing land compensated for the shorter grazing day.

TABLE 5
Ryegrass, Berseem Clover and other clovers treatment
Mean yield kg/ha D.M. of sub plots A and B
Planted 10 April, 1980

Harvest date	Days	Berseem clover	Ryegrass	Other clovers	Weeds	Total forage on offer
24 June	74	1 190	1 397	74	505	3 166
15 July.....	21	670	787	44	46	1 547
12 August.....	28	376	1 469	71	15	1 931
9 September	28	155	2 089	31	Nil	2 275
30 September	21	35	2 196	92	Nil	2 323
21 October.....	21	Nil	2 188	Trace	Nil	2 188
17 November	28	Nil	1 786	Trace	Nil	1 786
Total.....	221	2 426	11 912	312	566	15 216
Percentage of total		15.94	78.29	2.05	3.72	100



NOTE: Clover yields were so low that they could not be represented on this scale.
Figure 4. Ryegrass, berseem and other clovers treatment.

TABLE 6
Berseem clover and other clovers
Mean yield kg/ha D.M. of sub plots A and B
Planted 16 April 1980

Harvest date	Days	Berseem clover	Other clovers	Weeds	Total presentation forage
1 July	74	997	111	1 544	2 652
29 July	28	1 172	50	160	1 382
26 August	28	1 127	192	668	1 987
16 September.....	21	512	122	547	1 181
28 October	42	171	1 045	815	2 031
Total.....	193	3 979	1 520	3 734	9 233
Percentage of Total.....		43.10	16.46	40.44	100

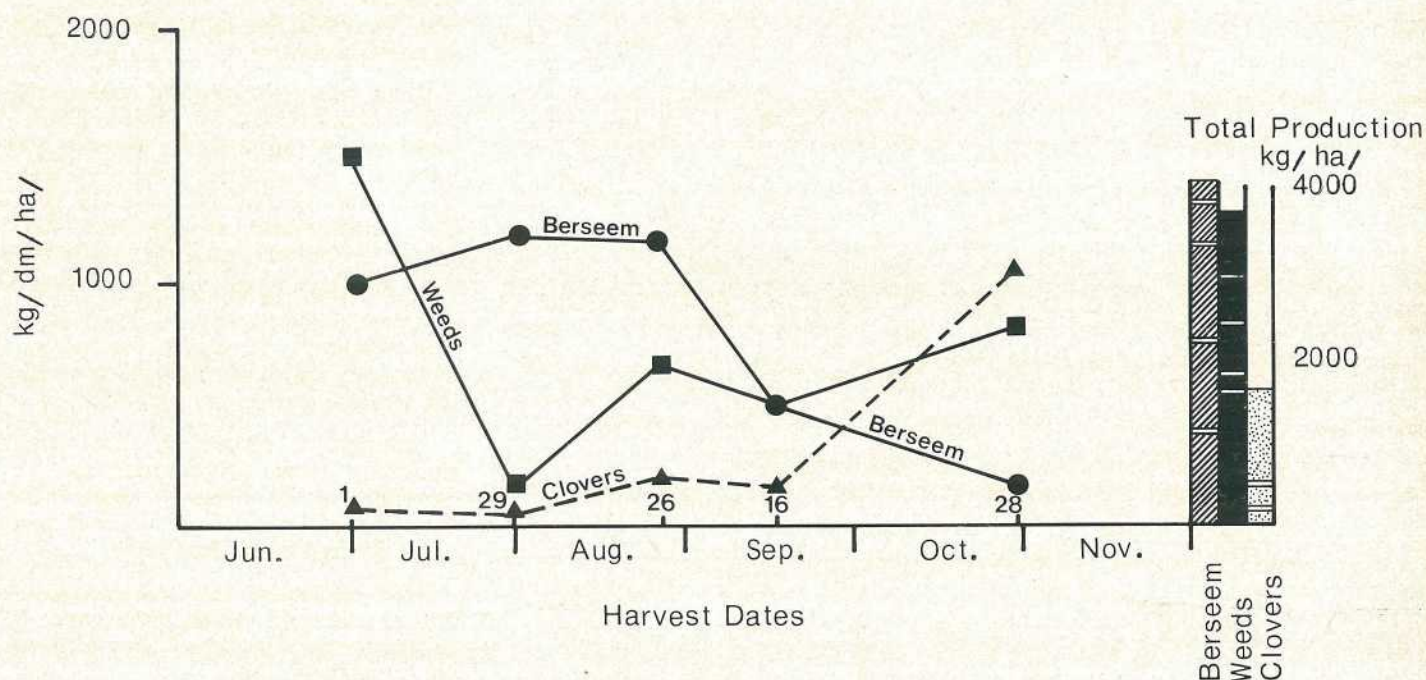


Figure 5. Berseem and other clovers treatment.

Results

Treatment 1—ryegrass

Weeds were never a problem and productivity was consistently high. The very cold weather in July slowed growth and additional nitrogen was used after the July grazing to increase growth rate, with what appeared to be little effect.

This treatment reliably produced ample supplies of high quality forage which was utilized under both wet and dry conditions. Rust was not a problem, although some was evident in November. Production from this treatment was 54 135 L of milk with an average of 14.34 L per head per day.

Treatment 2—ryegrass, berseem clover and other clovers

Berseem clover grew extremely well with ryegrass, and constituted approximately 50% of the dry matter yield for the first two grazings. Thereafter competition from ryegrass and the short grazing frequency caused berseem production to decline rapidly and ryegrass dominated the pasture. Berseem made no contribution after the fourth grazing.

The growth of Snail, Clare and Ladino clovers was very limited and the plant stand was thin. The high density of berseem and ryegrass in autumn and early winter suppressed growth of these clovers and eventually thinned the stand to the point

where only occasional plants survived. Weeds, mainly deadnettle (*Lamium amplexicaule*), were evident during the first grazing, but thereafter were not a problem.

The ryegrass in this treatment which was planted at 15 kg per ha, produced as much dry matter after the third grazing as that in treatment 1 which was planted at 40 kg per ha.

A total of 52 160 L of milk was produced from this treatment at an average of 14.6 L per head per day. This herd average is only slightly better than that achieved by treatment 1.

TABLE 7
Milk Production

	No. of herd recordings conducted	Av. no. milkers recorded	Av. milk (litres/day)	Av. milk (litres/cow)	Variation (litres/cow)
Treatment 1	7	76	1 093	14.3	13.1-16.0
Treatment 2	7	77	1 110	14.5	13.3-16.0
Treatment 3	5	76	1 147	15.1	14.2-16.4

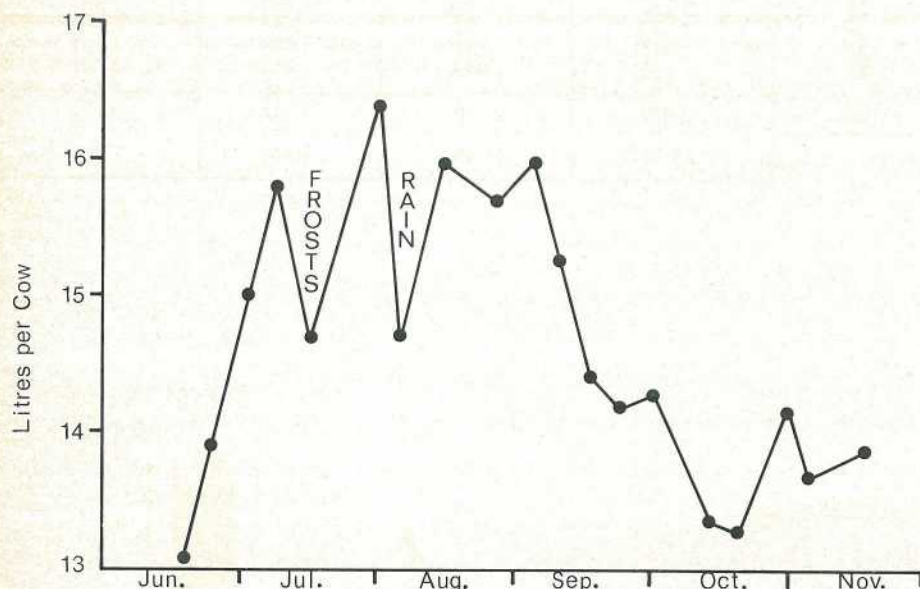


Figure 6. Milk production in L per cow from the trial area.

TABLE 8
Daily Production by Month of Calving

Month of Calving	Number of cows	Litres/cow/day
January	6	14.3
February	4	16.3
March	6	11.9
April	12	15.5
May	6	16.3
June	5	18.2
July	10	17.6
August	9	15.6
September	5	16.1

TABLE 9
Milk Production From Treatments

	Treatment		
	1	2	3
Number of days' grazing	49	47	35
Average number of milking cows per grazing	76	77	76
† Total milk production (litres)	54 135	52 160	42 950
Milk production (litres/grazing day)	1 105	1 110	1 227
* Average production (litres/cow) by herd recording	14.34	14.60	15.10

† To calculate gross margins, 'total milk production' obtained from each trial area (and not herd recording figures) were used for the calculation.

* It must be noted that these figures were obtained from only 19 days when herd recording was conducted.

Treatment 3—berseem and other clovers

Weeds were a major problem with this treatment and initially out-yielded berseem clover. The major weeds in autumn were deadnettle and stagger weed (*Stachys arvensis*) and both were well eaten by stock. Winter weeds were few, but a spring infestation of scotch thistle (*Cirsium vulgare*) was not accepted by stock. Weeds were not sprayed as berseem clover is susceptible to the herbicide 2, 4-DB.

Berseem clover was disappointing and could not be grazed as frequently as ryegrass. This resulted in fewer grazing hours being recorded.

The other clover components in this treatment made little contribution in autumn and winter, but became dominant by the last grazing in late October.

Bloat was a problem in midwinter but was contained by spraying anti-bloat oil on the pasture. Bloat is not normally associated with berseem clover and it may be assumed that the combination of berseem and other clovers was conducive to bloat.

The highest herd average of 15.1 L per cow per day was achieved from this treatment. However, production per ha was substantially reduced with the treatment producing 42 950 L.

Production recording from this treatment was terminated on 31 October as the berseem stand had deteriorated to the point where it was not contributing to production.

This treatment was not ploughed out at the end of the trial and it subsequently developed into a good clover pasture stand.

Supplementary feeding

Throughout the trial, all milkers received 1.6 kg per day of hammer-milled corn and cob meal produced on the farm. At night, the entire herd received 12 bales of average quality sorghum hay fed in racks adjacent to the bails.

Total amount of supplementary feed over the 159 day trial period was 51 t of hay and 19.3 t of corn and cob meal.

Milk production

During the 159/day period 19 herd recordings were conducted with most occurring on the sixth day of each treatment to nullify any carry over effect from the previous treatment (table 7).

TABLE 10

Factory Payments				
—	B.F.%	Cents/litre market milk	Price/kg b.fat	Av. price cents/litre
June.....	4.09	25.51	2.90	20.67
July.....	3.59	25.51	2.90	19.25
August.....	3.64	25.51	2.90	18.34
September.....	3.63	25.51	2.90	18.59
October.....	3.59	25.51 28.00	2.90	19.42
November.....	3.47	28.00	2.90	19.88

Milk Production Over Trial Period (159 days)

—	Liquid (litres)	Manufacture (litres)	Total (litres)	Gross value
June 13 to 30.....	9 056	8 669	17 725	\$ 3 664
July.....	19 002	13 995	32 997	6 352
August.....	19 261	18 506	37 767	6 925
September.....	19 280	17 263	36 543	6 792
October.....	19 210	16 102	35 312	6 860
November 1 to 18.....	11 083	9 468	20 551	4 086
Totals.....	96 892	84 003	180 895	34 679

Production figures for cows which calved by month from January to September were also extracted.

These are cows which calved and continued to milk throughout the trial period.

These figures are shown in table 8 and indicate that cows which calved on to top quality pasture produced more milk per day than cows which calved earlier in the year or in the spring.

Total milk production from the farm during the trial was 180 895 L in 159 days, of which approximately 149 200 L were produced from the trial area and approximately 31 700 L from 'other grazing' areas. These other grazing areas consisted of oats, lucerne and perennial temperate pastures.

Treatments 1, 2 and 3 produced 30%, 29% and 24% respectively of total farm milk output. The remaining 17% came from the other grazing areas.

The grazing cow numbers varied from 67 to 82 milkers on treatment 1, 65 to 68 on treatment 2 and 63 to 88 on treatment 3. Some dry cows also grazed with the milkers and increased the average number of cows grazing to 82 on each of the three treatments.

Higher milk production per day and per cow was obtained from treatment 3 although this treatment contributed only 22% of the total

grazing. Treatments 1 and 2 out-yielded treatment 3 in total milk yield and number of days grazing.

In May, before the trial commenced, factory payment for milk was 25.51 c per litre liquid milk and \$2.50 per kg butterfat. The herd comprising 67 milkers averaged 11.7 L per cow for May off native and temperate sown pastures.

The production per cow rose during the trial to peak at 16.4 L per cow in July and when the trial finished herd production was still averaging 13.9 L per cow.

Over the trial period, the manufacture milk price ranged from 10.72 c to 11.25 c per L. This reflected the variation in butterfat content. The price per L for liquid milk rose from 25.51 c to 28 c in mid October. This had a significant effect on income from total milk sales. Average price per L for all milk was 19.17 c from an average production of 14.61 L per cow.

Economics

Pasture costs incurred in each treatment are shown in table 11. Gross margins (returns less variable costs) are shown in table 12. The variable production costs in c per L are shown in table 13. All costs are those at the time of purchase or use except fertilizer costs. The costs of fertilizer used throughout the trial has been averaged.

Cost of production per kilogram of dry matter has been calculated as for treatments 1 and 2 by dividing total costs by dry matter yield. In treatment 3, the cost of production per kg of dry matter was calculated by dividing total cost by total dry matter yield less weed (scotch thistle) yield for the final three harvests.

TABLE 11
Costs per ha of Pasture

—	Treatments		
	1 Rye	2 Rye + Berseem + Clovers	3 Berseem + Clovers
Land preparation including fertilizing and planting.....	\$ 25	\$ 25	\$ 25
Planting fertilizer.....			
125 kg per ha muriate of potash	19	19	19
300 kg per ha sulphate of ammonia	47	47	47
Top dressing urea at \$260 per tonne	177	151	33
Application at \$2.50 per ha.....	13	13	3
Seed.....	44	77	76
Irrigation at \$20 ML.....	56	70	64
Anti-bloat oil.....	Nil	Nil	..
Terric at \$1.70 L.....	..	..	57
Application.....	..	..	8
Total cost per ha.....	381	402	332
Dry matter productivity kg/ha	14 340	15 216	7 871
Costs cents per kg dry matter	2.66	2.64	4.22

TABLE 12
Gross Margins per Treatment

	Treatment		
	1	2	3
Returns	\$	\$	\$
Milk at 19.17 c per L	10 378	9 999	8 234
Costs			
Hay at \$60 per t	893	869	638
Corn and cob meal at \$80 per t	476	463	340
Pasture	1 078	1 138	940
Total costs	2 447	2 470	1 918
Gross margin per treatment	7 931	7 529	6 316
Gross margin per ha	2 802	2 660	2 232

TABLE 13
Variable Cost of Production (c per L)

	Treatment		
	1	2	3
Hay	1.65 c	1.67 c	1.49 c
Meal	0.88	0.89	0.80
Pasture	1.99	2.18	2.19
Variable costs (c per L)	4.52	4.74	4.48

Conclusions

Berseem clover succumbed to competition from ryegrass and grazing pressure, and the ryegrass-berseem clover treatment had to be maintained as a high density ryegrass pasture.

The pasture legume treatment (treatment 3) produced the highest milk yield per cow at 15.1 L per head. The total milk yield was 20% less than that from the high density

ryegrass and the treatment produced 40% less grazing. Feed quality of the legume pasture was superior.

Ryegrass (treatment 1) produced the highest milk yield at a cost competitive with other treatments. It was most profitable treatment. The ryegrass treatment also was the most reliable forage in 1980. Berseem clover is more sensitive to time of planting, weed populations and frequency of grazing.

Winter fodder crops for dairy production must be tolerant of some mismanagement and excessive grazing pressure at times. Berseem clover either as a pure sward or as a component of ryegrass did not meet these criteria in 1980.

The major role of berseem clover is probably as a supplementary fodder crop which can be used to meet shortfalls in feed strategies.

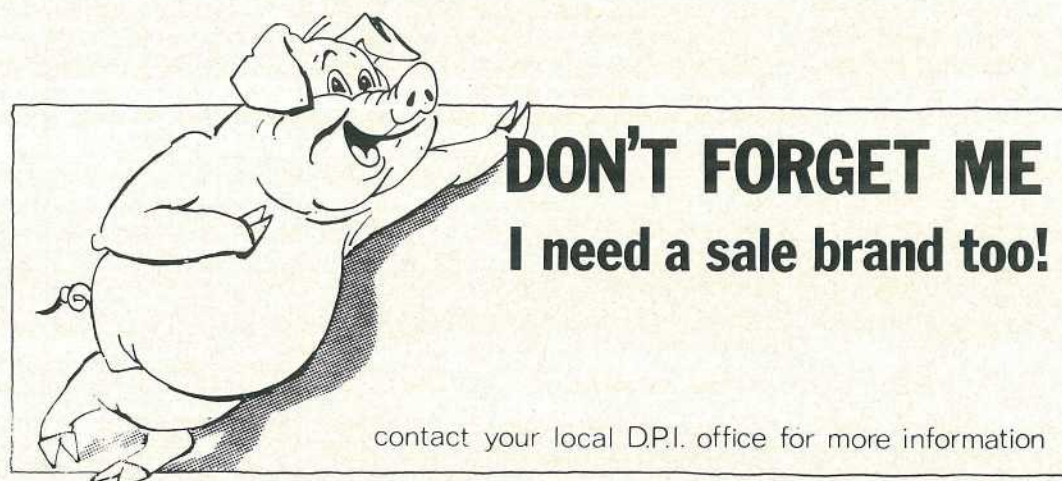
The other clovers, Ladino and Clare, and Snail medic, were disappointing. Ladino clover has performed well in other situations as a pure sward and provided useful grazing in late winter and spring. Snail medic has also performed well as a pure sward and has provided useful autumn and winter feed and Clare has shown potential for mid-season production. Further research is required to clarify the role of these species and that of berseem clover in an intensive forage system for dairy production.

The establishment phase of perennial temperate pastures generally provides little grazing until the following spring. The results from treatment 3 indicate that the inclusion of berseem clover in pasture mixtures could overcome this problem and provide early grazing while the perennial species are establishing.

Acknowledgments

The co-operation of Mr W. Holcombe and his family, of 'Truno,' Beaudesert, where the trial was conducted is gratefully acknowledged. Mr R. Horsey assisted with milk production recording and other observations.

The study was partially funded by the Commonwealth Extension Services Grant.



Potato varieties in Southern Queensland

by B. L. Bartholomew, Agriculture Branch

Sebago

The main variety produced in southern Queensland is Sebago and comprises more than 70% of the area planted. Sebago has maintained this position for 35 years and despite widespread testing of new varieties, some of which are higher yielding, no suitable replacement variety is available.

The variety is particularly versatile and can be used for all purposes including new grade. The tubers can be boiled, mashed, fried, deep-fried, roasted and baked when fresh. They are also suitable for commercial processing as French fries or chips, and are well suited for crisps and dehydrated potatoes.

Sebago is planted for autumn and spring crops but is not favoured for the winter crop.

The variety was developed by the United States Department of Agriculture and released in 1938. Maturity is medium to early—100 to 120 days. Yield ranges from 20 to 30 t per ha of No. 1 or new grade.

Tubers are elliptical to round, regularly-shaped, medium-large. The skin is smooth, white, the eyes shallow and numerous, lenticels are conspicuous and the flesh creamy-white. Keeping quality is fair, the tubers sprouting readily in 5 to 8 weeks.

Seedling emergence is rapid. Plants are large, erect to spreading, stems slightly reddish-purple, flowers purple with paler tips. Sebago is resistant to late blight, mild mosaic, and common and russet scab, but is susceptible to target spot and fusarium wilt. This variety withstands extreme conditions of heat and moisture very well, and is particularly suited to heavier alluvial soils. It has low resistance to wind and frost.

Sequoia

This variety is favoured for winter and early spring crops in southern Queensland. Despite the susceptibility of this variety to powdery scab, its high yielding capability during cool weather has enabled it to retain about 15% of the planted area.

Sequoia is a non-mealy potato, but if it is sown in April and May, a better cooking type of tuber is produced. It is acceptable for household use for cooking and baking but is not favoured by the processing trade.

The variety was developed by the U.S.D.A. and released in 1939. It is similar in maturity to Sebago but is the fastest-maturing commercial variety during the winter. Yield expectancy is in the range of 25 to 40 t per ha of No. 1 or new grade, for which it is accepted.

The tubers are oval to flattish in shape with smooth, white skin. There are few shallow eyes and they are concentrated mainly at the apical end of the tuber. The flesh is creamy-white, keeping quality is very good and the tubers sprout in 10 to 12 weeks.

Plant growth is strong and vigorous, stems are large, erect and green and flowers are white.

The variety has good resistance to common scab, fair resistance to late blight, but is very susceptible to powdery scab. It also has fair resistance to frost, wind and drought. This variety tends to overgrow and produce poor quality tubers if planted during the warmer weather.

Exton

This variety was selected by Mr C. Exton of Victoria and is considered to be a self-pollinated seedling from the Katahdin variety.

It has gained popularity on the heavier soil types, particularly in the Lockyer Valley, where it is found favour with the prepacking trade for sale in supermarkets and to a lesser extent the crisping trade. It is fairly well accepted for household use, including baking. It is tolerant to powdery scab and this has been a factor in its favour.

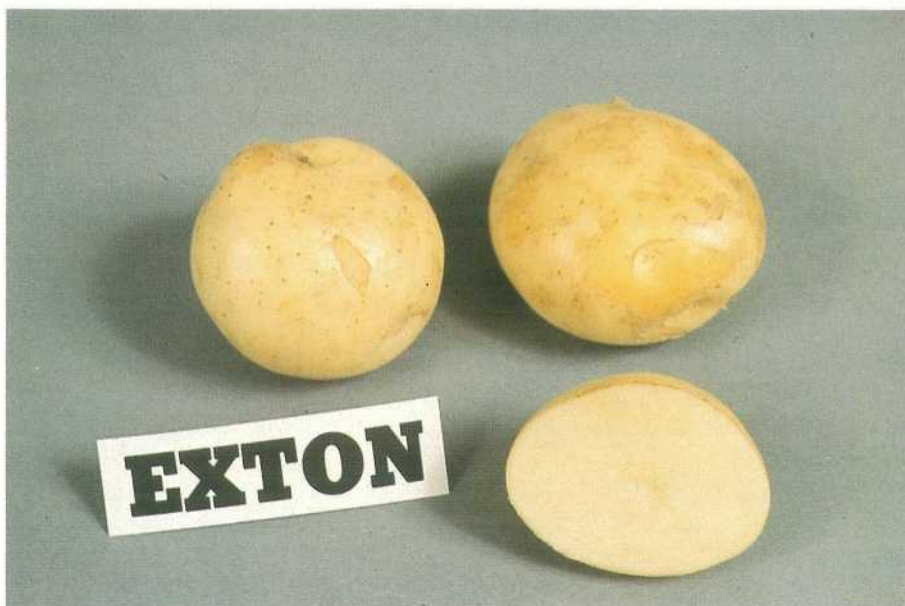
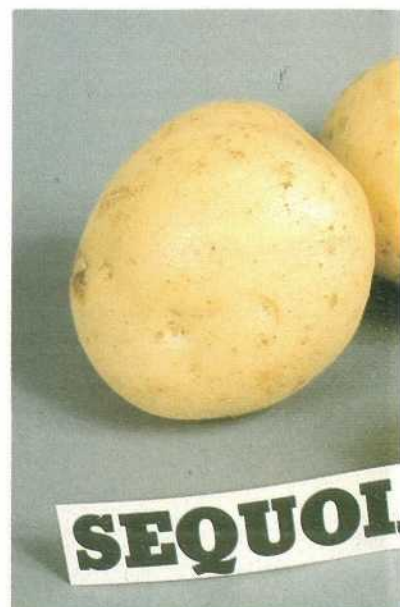
Planted from March to July, the main disadvantage is the slow maturity during the cold weather. It is 2 to 3 weeks longer in maturity than Sequoia. The yield range of 20 to 30 t per ha is similar to Sebago.

The tubers are white-skinned, thick and oval, very similar to Sebago tubers except for a characteristic roughness of the skin and a marked tendency to adhere to the stolon at harvest. The flesh is creamy-white, eyes are mainly apical, and the tuber keeping quality is quite good. Seedling emergence is late, growth is vigorous, and plants are upright with purple flowers. Exton is susceptible to Irish blight (foliage only), target spot and russet scab.

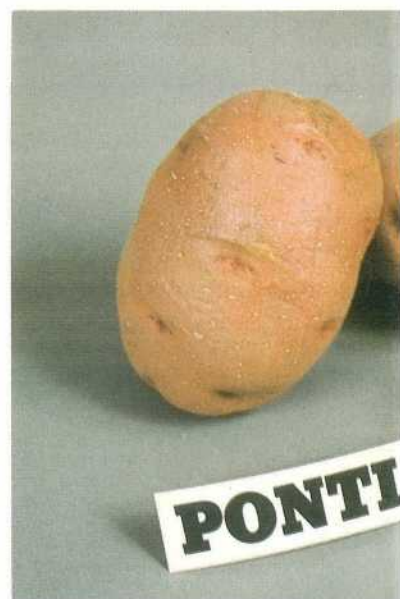
Kurriel

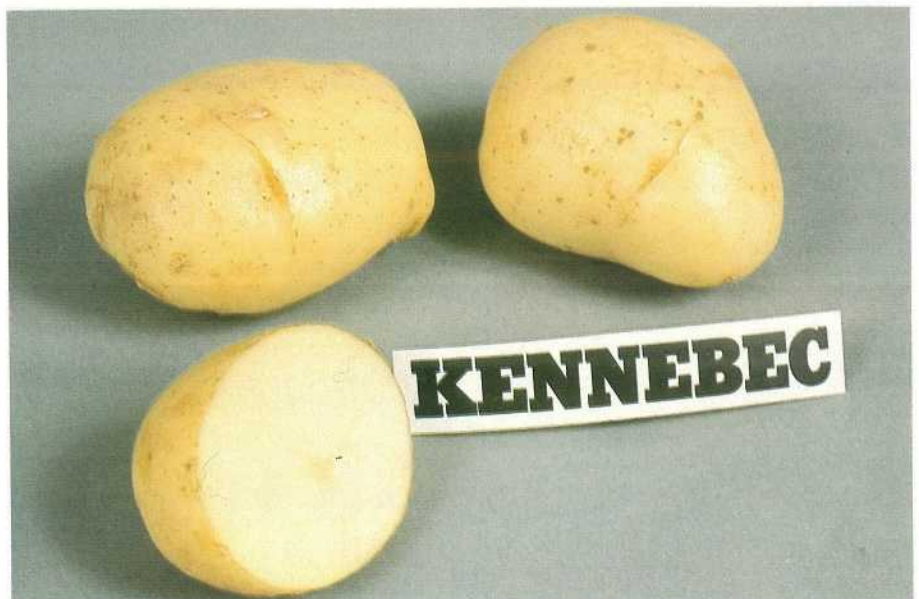
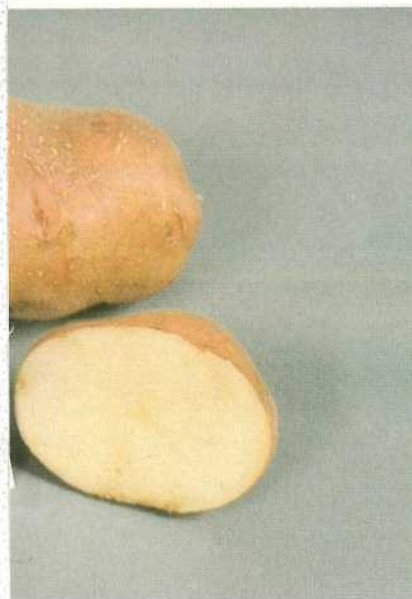
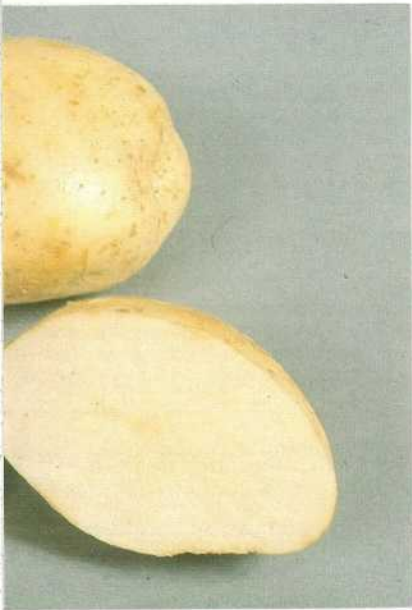
This variety was developed by the N.S.W. Department of Agriculture. It has limited use for winter crop plantings and possibly October and November plantings at high altitudes. It is grown mainly in the Rochedale, Redland Bay and Mt. Sylvia areas as an alternative to Sequoia due to its powdery scab resistance.

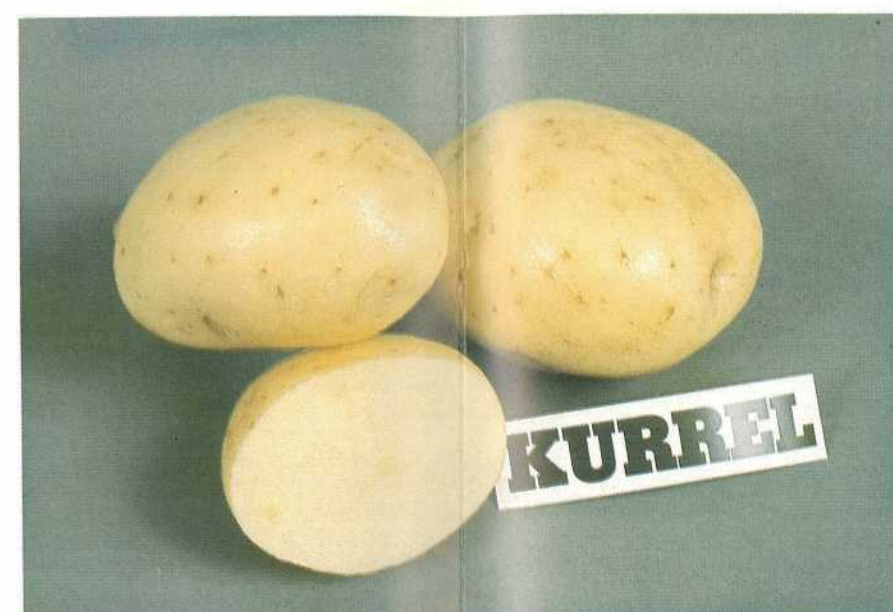
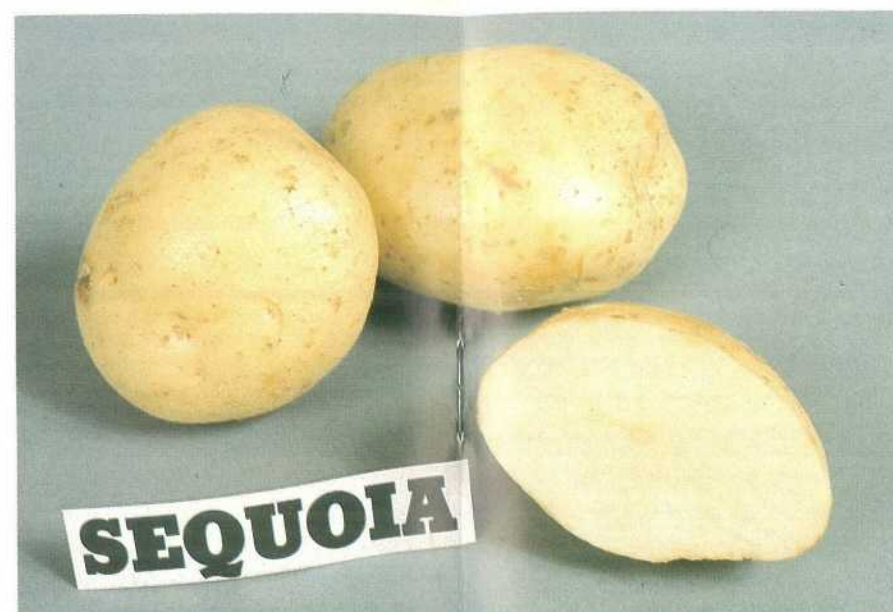
Its maturity is similar to Exton (120 to 130 days) and yields range from 18 to 30 t per ha. Both yield and quality are variable. It is a non-mealy type, generally of fair to good table quality suited to salads and stews and, to a limited extent, to boiling and mashing. It is not suitable for processing.



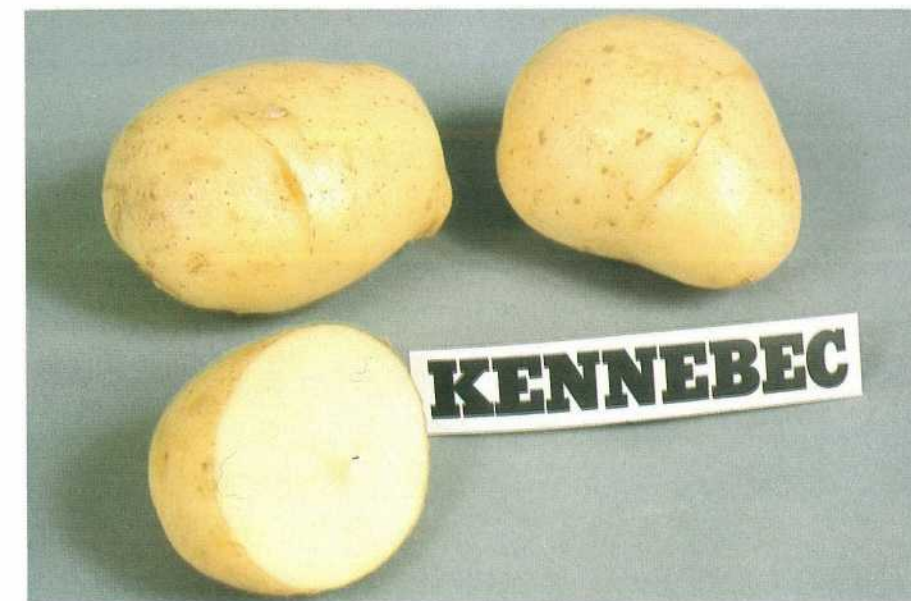
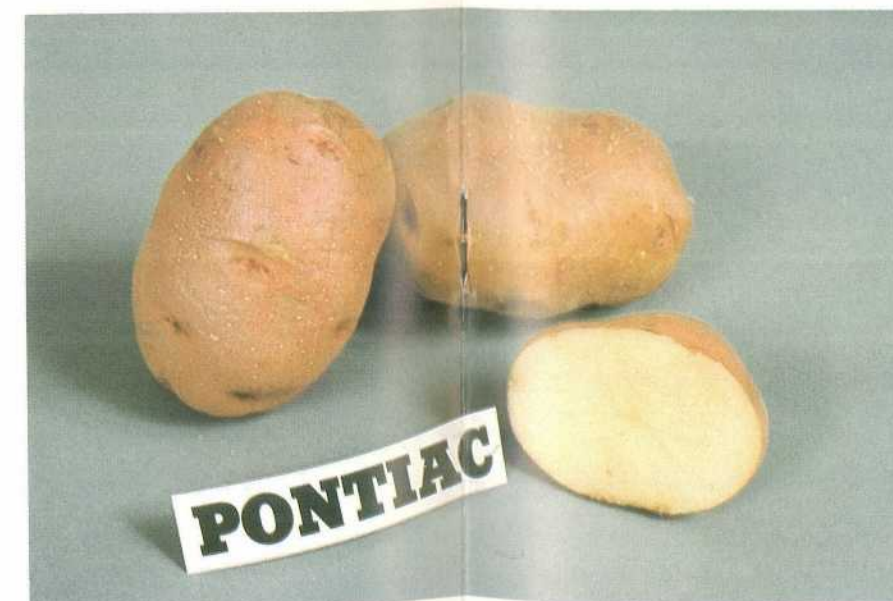
POTATO VARIETIES IN QUEENSLAND







POTATO VARIETIES IN QUEENSLAND



The tubers are round and the skin is slightly netted, the eyes are shallow, the flesh is creamy-white, and tuber keeping quality is fair. The variety tends to set tubers high and these are prone to greening, growth cracks and second growth.

Seedling emergence is rapid, growth vigorous, and plants are tall with large, white flowers.

Bungama

This variety was developed by the N.S.W. Department of Agriculture and released in 1960. Limited production takes place on the lighter soils of the upper valleys of the Lockyer district. It is planted in April to June. This variety is of similar maturity to Sebago (100 to 120 days), very high yielding (30 to 40 t per ha of No. 1 or new grade) with tubers having an attractive white skin when produced on light soils.

The cooking quality of this non-mealy variety is poor and the variety has very limited market acceptance. As with Kurrel, these tubers are suitable for salads and stews but are not suited to processing.

Tubers are very attractive, round to oval, very uniform in shape and size, and the flesh is white. The eyes are shallow with inconspicuous eyebrows. Tubers have a limited shelf life, sprouting in 5 to 7 weeks and they are prone to soft rot in storage. Seedling emergence is rapid, growth is tall, vigorous and upright, and plants are characterized by profuse, rounded, white flower heads. Bungama has good resistance to common scab, russet scab, and partial resistance to powdery scab.

Pontiac

This red-skinned variety was developed by the U.S.A. and released in 1938. This variety has fallen from favour in southern Queensland and very few crops of Pontiac are now grown. Although it is a mealier type of potato, it is generally not favoured by processors.

The tubers tend to overgrow, are prone to growth cracking and the formation of odd-shaped tubers. This is the main reason the variety has fallen from favour for household use. The maturity is early (90 to 100 days), tubers are round to oblong, with red skin, eyes medium to deep, and keeping quality is variable.

While this is a good table potato for boiling, mashing or baking, it is unsuited to frying or chipping. Seedling emergence is rapid and plant growth is vigorous and upright with purple flowers. Pontiac is susceptible to target spot, common scab, russet scab and Irish blight—both tubers and foliage.

Kennebec

Developed by the U.S.D.A. and released in 1948, this variety is very popular in southern States for processing but has not performed as well in southern Queensland. It does perform a little better on lighter soil types, but processing companies now contract mainly for the Sebago variety. Maturity is medium to early (100 to 120 days) and yields are high (25 to 40 t per ha of No. 1 or new grade).

Tubers are white-skinned, smooth, shallow-eyed, somewhat pear-shaped, of good length and white-fleshed. Cooking quality for table use is quite good, but crisping quality and chipping quality are variable, particularly from the autumn crop when solid matter content is low. The quality generally improves from the spring crop. Tubers tend to be subject to growth cracks, be set high, green and overgrow on heavier soils. The tubers are also prone to tuber moth attack.

Emergence is slow, growth vigorous and upright. The plants are tall with a light setting of white flowers. Kennebec plants have poor resistance to wind and frost.

The tubers are prone to soft rot in the ground. The variety is susceptible to target spot, resistant to Irish blight and partly resistant to powdery scab. Second growth can also be a problem as the variety is sensitive to adverse heat and moisture conditions.

The variety Kennebec generally requires a high degree of managerial skill and cannot be recommended on the heavier soil types.

Other varieties

The newer varieties Coliban and Tasman have been tried commercially in recent years and found to be unsuited to local conditions.

The variety recommendation for the various planting times in southern Queensland are summarized in the Table.

Potato Varieties for Southern Queensland

Locality	Planting time												Comments
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
S. E. Qld, flats (Lockyer, Brisbane, Fassifern Valleys)	<u>Sebago</u>	<u>Sebago</u> <u>Exton</u> <u>Pontiac</u> <u>Kennebec</u>	<u>Sebago</u> <u>Exton</u> <u>Pontiac</u> <u>Kennebec</u>	<u>Sequoia</u> <u>Kurrel</u> <u>Exton</u>	<u>Sequoia</u> <u>Exton</u> <u>Kurrel</u>	<u>Sebago</u> <u>Exton</u> <u>Sequoia</u> <u>Kurrel</u>	<u>Sebago</u> <u>Kennebec</u> <u>Pontiac</u>	<u>Sebago</u> <u>Kennebec</u>	..	..	..	..	Winter plantings, only in frost free areas or under solid set irrigation for frost control
Frost-free areas (Rochedale, Redland Bay coastal areas, Upper Tenthill)	<u>Sebago</u>	<u>Sebago</u>	<u>Sebago</u>	<u>Sequoia</u> <u>Kurrel</u> <u>Bungama</u> <u>Exton</u>	<u>Sequoia</u> <u>Kurrel</u> <u>Bungama</u> <u>Exton</u>	<u>Sebago</u> <u>Exton</u> <u>Kurrel</u>	<u>Sebago</u>	<u>Sebago</u>	..	..	..	..	Main planting April-June
S. Qld, ranges (450 to 900 m elevation)	..	..	..	..	..	..	..	..	<u>Sebago</u> <u>Kurrel</u>	<u>Sebago</u> <u>Kurrel</u>	<u>Sebago</u> <u>Kurrel</u>	<u>Sebago</u> <u>Kurrel</u>	Higher altitudes allow later plantings

Recommended varieties are underlined.

Potato growing in southern Queensland

by B. L. Bartholomew, Agriculture Branch

Potatoes can be grown successfully in many parts of southern Queensland.

New producers should, however, study local conditions carefully before commencing production, particularly in districts where potato production is not yet an established enterprise.

The main producing areas are situated in the south-east portion of the State. The Moreton region accounts for 83% of the south Queensland crop, with smaller areas centred on Maryborough and the Darling Downs.

The ability to place fresh potatoes on the market during most of the year, particularly in late winter and spring when few 'new' potatoes are available from southern States, has assured Queensland of a firm position in the Australian potato industry.

The main outlet for southern Queensland potatoes is Sydney with secondary outlets in Brisbane, Melbourne and Adelaide. Transport is principally by road transport in 50 or 66 kg sacks.

There has been a reduction in the area of potatoes grown in the Moreton region as a result of increased popularity of contract processing of French beans and peas and oilseed crops such as soybeans. In addition, market vegetables such as cabbage, cauliflower, broccoli and tomatoes compete with potatoes for farm land.

The total area of potatoes grown in Queensland has decreased from 7 715 ha in 1970 to 6 325 ha in 1979. The area planted is influenced by prices paid the preceding year, but overall the trend had been downward. There are signs that it will stabilize at about the present area.

The average yield since 1970 in southern Queensland is about 17 t per ha. Under good growing conditions, an experienced producer can expect yields of 25 t per ha.

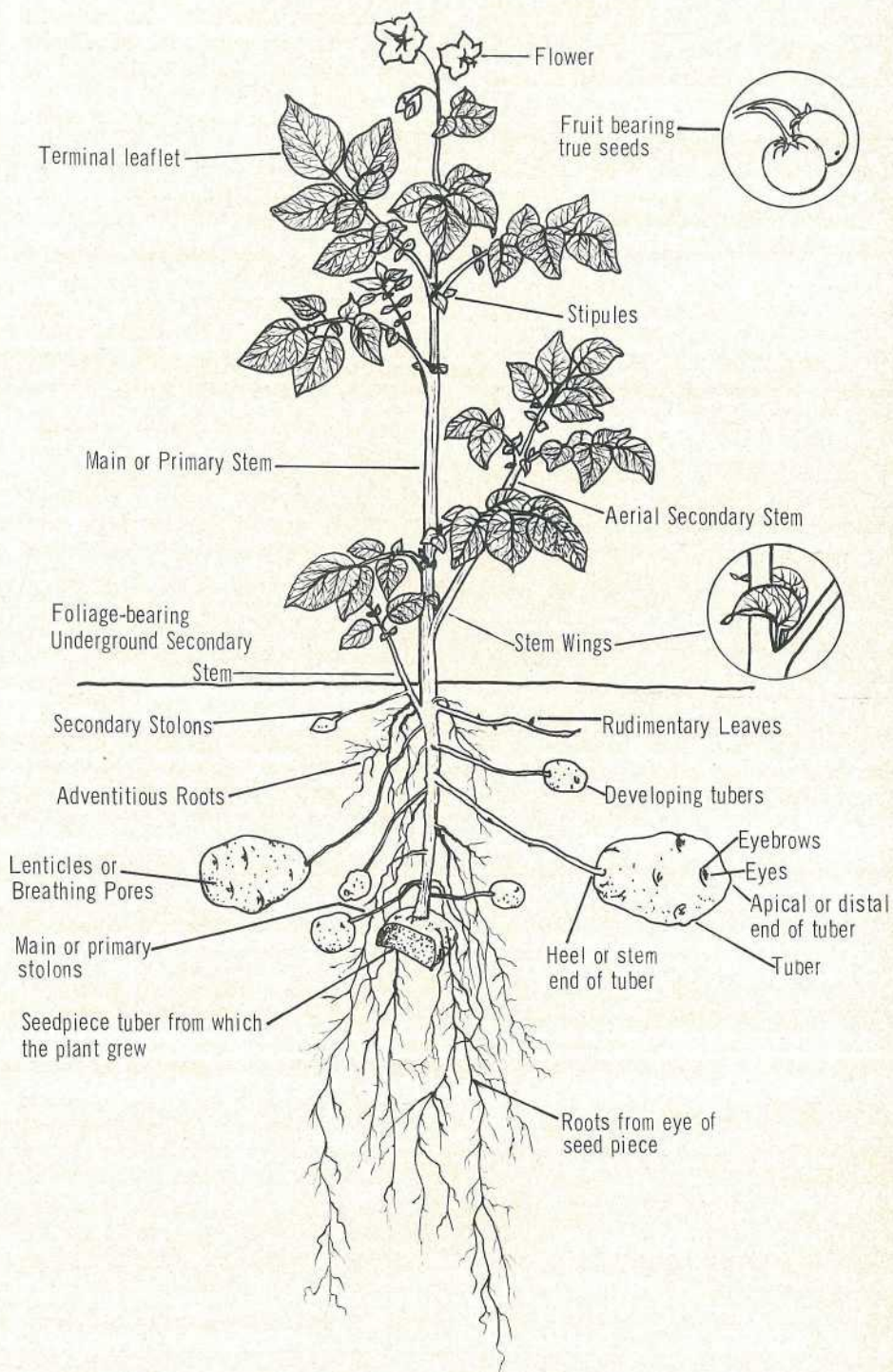


Figure 1. The potato plant.

The potato crop in southern Queensland is now grown under irrigation with only a few exceptions in the high rainfall areas near the coast and in the Killarney district.

Growing seasons and production

The major climatic factors limiting planting time are the heat of mid-summer and occasional frosts in winter and early spring.

The main planting times fall between June and early August—the spring crop, and February and March—the autumn crop. In wholly or partially frost-free areas, small areas of winter crops are planted during April and May.

The introduction of solid set irrigation systems fitted with frost alarms has enabled growers on farms subject to frost to commence planting in late May and early June.

There has been a tendency in recent years, particularly in the Lockyer Valley, to plant the bulk of the spring crop during June in an attempt to take price advantage of earlier marketing.

At the other end of the spring crop planting season, small areas are planted on tablelands with altitudes of 600 to 1 000 m during September to December. Some potatoes are being planted in south-east Queensland virtually throughout the year.

The autumn crop, which accounts for about 20% of the potato production, is planted using low-cost carry-over seed held in cool store from the spring crop. Irrigation costs are also low due to high rainfall expectancy. The risks involved in growing this

crop are high. This is mainly due to the adverse weather conditions normally experienced during the early stages of growth. However, the mature crop can be held in the ground for a considerable period which cannot be done with later plantings.

Monthly production figures are set out in table 1.

Crops are generally harvested as 'new' potatoes when supplies are low and when market demand is at its highest, rather than at the optimum time for yield and/or quality.

The tendency to grow out-of-season crops, and the incidence of extreme temperatures with high light intensities leads to comparatively low yields, and hence the cost of production per tonne is above that of southern States.

The potato plant

History

The potato plant had its origin in the highlands of the western part of South America. It is an ancient domesticated plant as some archaeological material has been carbon-dated at an age of 8 000 years.

It was widely distributed throughout South America by the time of the Spanish conquests early in the sixteenth century. The highland cultures in the region of Peru and Bolivia probably owed their existence to the potato since few other crop plants can be grown at altitudes in excess of 3 500 m. There is also some evidence that potato cultivation preceded the appearance of maize as a cultivated crop in the New World.

The first 'potato' to reach Europe was the sweet potato (*Ipomoea batatas*) which is not related. This

was brought to Spain from America by Columbus on his voyage of 1492. *Solanum tuberosum* did not reach Europe until about 1570, when it was probably brought to Spain as part of ships' stores. It is known to have been cultivated in the Seville region by 1573. From Spain it spread to Italy, Belgium and through Europe as a botanical curiosity.

The potato plant was introduced separately to England from America about 1590. From there it was taken to Ireland where its value as a human food and staple diet was first recognized in Europe.

From England it also spread to the British overseas colonies including Australia in the early days of settlement. The major varieties now cultivated in Australia are mainly introductions from North America about the time of World War II.

Botanical description

The common cultivated potato *Solanum tuberosum* L. belongs to the family Solanaceae. This family also includes the tomato, tobacco, egg fruit and petunia, as well as several weed species such as datura and nightshade.

The potato tuber is the enlarged end of an underground lateral shoot or stolon which usually arises from one of the basal nodes below soil level. The tuber is a modified stem with a shortened and broadened axis and rather poorly developed leaves in the form of leaf scars or 'eyebrows' and lateral buds in the form of 'eyes'.

The eyes follow a spiral pattern and tend to be concentrated at the apical end of the tuber. At the 'heel end' of the tuber can be found the stolon, or the scar of its attachment to the stolon.

TABLE 1

Production of Potatoes in southern Queensland by District 1978-79 (tonnes) and Estimated Seasonal Distribution (per cent)

Season ¹ Harvested	Wide Bay South Burnett	Brisbane Valley	Lockyer Valley	Bremer Fassifern	Beaudesert	South East Coast	Darling Downs	%
Dec.-Jan.....	..	..	0.4	..	..	..	30.0	0.5
Feb.-March	..	..	..	..	..	..	70.0	1.1
Apr.-May	..	..	2.0	0.7	..	..	..	1.4
June-July.....	18.8	45.5	18.2	20.6	19.3	..	..	18.7
Aug.-Sept.....	35.7	..	11.9	5.3	..	70.0	..	15.0
Oct.-Nov.....	45.5	54.5	67.5	73.8	80.7	30.0	..	63.3
Production ² (tonnes).....	1 468	10 774	59 530	9 273	5 703	8 902	4 194	
Per cent	1.5	10.8	59.6	9.3	5.7	8.9	4.2	100.0

¹ Seasonal Estimates by D.P.I., Gatton.

² Source: Australia Bureau of Statistics.



A potato plant after tuber setting and midway through the tuber bulking growth stage.

The skin of the potato consists of a layer of single, usually colourless, cells comprising the epidermis and several layers of corky cells below this comprising the hypodermis. Together these make up the periderm. The pigment anthocyanin which gives the distinctive colour to tubers of some varieties is contained in the periderm.

The potato plant is shown diagrammatically in figure 1.

Tuber setting usually takes place 35 to 50 days after planting. There are two separate processes involved, stolon formation and tuberization of the stolon tip.

The stolons normally develop first at the most basal nodes just above the seed piece, and then at progressively higher nodes. Low levels of mineral nutrients reduce the length and the number of the stolons.

Although tubers develop at the tips of stolons, not all stolons form tubers as separate factors are involved in tuber formation and stolon formation. Tuber formation occurs earlier at low temperatures and is delayed by high temperatures. There is also a photoperiod effect in that plants grown under short-day conditions form tubers earlier than those grown under long-day conditions.

Tuber formation also has been shown to be associated with a high concentration of soluble sugars in the stolon tip. The accumulation of carbohydrates in excess of the plant's requirements for vegetative growth is a prerequisite to triggering tuber formation.

Tuber setting is independent of flowering and tubers can be set without the plants flowering. The degree of flowering varies between varieties. Dry weather conditions and ageing of the seedpiece are factors that can reduce flowering.

Seed berries or 'seed balls' which resemble small, green tomatoes and which contain some 100 to 300 true seeds can develop after the flower has been fertilized. This seed is of no commercial value to Queensland growers although in recent years China and some tropical countries have developed or are developing commercial potato production systems using true seed as a means of reducing freight costs in food production.

Climate

The potato crop grows best in cool, moist climates in temperature regions at the higher latitudes. Potato plants have different temperature requirements for different stages of development.

The stages are usually defined as:

Stage 1—The period during emergence and early development of the plant, up to tuber initiation.

Stage 2—The period of tuber initiation and early tuber development.

Stage 3—The period of rapid tuber enlargement and beginning of maturation.

In stage 1, low temperatures are undesirable. Low soil temperatures (below 15°C) give slow emergence and increase the susceptibility of the plant to soil-borne diseases. Growth of potato tops is greatest at about 25°C. The rate of top and stolon growth is reduced at lower temperatures while the initiation of tubers is hastened.

In stage 2, high temperatures are detrimental to high yields. Low temperatures are more favourable for tuber set, the optimum average temperature being about 15° to 20°C. At temperatures over about 29°C, new tubers are unlikely to set.

In stage 3, low yields can be expected if daytime temperatures consistently reach 30°C.

In southern Queensland, night temperatures can also limit production. If a significant drop in temperature does not occur at night, plant respiration continues at a high rate, using up assimilates build-up during the day; Potato crops planted during the August to January period in low-lying coastal and subcoastal areas are unsuccessful because of these temperature effects.

The temperature issue is complicated by day-length. In tropical and subtropical latitudes, the short days of the potato-growing season are a factor limiting yield potential.



A newly-emerged potato crop.

There are some variety differences associated with temperature. Sebago is the commercially available variety most tolerant of high temperatures.

The high temperatures which occur in southern Queensland potato-growing areas are also responsible for the low solid matter content of tubers produced compared with that of the tubers produced in southern States. The bulk of the southern Queensland potato production is aimed at filling the gaps in southern markets. As a result, most are harvested in an immature or 'new grade' state which means a low solid matter content.

While the solid matter content can be regulated to some extent by reducing irrigation towards the end of the crop and extending the growing season, price movements and/or weather conditions dictate when most potatoes are harvested in southern Queensland.

Seed potatoes

Selection

The better the quality seed planted, the higher are the chances of producing a high-yielding, trouble-free crop. In southern Queensland, the potato grower can purchase certified seed either from Victoria or New South Wales for the main spring

planting in May to July, to a limited extent for the winter crop in April, and for the early summer planting in September and October in elevated areas. Seed for the autumn crop is obtained by cool storage of small, round seed or 'chats' kept from the spring planting.

The bulk of certified seed is obtained from the Thorpdale, Kinglake and Beech Forest areas of Victoria with limited supplies from Guyra in New South Wales.

There is extreme difficulty in obtaining certified seed of varieties suitable for the April planting and most winter crops are planted with either carry-over, cool-stored seed from the spring crop or ware potatoes from New South Wales. Some growers plant a seed production area of varieties required for this April planting in August, holding the tubers in cool store over summer.

The value of using certified seed has been confirmed over the years by the improved yields obtained.

Tables 2 and 3 provide details on seed sources, availability and approximate usage per month.

Certified seed is potato tubers which have been grown and inspected under Government supervision and as such have been attested to being true-to-type in relation to variety, free or virtually free from

disease, generally sound, bred from high-yielding stock and graded to fall within the weight range of 35 g to 250 g for 'run' grade and not to exceed 350 g for special large size.

It is impossible to assess seed potato quality visually. Some symptoms of rhizoctonia, powdery scab, fusarium rot and soft rot may be visible, but symptoms of diseases such as leaf roll virus, bacterial wilt, blackleg, fusarium wilt and verticillium wilt cannot be seen. It is most important to know the history of the tubers to be used as seed.

With non-certified seed, the grower has no assurance of freedom from disease, varietal purity and age of the tubers. There is also the possibility of infesting valuable potato ground with persistent diseases such as bacterial wilt.

The small, round seed used for autumn planting is the by-product of the spring crop planted with certified seed and may carry disease.

Every care should be taken by the grower to ensure that the parent crop from which such seed is to be retained is kept healthy. If disease is present, it is better to obtain seed from a neighbour with a clean crop rather than use diseased seed.

Round seed is less likely than cut seed to rot or break down under the wet, hot conditions usually experienced during February and March. In general, reasonable yields have been obtained from this seed at low cost to the grower.

Age of seed

The ageing process in potato tubers after maturity is reflected in the degree of visible sprout development and in the feel of the tuber. The potato tuber remains dormant for many weeks after maturity, then commences to sprout at the apex and finally all "eyes" sprout and eventually thicken. Small, marble-sized tubers may in time develop on the outside of the original tuber which usually by this time has become flabby and rubbery.

Potato tubers harvested under hot conditions age more quickly than those harvested under cool conditions. Cool storage soon after harvest slows the ageing process. Physiological age of seed tubers has a marked effect not only on the size of sprout and plant growth rate but also on the size, maturity and yield of the crop.

Plants grown from physiologically old seed are stunted, thin-stemmed and narrow-leafed. They tend to develop leaf roll symptoms. The

TABLE 2

Seed Potato Sources for Queensland (1979)

State and Type	Variety	Quantity (t)	Delivery Time	Cost (\$/t)
Victoria certified	Sebago	3 918	March-Apr.-May	
	Sequoia	1 410	March-Apr.-May	\$185
	Exton	496	March-Apr.-May	to
	Pontiac	120	March-Apr.-May	\$340
	Other	96	March-Apr.-May	
Victoria total		5 920		
N.S.W. certified	Sebago	610	Apr.-May-June	
	Sequoia	190	Apr.-May-June	\$170
	Kurriel	150	Apr.-May-June	to
	Other	60	Apr.-May-June	\$300
N.S.W. total		1 110		
Ware potatoes purchased for seed	Sebago	80	Feb.-March-Apr.	\$45
	Sequoia	100	Feb.-March-Apr.	to
	Kurriel	100	Feb.-March-Apr.	\$200
	Other	40		
Total ware		370		
Qld. round seed held over from spring crop	Sebago	2 700	Feb.-March	
	Sequoia	490	Held over in cold store	\$75
	Pontiac	50	from spring crop	
	Exton	288		
	Other	72		
Total Qld. Seed from spring crop		3 600		

Source: Department of Primary Industries.

TABLE 3

Approximate Monthly Requirement of Potato Seed in Queensland (tonnes)

Variety	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Sebago	400	1 000	1 300	..	350	3 000	1 008	100	50	100	..	..	7 308
Sequoia	..	40	450	500	700	500	..	..	..	..	..	..	2 190
Exton	..	144	144	36	200	300	..	..	..	..	..	..	824
Pontiac	..	10	40	..	..	50	50	50	..	..	..	..	200
Kurrel	..	..	..	100	150	..	..	..	..	..	..	..	300
Bungama	..	..	..	60	20	..	..	..	..	..	..	..	80
Kennebec	..	..	12	..	20	28	38	..	..	..	..	..	98
**	**	**	*	*	*	*	*	*	*	*	*	*	
400	1 194	1 946	696	1 440	3 928	1 096	150	50	100	..	..	..	11 000

** Not readily available from certified sources; also growers prefer to use their own seed.

* Difficult to obtain certified seed.

Source: Department of Primary Industries.

plants are very susceptible to disease and produce a low-yielding crop with large numbers of small tubers.

Dormancy

Dormancy is the absence of consistent sprout growth because of chemical and physiological conditions in the tuber. Dormancy is influenced by a number of factors including variety, growing conditions of the parent plant, time of harvesting and storage temperature and humidity. Varieties such as Sequoia, Pontiac and Kennebec have a longer dormancy period than either Sebago or Bungama.

High temperatures during crop growth shorten dormancy, whereas low temperatures increase dormancy. Sebago sprouts readily after 6 weeks when stored at 21°C but can be kept for 11 weeks if held at 10°C. Planting wholly or partly dormant seed can result in delayed and uneven emergence, seed piece breakdown and subsequent uneven maturity.

In general, few problems are experienced breaking the dormancy of seed potatoes from Victoria for the spring crop. Cool-stored, carry-over seed for autumn planting is usually sprouting on removal from the store. The main dormancy breaking problems are with Sequoia seed from N.S.W. and, to a certain extent, seed from Victoria for winter plantings.

Chemical sprouting agents are available but are rarely used due to toxic effects on humans and side effects on the growing crop.

A common method of breaking dormancy at planting time of the winter crop is to moisten the bagged seed, stack it on a trailer, and cover with a tarpaulin to warm for short periods in the sun. If too much water is used or too much air excluded, soft rot will be induced. Storing under cool conditions followed by rapid

warming has also been used successfully to break dormancy and is probably the best and safest method.

Removing the seed from the cool store usually results in breaking dormancy with the sprouting of all eyes of the tubers.

General guidelines

General guidelines in selecting tubers as potato seed are:—

- Whenever possible use certified seed. Certified seed containers bear a label of certification but also must carry a metal seal from the State Department which certified them.
- The certified seed selected should be of the correct variety for the intended time of planting and should come from an area recognized as producing seed suited to southern Queensland.
- Certified seed should be examined on delivery for obvious physical defects such as bruising, dry rots and powdery scab infestation.
- Do not use seed more than once removed from certification.
- Do not buy old seed tubers which have numerous shoots well advanced or which are flabby.
- If intending to store small, round tubers from a spring crop for an autumn planting, keep the parent crop as free from disease as possible. Alternatively, grow a small area specially for seed tubers and rogue it several times, removing and destroying diseased plants and tubers.
- Avoid seed tubers harvested during hot conditions and remove round seed as quickly as possible from the field and place it in a cool store or shed. Do not leave tubers intended for seed in the hot sun.

Cool storage

Most seed tubers carried over from the spring crop for autumn planting are now cool-stored in the Lockyer Valley, Stanthorpe or Brisbane.

Seed tubers should be moved out of the paddock as soon as practicable after digging and stored temporarily under cool, well-ventilated conditions in a farm shed. They should be transported to the cool store as soon as possible—certainly prior to the commencement of sprouting as sprouts continue to grow within the cool store.

Seed tubers can be stored either in bags or in bulk bins. The bulk bins are preferred as these can be handled easily with fork lift trucks which reduce the chances of injury and bruising. The bulk bins must have gaps between the slats to allow air to circulate.

Bags tend to rot in cool store and are more difficult to handle on pallets. They also require more handling, causing significant damage to the tubers.

Cool store temperatures for seed potatoes should be kept between 4 to 5°C and humidity 85 to 95%. Good circulation of air within the cool store is essential to maintain even temperature and humidity.

Cool stores start accepting seed potatoes in October and commence emptying them in February. Seed is generally not cool-stored for longer than 6 months, but if both the seed tuber quality and cool store operating conditions are good it is possible to hold them for up to 9 months.

Seed potatoes need not be treated with insecticide prior to cool storing as tuber moths cannot survive in cold temperatures for more than 3 weeks.



Autumn crop potatoes may be stored in the ground. In this photograph, the tops have died off due to sclerotinia and target spot infestations.

Some Victorian certified seed, particularly of the Sequoia variety, is not delivered to southern Queensland for cool storing until April–May as an aid in breaking dormancy.

On removal from cool store, the potatoes should be held to warm up over a period of at least 1 week prior to planting. Seed for autumn planting sprouts rapidly on removal from cool store.

Planting the crop

Seedbed preparation

Soil preparation for potatoes should aim at providing a deep, loose seedbed of fine tilth at the time of planting with a minimum of clods.

In recent years, ploughing has been replaced in many instances by a combination of deep tine ripping and harrowing with heavy duty offset disc harrows. The final preparation is frequently carried out by rotary hoe.

Some growers plough every second or third year, particularly on the heavier alluvial soils. The heavier clay type soils used for potatoes should be worked well in advance of planting, but lighter soils can be prepared a short time before planting.

The period between discing the preceding crop residues and planting the potato crop is often only several weeks. The breakdown of organic plant residues can be assisted by rotary hoeing and/or broadcasting urea during the final preparation period.

Potatoes do not grow well in compacted soil and cultivation methods which require a considerable number of passes with heavy machinery should be avoided. The correct machinery for potato land preparation is most important, and in many instances crawler-type tractors are preferred on compaction-prone soils.

Rate of planting

The optimum planting rate under a particular farm situation can only be determined by the farmer himself, and his experience over a few seasons will be his best guide.

The normal planting rate is in the range of 1 200 to 1 900 kg per ha. The heavier rates are usually for machine-cut seed for the main spring crop when growing conditions are better than during autumn or summer. This applies particularly to Sequoia.

Some varieties such as Kennebec may have to be planted at higher than normal on fertile soils to avoid oversize tubers.

Row width

The normal row width in southern Queensland is 76 to 86 cm which suits most specialized potato machinery. Provided that the same quantity of seed is planted per ha and the width suits the machinery available, variation in yield has not been of any consequence within this range.

Plant spacing

The normal distance between planted setts ranges from 20 to 30 cm dependent on row spacing, seed piece size and seed price.

Seed piece size

Many growers of larger potato crops either own an automatic seed cutter or have access to one. Only on the smaller farms is seed cut by hand. The size of the sett depends on the size of the tuber and can range from 20 to 30 g for single eye setts to 40 to 60 g for multiple eye setts. Single eye setts have to be cut by hand.

Certified seed used for late winter and spring crop plantings is cut prior to planting whereas for autumn and early winter plantings largely whole seed of 50 to 100 g is used from cool-stored material held over from the spring crop.

Planting depth

This varies according to the type of seed piece to be planted and soil type. The normal depth range is between 5 and 13 cm. A general rule of thumb is to plant small setts at a shallow depth and larger setts more deeply.

Deep planting is more desirable for rain-grown crops than for irrigated crops. The seed pieces should be planted deeply enough to ensure that they have ample moisture without being so deep that emergence is difficult.

The method of planting also has a bearing on planting depth; many farmers ridge-up at planting whereas others follow with this operation later.

Sprouting

All seed should have commenced to sprout at planting.

Potato planters

The most common potato planters in use are double row planters, either cup or needle type. The newer planters are fully automatic and can be a one-man operation. On larger farms, a second operator fills seed and fertilizer hoppers for a more rapid turnaround.

Cup type planters are preferred as there is a risk of spreading disease from one seed piece to the other through the needle wheel of needle type planters.

There are some single row planters still in use but these are gradually being phased out. The four row planter available in southern States has not become popular in Queensland.

Growing the crop

Cultivation

The objectives in cultivation are to destroy weeds and to hill the rows to provide a soil covering for the developing tubers. A satisfactory soil cover is particularly desirable under Queensland conditions to prevent greening and to minimize potato moth damage. Improvement of soil aeration and internal drainage may also be involved, while hilling facilitates harvesting on heavier soils.

The first cultivation should be carried out as soon as weeds emerge; this not only controls weeds but eliminates any surface crusting which may have developed.

It is usual to flatten the hills with peg tooth or tickle type harrows followed by rehillng and inter-row cultivation as soon as weed seedlings are dead. These operations are carried out several times until emerged potatoes are 5 to 10 cm high.

An alternative to this system is the use of rolling cultivators which can be set either to cut away or to hill up to achieve the same result. These cultivators can be fixed to any three-point linkage toolbar and effectively control weeds and break surface crusts.

Hills are sometimes rolled either at, or immediately following, planting to compact the soil around the seed pieces.

Inter-row cultivations are usually incorporated with hilling using deeper tines in the middle. The final

hilling should take place as soon as possible after all plants have emerged. Late hilling can cause a considerable reduction in yield through damage to developing tubers, while hilling too early has a smothering effect on young plants.

All cultivation should cease when tubers start to set and this can, in many instances, be well before flowering.

All tractor operations following planting should be carried out using narrow tractor wheels. Tyres may be either steel fitted with spuds or special narrow pneumatic rubber tyres. Steel types are preferred on the heavier alluvial soils. If wide tyres are used, considerable yield reductions can result due to compaction and damage to developing tubers. In addition, damage to foliage can result.

Herbicides

Due to the need to hill the crop, inter-row cultivation continues to be the main form of weed control. Some potato growers, however, use herbicides either to reduce the number of cultivations or to control weeds which are hard to kill.

The most commonly used herbicides are linuron, metribuzin and paraquat. Information on these and other herbicides used on potatoes in 1980 is contained in table 4.

The use of herbicides can be a problem due to residual effects on following vegetable and grain crops. This should be considered carefully when selecting a herbicide.

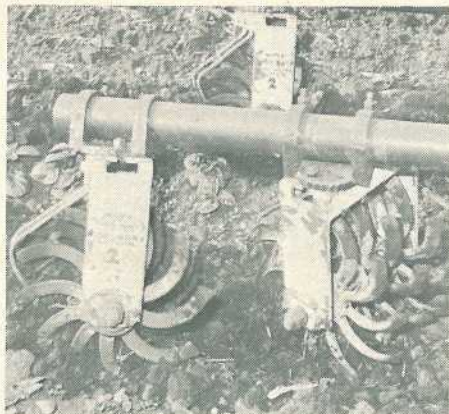
Crop requirements

The yield of potato tubers is related to the amount of plant food available for storage over and above the requirements of the plant for growth. Adequate mineral nutrition to ensure vigorous carbohydrate assimilation rates is extremely important.

The amount of solid matter deposited within the tubers has a marked effect on the eating and processing quality of potatoes.

Soil requirements

Potatoes can be grown on any well-drained, sandy to clay loam soil of reasonable fertility. Most potatoes in southern Queensland are grown on the deep, self-mulching, alluvial clay loams of the Lockyer, Brisbane and Fassifern Valleys. The heavier alluvials are not favoured for potato production. Shallow, sandy soils overlaying clay subsoils should be avoided due to waterlogging problems.



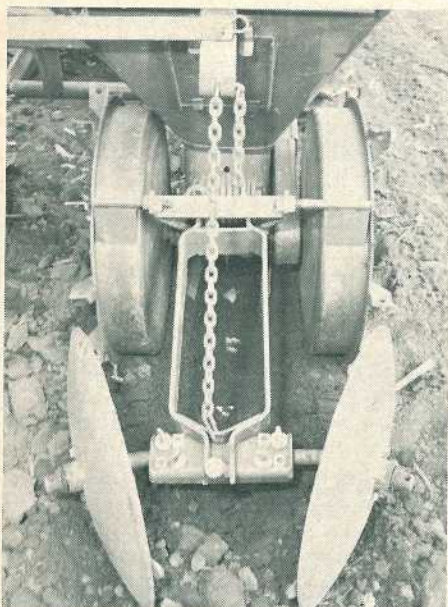
Close up of rolling cultivator gangs.



Cultivation and hilling using rolling cultivators.



Cup type potato planters use holders to separate individual setts for uniform plant spacing. A double row planter is illustrated.



Uniform spacing of potato sets in the drill by a cup type planter.

Potatoes are also grown on the red loams of the Redland Bay area, the sandy loams in the coastal areas to the north of Brisbane, the red loams of the Tent Hill and Mt. Sylvia areas and the red volcanic loams around Killarney.

Potatoes generally prefer a slightly acid to neutral soil (pH 6.0 to 7.0) reasonably well supplied with organic matter. The use of gypsum at the rate of 4 to 5 t per ha on the self-mulching, alluvial potato soils is of benefit in reducing clod size and improving soil structure generally. This effect lasts for 2 to 4 years depending on application rates and cropping systems. Deep ripping of these soils results in only short-term benefits and is generally not worth the expense.

Soil erosion control practices should be implemented on the steeply sloping lands.

Nutrition

A 25 t per ha crop removes about 90 kg of nitrogen, 12 kg of phosphorus, and 120 kg potash from the soil.

NITROGEN. Any deficiency in nitrogen causes stunted growth, crop yellowing, leaf rolling and early maturity in potato crops. Provided phosphorus and potassium are in adequate supply, added nitrogen provides a marked increase in vegetative growth and in the size and dry matter content of tubers. If excess nitrogen is applied late in the growing season to a healthy crop, delayed maturity, excessive vegetative growth and a lowering of quality can result.

Part of the crop's nitrogen requirements are normally applied in high analyses mixed fertilizers. Additional nitrogen is usually applied in the form of urea but on alkaline soils, sulphate of ammonia can be more effective. Aqua ammonia can also be used where bulk supplies and applicators are available. The relative small size of individual potato plantings favours use of solid forms of nitrogen.

PHOSPHORUS. Applied phosphorus becomes available to plants only relatively slowly, and the phosphorus fertilizer requirements must be applied very early—preferably at planting.

Adequate phosphorus increases the number rather than the size of tubers, shortens the growing season and improves quality. Excessive applications of applied phosphorus could reduce yield. Phosphorus deficiencies result in stunted, very dark green plants.

The dark grey alluvial soils of the West Moreton district are usually fairly high in phosphorus, but scrub soils, the red loams of Redland Bay, the South Burnett district, Killarney and the near North Coast are usually low.

POTASSIUM. Potatoes need a large amount of potassium and deficiency symptoms usually become obvious at bulking up or filling out of tubers. The leaves become bronzed and show a distinctive crinkling and

firing or burning of the leaf edges. Potash deficient plants are also more susceptible to disease.

Potassium sulphate is the form preferred due to the high chloride levels in muriate of potash. The alluvials of the West Moreton district are normally well endowed with potassium.

CALCIUM. Apart from being an important plant food in itself, calcium improves soil structure and neutralizes soil acidity. Most of the soils used for potatoes in southern Queensland are neutral and do not usually require lime or dolomite. In general, the pH should be below 5 before calcium, either as lime or dolomite is applied. Trace elements such as boron, copper, manganese and zinc become less available where the soil pH is higher than 6.5.

ZINC. Applications of zinc may be beneficial where zinc soil levels fall below 2 p.p.m. This may be applied as a foliar spray as zinc sulphate heptahydrate at the rate of 840 g per ha in one to two sprays or soil application pre-plant of 30 kg per ha.

Application of other micro nutrients such as sulphur, boron and magnesium is rarely necessary. The use of sulphate fertilizers in the case of sulphur and foliar sprays of boron and magnesium can be used to rectify deficiencies.



Removing weeds and tops with a pulveriser before harvesting.

TABLE 4
Herbicides for Potato Crops

Trade Name	Common Name	Time of Application	Rate	Susceptible Weeds	Resistant Weeds
Eptam	EPTC	Pre-plant (incorporated)	5.5 L/ha of 720 g/L product	Nut grass, fat hen, and some annual grasses	Most broad-leaved weeds
Dacthal	chlorthal-dimethyl	Post planting pre-emergence	6 to 15 kg/ha of 750 g/kg product	Many annual grasses and broad-leaved weeds	Galinsoga, mustards, clovers, wild oats, nut grass
Afalon Linuron 50	linuron	Post planting pre-emergence	2.2 to 4.5 kg/ha of 500 g/kg product, higher rate for heavier soils	Many annual grasses and small-seeded broad-leaved weeds	Large-seeded broad-leaved weeds
Gramoxone Shirquat	paraquat	10–25% emergence	2.8 to 4 L/ha of 200 g/L product	A wide range of grasses and some broad-leaved weeds	Established perennial weeds including nut grass
Gramoxone Shirquat	paraquat	1 week before digging	3.5 L/ha of 200 g/L product	As above. Also destroys potato top growth	As above
Lexone 70 Sencor 70	metribuzin	When weeds have emerged and the crop is no more than 15 cm high	500 to 1 000 g/ha of product 700 g/kg	Most broad-leaved weeds and grasses. Use higher rates on grasses in summer crops	Established perennial weeds including nut grass. Poor control of common sow thistle (milk thistle)

NOTE.—Check the container labels for residual effects on subsequent crops; e.g. metribuzin has a 6-month residual effect on crops such as onions, cucurbits, brassicas, sunflowers, and lettuce.

Fertilizer recommendations

The main fertilizer requirement for potatoes on black soil alluvials is nitrogen. However N:P:K mixtures such as 17:3:6, 15:3:10, 13:2:13, 15:4:11 or 10:2:8 are recommended to ensure adequate levels of phosphorus and potassium under the intensive cropping systems commonly used.

If phosphorus is marginal as on the lighter soil types, a mixture such as 12:14:10 or 11:12:17 should be used.

Fertilizer mixtures should be applied as a band at planting at a distance of 5 cm to the side and slightly below the seed piece. The application rate varies from 350 to 650 kg per ha.

Further nitrogen should be applied within a month of emergence, but the earlier the better. The rate applied varies from 80 to 130 kg of nitrogen per ha. This sidedressing can be applied in a band or spun on prior to irrigation or hilling. The amount of nitrogen sidedressed should be related to the quantity applied as a basal mixture. As a general rule of thumb total nitrogen applied should be around 150 kg per ha and should not exceed 200 kg per ha.

In special circumstances such as very high initial soil nitrogen or set backs such as frost, the rate of nitrogen applied should be lowered or raised accordingly.

The use of fertilizers containing trace elements and some major plant nutrients is widespread. The value of their use is doubtful. They are normally applied at the same time as insecticides or fungicides.

Crop rotation

Most potatoes in southern Queensland are grown under an intensive cropping situation on high-priced land with an average farm size in the vicinity of 30 to 40 ha.

In most cases, two crops a year are grown on the same land. Following the introduction of quick-growing processing crops such as French beans, three crops are possible within the 1 year.

In other potato-growing areas in Australia, land is spelled from potatoes systematically for periods of 2 to 4 years. This seldom occurs in

southern Queensland. It is a common practice on the dark grey alluvial soils to grow potatoes on the same land for several years in succession.

The only practical long-term rotation crop available is lucerne. Under commercial conditions, however, the lucerne on potato-growing farms is usually a separate crop, planted in 3 to 4 ha areas and not always in direct rotation with potatoes.

The choice of rotations is limited as potatoes and many other vegetables cannot be grown within the main production area of the West



Hand harvesting following a mechanical digger. The drums are emptied into branded sacks.

Moreton during summer. The annual crops available are grain sorghum, sunflower, soybean, French beans, maize and sweet corn.

The best rotation crops for disease prevention are grain sorghum, maize and sweet corn. *Sclerotinia* stem rot can build up under crops such as sunflowers, soybeans and French beans.

The practice of ploughing in green manure crops such as cowpeas, lab lab, fodder sorghum or ratooned grain sorghum is to be commended but is rarely practised because these crops provide no direct cash return. The organic matter returned to the soil from a green manure crop has the effect of improving soil structure. This results in fewer clods and better water infiltration.

Ploughing in large quantities of undecomposed dry stubble and trash just prior to planting should be avoided as it leads to a build-up of soil borne fungi, particularly *Rhizoctonia*. Any excess stubble can be baled.

Other crops grown in conjunction with potatoes and sometimes in rotation but often as separate crops on heavier soil types within the farm unit are onions, pumpkins, cabbages,

cauliflowers, broccoli, processing vegetables (beans, peas and sweet corn), winter grains and millets.

Irrigation

Potatoes require adequate moisture to maintain rapid growth for setting and filling of tubers. Moisture requirements taper off towards maturity and the critical periods are planting, tuber initiation and during filling out or bulking up of tubers. Water stress at these crop growth stages results in low yields, misshapen or growth-cracked tubers, and internal discolouration.

Excess irrigation should also be avoided as wet conditions favour diseases such as blackleg, powdery scab and wilts. Skin blemishes and enlarged lenticels which spoil the appearance of the tubers and reduce their marketability can be induced by excess soil moisture.

The most common system of irrigation used is the medium pressure, hand shift spray type. The solid set system is gaining in popularity, particularly in early crops in which the irrigation system is also used for frost protection. Travelling irrigators are also used.

A recent trend is the integration of these different spray systems. Sometimes the crop is watered until hilling stage with portable irrigation pipes after which a solid set system may be installed. The solid set may then be transferred to a later planted paddock when the first crop approaches maturity. Irrigation of the early crop may then be completed with the travelling irrigator at night to take advantage of lower electricity tariffs.

Routine irrigations every 7 to 10 days should be commenced after emergence and carried through until the tubers have filled. Usually 30 to 50 mm is applied at each irrigation, but on lighter soils and with solid set during the winter, frequent, lighter irrigations are more suitable.

Irrigations water should be of reasonable quality—not more than 300 to 600 p.p.m. chloride. Potatoes will tolerate up to 800 p.p.m. chlorides on the lighter alluvials provided some rain falls during crop growth. Reduction in yield and foliage burn results if high chloride water is applied. Irrigation water with above 600 p.p.m. chloride is best applied at night and under relatively still conditions to minimize burn.



A local carrier picking up bagged potatoes. Potatoes destined for interstate markets are normally transferred to semi trailers.



Solid set sprinkler irrigation of potatoes. This method can also be used to minimize frost damage.

Crop protection

Many pests and diseases attack the potato plant in southern Queensland.

Both chemical and cultural control measures are used, particularly in potato moth control where adequate hilling plus regular irrigation to close cracks in the soil plays an important role as soil cracks allow the pest ready access to the tubers. Damage usually begins at the eyes and, as the infestation develops, tunnelling will rapidly render infested tubers unfit for market. The destruction of self sets following a potato crop reduces the possibility of carry-over diseases such as leaf roll virus and pests particularly potato moth.

Chemical control starts with the seed and if *Rhizoctonia* is a problem, whole seed can be dipped in a mercury based solution. This should be done well before cutting and before the eyes have sprouted. Severe burning can result from improper use of mercury dips.

Cut seedpieces can be treated against seedpiece breakdown by dusting with a 40% mancozeb dust at a rate of 500 g per 50 kg seed following cutting. Dust tends to cause problems at planting with build up on the planting cups.

Cut seedpieces which have not been dusted should be planted as soon as possible after cutting.

If aphids are present, insecticides should be applied when 75% of the plants have emerged. This prevents these sucking insects infecting the crop with diseases, particularly leaf roll virus, early in the life of the crop.

The main insect pests in potatoes are aphids, potato moth and mole crickets. There are adequate chemicals available to control aphids and potato moth but at this stage chemical recommendations for the control of crickets are not practicable. Sprays should be applied at the first signs of pest attack. Treatment as often as every 7 to 10 days may be necessary.

The insecticide most commonly used by potato growers is methamidophos which controls both aphids and potato moth. The fungicide mancozeb is usually mixed with it from hilling up to control the leaf diseases, mainly target spot.

Fungicides should be applied routinely at 7 to 10-day intervals as

a preventative measure, starting when the crop is 5 to 15 cm high. Fungicides are normally applied in conjunction with insecticides.

The general practice is to spray with a ground rig boomspray up to tuber initiation using tractors fitted with narrow steel or rubber tyres. From tuber setting onwards, many growers prefer to spray by aeroplane to avoid compaction, foliage damage and subsequent yield loss.

Insecticide/fungicide sprays should be applied at the correct pressure and quantity to ensure adequate coverage of foliage. The quantity of water applied varies with plant growth, but for high volume spraying it should be at least 375 to 500 L per ha. Boom sprays should be fitted with hollow cone nozzles all of the same output, and the nozzles should be checked regularly.

Pest and disease control recommendations current in 1980 are found in tables 5 and 6.

Frost, hail and wind damage

The winter and spring crops in southern Queensland are prone to this type of damage.

The use of additional nitrogen applied as urea through irrigation shortly after damage occurs, has proved successful in salvaging damaged crops.

Solid set irrigation in conjunction with temperature alarms set at -2°C , have proved valuable as a means of minimizing frost damage.

Wind damage can reduce yields, particularly if it occurs during the bulking up stage. Irrigation at 4 to



Pest and disease control with a boom spray.

5-day intervals may be necessary during prolonged periods of dry westerly winds to maintain adequate soil moisture.

Similarly, if the crop is set back by disease during this period, treatment with nitrogen and irrigation can improve the yield situation. Nitrogen, however, should never be applied to a healthy, undamaged crop in the latter stages of maturity.

Harvesting

The bulk of potatoes in southern Queensland is harvested in a slightly immature or new grade condition. This applies particularly to the

winter and spring crops. The autumn crop is either harvested as new grade or can be stored in the ground, according to the market.

The yield potential of a potato crop peaks at full maturity. Harvesting 10 to 14 days prior to full maturity can result in a much lower yield as the smaller tubers do not fill. The full yield potential is rarely obtained because of the market and other factors such as storm rains, high temperatures and diseases.

Very immature potatoes are easily bruised and can blacken where the skin has been removed. These tubers must be harvested under moderately moist soil conditions and the digger or harvester operated at a slow speed

to minimize damage. A good flow of soil should pass over the digging chains and the speed regulated to stop tuber bounce during harvest. If the soil is dry, hard clods cause a high level of mechanical injury.

Tops or haulms have often yellowed and died back with disease (usually target spot) by harvest time. Weeds, grasses and tops are usually slashed or pulverized mechanically immediately prior to harvest. This is particularly necessary in the spring crop when the practice is to allow weeds to establish prior to maturity to remove excess moisture from storm rains. In some instances, dessicants such as paraquat and diquat are sprayed to kill the tops and weed growth.

TABLE 5

Disease Control Recommendations—Potatoes

Disease	Chemicals	Some Trade Names	Rate/Remarks
Irish blight	mancozeb	Mancozeb, Manzato 200, Manizon A, Dithane M-45	150–200 g of 800 g/kg product per 100 L or 1.7–2.2 kg/ha
	maneb	Maneb, Manzinc, Brymazine	150–200 g of 800 g/kg product per 100 L or 1.7–2.2 kg/ha
	zineb	Zineb, Curit	175–250 g of 800 g/kg product per 100 L or 1.7–2.2 kg/ha
	metiram	Polyram combi, Polyram 2000	150–200 g of 800 g/kg product per 100 L or 1.7–2.2 kg/ha
	propineb	Antracol	150–200 g of 800 g/kg product per 100 L or 1.7–2.2 kg/ha
	captafol	Difolatan wettable powder Difolatan flowable, Difolatan 50 Flocol	1.9 kg of 800 g/kg product per ha 3 L of 480–500 g/L product per ha
	copper oxychloride	Copper oxychloride, Oxydul, Cuprox, Cupravit, Cobox, Copper 50, Green Copper 50	500 g of 500 g/kg product per 100 L
	zineb-copper oxychloride	Copper curit Zinox Zinocop	350 g per 100 L, 3.5 kg per ha 250 g per 100 L, 4.0 kg per ha 350 g per 100 L, 4.5 kg per ha
	maneb-copper oxychloride	Man-cop	350 g per 100 L, 4.5 kg per ha
Target spot (Early Blight)	as for Irish Blight plus chlorothalonil and Dek	Bravo W75 Bravo Flowable Dek	1.1–1.7 kg/ha or 100–150 g per 100 L 1.1–1.8 L per ha or 100–160 ml per 100 L 150 g per 100 L or 2.2–3.5 kg/ha
Seedpiece breakdown	mancozeb	Potato seed dust, Mancozeb potato seed dust	Use at 500 g/50 kg seed. Thoroughly dust entire surface of the seedpieces. Alternatively, a dust can be made up on the farm by mixing one part of mancozeb 80% product with one part of kaolin. Dust entire sets
Tuber borne diseases (including Rhizoctonia)	methoxy ethyl mercuric chloride, penyl mercuric acetate	Cane-tan, Shirtan, Aretan, Adstan	1 kg or 1 L of 6% mercury product per 4 t of seed (concentration 250 g or 250 ml of 6% product in 100 L of water). Seed dipped as per label directions
Sclerotinia rot	benomyl	Benlate	100 g per 100 L or 1.1 kg/ha
Storage rots	thiabendazole	Tecto Flowable	1 L per 20 L per 10 t as a mist
Powdery scab	quintozene	Quinten, Purasoil, Terraclor	Apply quintozene 75% at 44 kg/ha mixed with fertilizer at planting so as not to contact seedpieces. Avoid susceptible cultivars and use only resistant Exton, Kurrell and Pontiac or partially resistant Sebago, Kennebec or Bungama
Bacterial wilt (milky eye)	Use certified seed, rotate with cereal crops		
Black leg	Use certified seed		

TABLE 6

Pest Control Recommendations—Potatoes

Pest	Pesticide	Commercial Preparations	Rate of Use of Commercial Preparation	With-holding Period
Green peach aphid	methamidophos	Bayer Nitofol Insecticide Spray 580 g/L Lane Monitor Insecticide 290 g/L	550 ml of 580 g/L per ha 1.1 L of 290 g/L per ha	7 days
Cutworms <i>Agrostis</i> spp.	trichlorfon	Nufarm Lepidex Insecticide (600 g/L)	80 ml/100 L	2 days
Green vegetable bug <i>Nezara viridula</i>	monocrotophos	Nuvacron 40 Systemic Insecticide 400 g/L	1 L of 400 g/L per ha	3 days
Leaf-eating ladybird <i>Henosepilachna sparsa</i>	carbaryl	Barmac Carbene Liquid Insecticide 500 g/L Septene Liquid 500 g/L Septene 80 800 g/L Bugmaster 80 800 g/L	200 ml of 500 g/L/100 L 2.2 L of 500 g/L per ha 125 g of 800 g/kg per 100 ha 1.4 kg of 800 g/kg per ha	3 days
Leaf hoppers	dimethoate	Campbell Chloropest E.C. Insecticide 300 g/L Lane Rogor Insecticide 300 g/L Nufarm Dimethoate Systemic Insecticide 400 g/L BASF Perfekthion E.C. 40 Systemic Insecticide 400 g/L Barmac Go-Mite Insecticide 400 g/L Rogor Diostop Insecticide Spray 400 g/L Cygon 400 E Insecticide 400 g/L G.F. Thion E.C. 40 Systemic Insecticide 400 g/L	100 ml of 300 g/L/100 L 75 ml of 400 g/L/100 L 780 ml of 400 g/L/ha	7 days
Loopers	methomyl	Du Pont Lannate L Insecticide Water Miscible Liquid 225 g/L	1.5 L of 225 g/L per ha	..
Potato moth <i>Phthorimaea operculella</i>	acephate	ICI Orthene 75 Soluble Powder Insecticide 750 g/kg	660 g of 750 g/kg/ha	3 days
	azinphos-ethyl	Bayer Gusathion A Liquid Insecticide Spray 400 g/L Lane Kilathion Insecticide 400 g/L	1.1 L of 400 g/L/ha 100–125 ml of 400 g/L/100 L	14 days
	chlorfenvinphos	Shell Birlane 50 Insecticide 500 g/L	50 ml of 500 g/L/100 L	1 day
	methamidophos	Bayer Nitofol Insecticide Spray 580 g/kg Lane Monitor Insecticide 290 g/L	700 ml of 580 g/L/ha 65 ml of 580 g/L/100 L 1.4 L of 290 g/L/ha 130 ml of 290 g/L/100 L	7 days
	methomyl	Du Pont Lannate L Insecticide Water Miscible Liquid 225 g/L	1.5–2 L of 225 g/L/ha	..
	monocrotophos	Shell Azodrin 400 Systemic Insecticide 400 g/L Nuvacron 40 Systemic Insecticide 400 g/L	1 L of 400 g/L/ha	3 days
	rotenone (Derris)	Crop King Agricultural Chemicals Derris Dust Insecticide	250 g of 7.5 g/kg rotenone/bag	1 day

Harvesting machinery

Most of the crop is still harvested with double-row, chain conveyor type diggers with contract hand labour picking up the dug potatoes into bags or bins. The speed of digging varies with the soil type, moisture and weed growth. Drops from elevators should not exceed 15 cm, and sharp corners and deflectors should be padded.

Mechanical harvesters have been tried but at the present time their use is limited. Their main disadvantage is the slow throughput and the number of people necessary to remove clods. Growers with harvesters tend to use them for harvesting the autumn crop and revert to hand labour under contract for the winter and spring crops.

On the lighter creek bank soils, light weight harvesters pulled by four-wheel-drive tractors are used to harvest potatoes during wet periods when potato prices are higher.

Contract potatoes for local and Brisbane processors are mostly handled by mechanical harvesters but these crops are mainly on the lighter soils.

The bulk of potatoes is harvested into chapman sacks and hand sewn in the paddock. Grading is carried out during the operation when pickers separate the marketable tubers from greens, potatoes with growth cracks and small potatoes. The latter group are placed into bags or bins as seed. Potatoes with rots and/or tuber moth are left in the field.

Potatoes are not brushed or washed prior to being sold and consequently the amount of soil adhering to the potato varies with soil conditions at harvest.

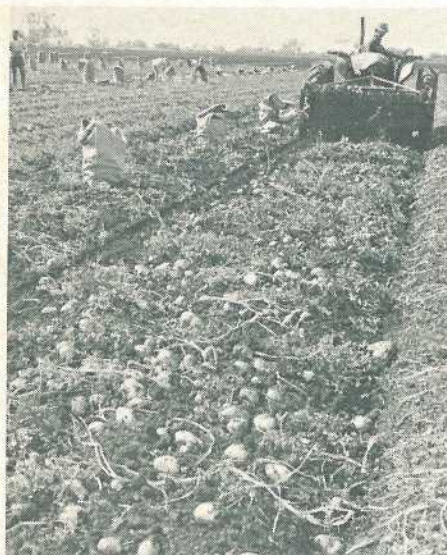
Some farmers are now packing into 50 kg sacks which are machine sewn and easily palletized. This means fast

loading of semi-trailers, quick unloading at the destination and less handling damage since fork lifts can be used.

Some potatoes destined for processing works and pre-packers are being harvested into half tonne bulk bins. Southern processors still require bagged potatoes in case they have to be resold for table use.

Grading

Regulations relating to maturity, size, freedom from blemishes, disease breakdown, mechanical injury and adhering soil cover the marketing of potatoes in Queensland. The main problems are mechanical injury, rots, greening, dirt, potato moth injury and mole cricket damage. Care should be taken to ensure that pickers reject potatoes falling into these categories and remove adhering dirt from tubers.



A double row potato digger in action.

Potatoes which do not meet these standards are either condemned or seized for picking over and re-grading. Potatoes appearing on the market which do not comply with these standards cannot be returned to the grower or his agent.

Grades currently in operation in Queensland are:

No. 1 Grade—to weigh not less than 80 g nor more than 350 g, that are sound, of similar varieties and having a mature skin.

No. 1 Large Grade—to individually weigh not less than 250 g, that are sound, of similar varieties.

No. 1 Small—to individually weigh not less than 30 g nor more than 100 g, that are sound, of similar varieties.

Cocktail Grade—to individually weigh not more than 30 g, that are sound, of similar varieties.

New Grade—to individually weigh not less than 50 g nor more than 350 g, that are sound, of similar varieties with an immature skin.

No. 2 Grade—to individually weigh not less than 70 g, that are sound, of similar varieties; that are practically free of soft rots and greening; that are reasonably free of dirt and other foreign matter, deterioration due to storage, sprouting, glassy end, any abnormal condition of damage or growth and damage from insects and diseases; that may be affected with second growth, scab, growth cracks and mechanical damage any of which may be removed without appreciable loss in the ordinary process of peeling.

Potatoes for sale must have the grower's initials, name and address stencilled on the outside of the bag followed by the grade as prescribed in the regulations. The stencil figures should not be less than 20 mm in height.

Processing requirement

Potatoes can be processed as French fries or chips, crisps, and dehydrated potatoes.



Sorting and bagging are carried out while the harvester is operating.

Processors, in general, require an easy to peel, good length potato of high solid matter, low reducing sugars and shallow eyes which cooks to a golden brown without blackening. They usually rely on the solid matter content or specific gravity (S.G.) to determine quality.

A common rule of thumb is that potatoes of S.G. 1.065 or higher are mealy and floury after boiling, and fry and crisp without blackening. Potatoes under S.G. 1.065 are firm after boiling and non mealy; they are not suitable for frying or dehydration, but are suitable for the salad trade and canning.

Marketing

Most potatoes are sold through local merchants, in chapman sacks on an on-farm basis. Price is usually negotiated over the telephone subject to an inspection confirming quality and variety. Prices are on a daily basis determined by Sydney sales at that time.

At times, considerable premiums are paid for Sebago and, to some extent, Exton. During periods of shortages, the gap between varieties narrows and conversely during gluts, poorer quality varieties such as Bungama and Kurrel become virtually unsalable.

A small percentage of the crop is grown under contract or by private treaty for processing companies and handled in company bulk bins. However, the bulk of processing potatoes are purchased in the usual manner by local merchants on a daily price basis.



A mechanical potato harvester drawn by a four-wheel-drive tractor.

Horticulture in Central Queensland

by P. L. Deuter and A. T. Jordan, Horticulture Branch

The Central Queensland horticultural region extends from near Bustard Head on the coast just south of Gladstone to near Carmila just south of Mackay. It extends inland along the Tropic of Capricorn and includes the areas of the Central Highlands and Central West.

The region is divided into four districts, namely, Central Coast, Dawson/Callide, Central Highlands, and Central and Far West. The shires in each district are listed in table 1. Map 1 shows the location of the region within Queensland.

Rockhampton is the major centre of population and, together with the rapidly growing port city of Gladstone, serves an immensely rich mining, pastoral and grain growing region.

Most horticultural production is confined to the Central Coast district Shires of Livingstone, Fitzroy, and Calliope. These areas were developed originally in the late 1800s to supply fresh fruit and vegetables for local consumption. Further development occurred as miners looked for alternative incomes after the decline of mining in the 1920s and the large scale immigration of the 1930s and 1950s.

Relative freedom from frosts allows for the production of crops through the winter. This has resulted in the development of tropical fruit industries, and the growing of small crops during the winter and early spring.

The main producing areas of the Central Coast are Yeppoon (pine-apples, avocados, mangoes, small crops), Byfield (citrus, papaws, bananas, avocados), Gracemere/Bouldercombe (small crops, citrus), Yarwun (papaws, small crops, mangoes) and Calliope/Boyne Island (small crops, papaws).

In the Central Highlands, Central West, and Dawson/Callide areas, small plantings of fruit and vegetables are made to meet local demand. The growing of beans for seed production is a new, but expanding industry in the Dawson/Callide district.

Climate

The climate in the coastal and subcoastal areas is mainly tropical. Winters are usually short and mild and only low-lying areas are frosted. Summer temperatures are high and tend to limit small crop production.

Along the coast, the annual rainfall varies from 1 000 mm at Rockhampton to over 2 200 mm at Byfield. Approximately two-thirds of

the annual rainfall is registered between November and April.

Summer storms occur in November and December and monsoonal rains fall in January and February. Heavy rain and strong winds associated with cyclones are often experienced at that time of year. Winter and spring rains are erratic and not usually sufficient to satisfy crop needs. Irrigation is necessary in these periods.



Map 1. The Central Queensland horticultural region.

The climate in inland areas is not conducive to horticultural production. A hot summer and cold winter limit production to the autumn and spring months.

Climatic data for Rockhampton, Gladstone, Biloela, Emerald and Yeppoon are shown in Table 2.

Soils

A wide variety of soil types is used for growing horticultural crops in Central Queensland.

In the Yeppoon area, the two main soil types used are the shallow to medium duplex soils with mottled yellow or grey clay subsoils, and the shallow to medium red duplex soils with red clay subsoils. Both soil types are naturally acid. Deficiencies of zinc, magnesium, molybdenum and boron are common. Some of the red soils are rich in manganese and a toxicity sometimes occurs.

Both soil types are used for pineapple growing, while the red soils are used mainly for other crops.

In the Byfield area, three different soil types are used for horticulture.

A well-drained, decomposed granitic soil with massive granite outcrops predominates in the hill country. This country is used for growing bananas, papaws, and avocados. A dark alluvial loam found along creeks, and a shallow to medium depth grey duplex soil with a mottled yellow clay subsoil are both used for citrus.

District	Shires
1. Central Coast.....	City of Rockhampton, City of Gladstone, Shires of Broomsound, Fitzroy, Livingstone, Calliope, Mt. Morgan, and Duaringa (north of the Dawson Range and east of a line through Dingo township).
2. Dawson/Callide	Banana and Duaringa (south of the Dawson Range).
3. Central Highlands	Bauhinia, Emerald, Belyando, Peak Downs, and Duaringa (north of the Dawson Range and west of a line through Dingo township).
4. Central and Far West.....	Tambo, Blackall, Jericho, Barcaldine, Aramac, Isisford, Ilfracombe, Longreach, Barcoo, Diamantina.

Soils in the Gracemere-Rockhampton area are predominantly yellow or grey duplex associated with small pockets of red duplex. While both are used for horticulture, the red duplex is favoured. Around Yarwun, yellow and grey duplex soils of predominantly granitic origin are the main types. Closely associated with these soils are pockets of acid red duplex soils and some red earths. Papaws and small crops are grown on all soil types.

Two soil types predominate in the Dawson-Callide area. The first is a deep alluvial clay soil with a thin clay loam or loam surface layer, usually dark grey, or brown, in colour. The second is a grey to

brown medium depth, cracking, clay soil. Both types are used for horticultural crops.

Horticulture in the Central and Far West is generally confined to alluvial soils along river banks. These vary from very deep sandy soils at Barcaldine, to dark heavy clays near Longreach.

The soil of most commercial interest in the Central Highlands is a deep red earth that has a gravel base and is extremely well-drained.

Irrigation

Irrigation is generally considered essential for successful production of most horticultural crops, particularly during the dry winter and spring

TABLE 2
Climatic Data for Central Qld. Horticultural Region

—	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean for Year
Average mean temp. (°C)													
Rockhampton.....	32.2	31.5	30.7	29.0	26.3	23.6	23.1	24.8	27.6	29.9	31.4	32.2	28.6
Gladstone.....	29.8	29.7	29.1	27.6	25.2	22.8	22.1	23.0	24.8	26.7	28.1	29.5	26.6
Biloela.....	33.6	31.9	31.0	28.4	25.3	21.8	21.6	24.1	27.1	29.8	31.9	33.0	28.3
Emerald.....	35.1	33.9	32.5	29.9	26.2	23.1	22.7	25.1	28.4	32.1	34.2	35.2	29.9
Average max. temp. (°C)													
Rockhampton.....	27.3	26.9	25.8	23.6	20.4	17.9	16.9	18.2	21.1	23.8	25.7	26.9	22.9
Gladstone.....	26.1	25.8	25.0	22.9	20.2	17.8	16.7	17.7	19.8	22.3	24.1	25.6	22.0
Biloela.....	26.7	25.4	24.1	20.4	17.2	14.0	12.9	14.4	17.5	21.2	23.9	25.6	20.3
Emerald.....	28.3	27.6	25.9	22.6	18.6	15.8	14.8	16.3	20.2	24.0	26.5	27.8	22.4
Average min. temp. (°C)													
Rockhampton.....	22.4	22.3	21.0	17.9	14.6	12.2	10.7	11.6	14.6	17.8	20.0	21.6	17.2
Gladstone.....	22.3	21.9	20.9	18.2	15.1	12.8	11.3	12.3	14.8	17.9	20.1	21.6	17.4
Biloela.....	19.7	19.0	17.0	12.4	9.0	6.3	4.3	4.8	8.0	12.6	16.0	18.1	12.3
Emerald.....	21.5	21.2	19.3	15.2	11.1	8.6	6.8	7.5	11.8	15.8	18.9	20.6	14.8
Average monthly rainfall													
Rockhampton.....	166.6	207.5	111.8	63.2	42.2	54.4	46.2	18.0	22.1	48.0	64.5	98.6	943.1*
Gladstone.....	158.4	217.1	132.0	58.6	45.2	58.1	53.0	20.5	24.8	65.2	83.5	109.9	1 027.1*
Biloela.....	105.9	124.4	70.1	41.4	41.9	39.3	32.0	17.5	20.0	54.8	71.8	92.7	712.2*
Emerald.....	92.4	114.0	70.6	33.7	27.4	32.0	31.2	13.7	17.5	41.6	70.8	81.2	626.8*
Yeppoon.....	195.5	259.8	163.5	81.5	57.9	71.3	47.4	21.3	29.7	50.0	61.2	118.1	1 157.2*

* Total for year.



Pineapples are the major horticultural crop grown in the region.

periods. At this time, small crops need water for establishment and maintenance, while most tree crops require it for flower production and fruit set. Water stress can reduce cropping quite markedly.

The main local exception is pineapples. This crop is grown almost entirely without irrigation. However, a few growers occasionally irrigate to ensure even establishment or to maintain plants for early fresh fruit production.

Only about 40% of the papaw area is irrigated. Drip or fixed overhead sprinkler systems are most commonly used.

Most plantings of avocados are irrigated by under tree sprinkler or movable sprinkler line systems. By comparison, less than 30% of the mango area, and only about 50% of macadamia plantings are irrigated. Once again, movable sprinkler lines and under tree sprinklers are most favoured.

Most citrus plantings are irrigated either by fixed overhead sprinklers or movable sprinkler lines.

Grape plantings are irrigated mainly by drip or under vine sprinkler systems. Bananas are rarely irrigated. Drip systems are commonly used where irrigation is practised.

Most small crops are irrigated regularly. Movable sprinkler lines are most commonly used, but there is a distinct move towards various forms of drip irrigation, particularly where water quality and quantity are limiting.

Lack of adequate good water, both surface and underground, is the major limitation to horticultural development in Central Queensland.

Use of farm dams for horticultural crops is not common. Dams have to be extremely large to carry enough water to last through the dry winter and spring. Dam sites with suitable subsoil and catchment areas are often difficult to find.

In the Yeppoon area, very little permanent surface water is readily available. The quality and quantity of underground water varies considerably throughout the district.

At Byfield, underground water is limited in quantity. Waterpark Creek is a permanent source of good quality water. Flows in other creeks are seasonal.

A barrage has been constructed across the Fitzroy River near Rockhampton and this provides permanent, good quality water for the few horticultural ventures on the river. Elsewhere in the Rockhampton-Gracemere area, permanent surface water is rare and the quality is usually doubtful. Underground water varies greatly in quantity and quality and water suitable for most horticultural crops is often difficult to find.

In the Yarwun-Calliope area, very little permanent surface water is available for horticultural enterprises. Underground water is unreliable in both quantity and quality except for a few isolated pockets.

Suitable underground water is readily available in most of the Callide-Dawson area, but permanent surface water is rare. There is an irrigation scheme based on the Callide dam.

The Fairbairn dam near Emerald provides water for the Emerald Irrigation Scheme. Underground water varies in quantity and quality, but generally speaking it is not suitable for large scale horticultural ventures.

Irrigation in the Central and Far West is mainly from permanent weirs and semi-permanent waterholes along the local river systems.



The papaw industry is based mainly on dioecious types which have been selected for excellent flavour.

Artesian bore water is available in sufficient quantities for horticultural purposes, but the quality is often doubtful.

Horticultural crops

Pineapples and papaws are the two major crops in the region accounting for 70% of the gross income from horticultural produce. Production from these two crops in the central region amounts to 20% of Queensland's total production.

Pineapples

The main producing area is the coastal strip from Bungundarra to Emu Park. Warm, protected slopes are generally utilized, but some plantings are being made on flatter land which is less costly to work.

The industry is relatively stable at present. This is mainly due to the influence of the processing outlet through the Golden Circle Cannery in Brisbane. The industry in Central Queensland, though based on a Cannery outlet, supplies one-third of its production to the fresh fruit market.

Harvesting is generally carried out earlier than in southern areas and so there is a price advantage. The industry is based on the Smooth Cayenne variety, but some rough-leaf types are grown for the fresh fruit market.

Papaws

The major centre of production in the region is Yarwun, but other areas such as Yeppoon, Byfield, Cawarral, Coowoonga and Calliope produce small quantities of fruit.

The papaw industry has traditionally been one of rapid change because of the uncertainties of weather, disease and price. Cyclones and dieback have reduced potential production on many occasions in the last 10 years. The effects of such natural disasters are felt for up to 2 years before new plantings bring production back to normal.

The industry is based mainly on dioecious types which have been selected in the Yarwun area for excellent flavour. Variability still exists in fruit shape and size and resistance to disease, but a breeding programme by the Department of Primary Industries, Horticulture Branch is reducing the variability.

This industry is almost exclusively dependant on the fresh fruit market as processing problems have eliminated the use of papaw in canned tropical fruit salad. Brisbane and Sydney are the major markets, with Melbourne being a large potential market once the problem of fruit fly disinfestation has been solved.

French bean seed

This is a relatively new industry, the first crops being grown in 1975. The industry is based in the Dawson-Callide district where farmers are growing bean crops specifically for seed production under contract to merchants. Seed is grown for the production of culinary dry beans. In addition, seed of processing and fresh market varieties of French bean is grown under the Certified and Approved Bean Seed Schemes administered by the Department of Primary Industries.

These crops are grown under irrigation and the seed is harvested mechanically.

Avocado and mango

Production of these crops is small at present, but should increase as trees come to maturity in the near future. The fungus disease Anthracnose is the major problem in mango production and to a lesser extent in avocados.

Phytophthora Root Rot continues to be the major disease in avocado plantations.

Both avocado and mango growing require a high degree of management in this area to ensure a viable long-term enterprise.

Citrus

Citrus fruits are grown mainly at Byfield and Bouldercombe (just west of Rockhampton). Small orchards have been established at Barcaldine and some other western towns.

The industry in Byfield supplied early Emperor mandarins to southern markets, but an outbreak of Brown spot disease in the late 1960s and the introduction of earlier-maturing varieties in other districts has reduced the importance of this citrus-producing area. Most of the crop is now directed to local markets, and varieties other than Emperor mandarin are becoming more popular with growers.

Other areas produce a range of citrus for local markets.

TABLE 3

Horticultural Crop Production—Central Region (1978-79)

	Gross value (\$M)		Area (ha)		Production (tonnes)		
	Central Qld.	Qld.	Central Qld.	Qld.	Central Qld.	Qld.	No. of Farmers
MAJOR CROPS							
Pineapples	2.6	17.0	400	3 800	30 000	112 000	135
Papaws	1.0	1.4	100	209	2 400	2 800	85
Bean Seed	0.75	3.0	324	1 800	260	1 300	9
Plant Nurseries	2.0	15.0	..	..	..	..	45
INTERMEDIATE CROPS							
*Vegetables	0.7	28.0	200	7 300	2 000	90 000	160
Avocado	0.1	0.8	40	180	50	400	30
Mango	0.1	1.0	40	430	155	1 400	24
Grapes	0.1	4.5	16	1 400	80	5 500	12
Citrus	0.16	13.0	65	2 200	720	48 000	19
MINOR CROPS							
Macadamia	0.02	0.5	20	600	11	400	12
Banana	0.7	12.0	30	1 700	25	32 000	23
Litchi	0.01	..	4	..	0.5	..	6
Strawberries	0.03	2.0	2	150	50	4 000	12

* Vegetables include—lettuce, tomato, cabbage, cucumber, watermelon, rockmelon, zucchini, capsicum.

Grapes

A relatively small industry supplying early season grapes exists close to the City of Rockhampton. This industry, though small, produces some of the first grapes on the market before Christmas. This is a high risk crop, and often suffers from late frosts, hail damage, disease, and bird pests.

The industry is based almost entirely on the Black Muscat variety.

Bananas

Bananas are not a major crop in Central Queensland. Small areas are grown around Byfield, Yeppoon, Calliope and Many Peaks to help satisfy local consumption.

Central Queensland is part of the Banana Buffer Quarantine Area, and movement of banana planting material into the area from south of Cooroy is prohibited.

Vegetables

A large variety of vegetables is grown in the Central Region. Most of the production occurs near the cities of Rockhampton and Gladstone where there is a small market outlet for the produce and a source of labour is available. However, most of the vegetables are consigned to the southern markets of Brisbane and Sydney.

Production mainly occurs during winter and spring. Most vegetable-producing areas are relatively frost free. Very little of the land is steep, so a high degree of mechanization is involved.

The crops in order of importance are—tomato, cucumber, rockmelon, cabbage, lettuce, watermelon, and zucchini. Other minor crops are grown in small areas for local consumption.

Fruit crops of minor importance

These include macadamia nut and litchi. Orchards are confined mainly to the high rainfall areas along the coast. The importance of crops such as litchi will most likely increase as more people are becoming interested in them. The climate in this area is ideally suited to the litchi.

Future prospects

The central region possesses sufficient suitable soils for expansion of all the existing horticultural industries. The two major restraints on a large scale expansion are

markets and irrigation water. The markets in Australia are generally well supplied with commodities grown in this region.

To support any large expansion in production, export markets would have to be found or the Australian demand greatly increased. Local demand is expected to increase slowly with the expansion of coal mining towns and the port city of Gladstone.

Underground water supplies are generally not large in the region so irrigation is often dependant on farm dams, rivers and streams. Large capital outlays will be required to improve this situation if significant expansion is to occur in the future.

The right bank of the Emerald Irrigation area is one such new area which possesses some soils suitable for horticultural production. However, this area is marginal for frost, and its distance from traditional markets is a problem. These two factors are the major restraints on horticultural expansion in the Central Highlands.



ABOVE. Production of vegetables occurs mainly during winter and spring.

RIGHT. Young avocado trees in one of the nurseries at Rockhampton.



Grazing improved and native pastures

by K. G. Rickert, Agriculture Branch

Most beef cattle in Queensland graze native pastures such as speargrass (*Heteropogon contortus*).

Even when cleared of timber, these pastures are of low quality in the cool season and cattle lose weight. As a result, bullocks are not slaughtered until they are 3½ to 5½ years old.

Native pastures can be replaced by improved pastures to increase beef cattle production. The improved pasture might be a sown grass/legume pasture or native pasture oversown with a legume; they are often fertilized to reduce deficiencies in soil nutrients.

The plant species used in improved pastures vary from region to region, but most improved pastures share one common feature. Compared to native pasture, cattle on improved pasture grow faster and are carried at higher stocking rates. As a result, the productivity and structure of the herd changes as the area of improved pasture increases on a property.

Some of these changes are illustrated in this article by considering two examples typical of the southern speargrass region of Queensland.

Growing and fattening

Improved pastures are often used to grow and fatten cattle after weaning, or to fatten store cattle. Benefits from this management practice can be seen by considering two separate herds, one on native pasture and one on improved pasture.

To compare animal production from native and improved pastures the term 'production unit area' will be used. This is the area required to carry one 'production unit' per year (such as a sale bullock), together with the 'followers' necessary to maintain that unit.

For example, to produce a bullock at 3½ years of age each year, three different animals must be carried—a weaner-yearling, a 2-year-old and a 3-year-old. Together they constitute a production unit, and the area required to carry all three is called the production unit area.

Table 1 shows the likely growth rates of cattle after weaning on to improved or native pasture at 7 months of age and 170 kg liveweight. Bullocks reach a market weight of 460 kg live at 2½ years of age on improved pasture at a production unit area of 2.5 ha. On native pasture, bullocks reach the same weight at 3½ years of age at a production unit area of 7.5 ha. Half the cattle on improved pasture and one-third of the cattle on native pasture are sold each year.

Data from table 1 can also show the increase in total animal production on a property as the proportion of the property sown to improved pasture increases. Simple equations are used for this purpose assuming the two pastures are grazed by separate herds. The equations are described in the Appendix but results from the analysis are given in figures 1a and 1b.

The total herd increases linearly from 40 to 80 head per 100 ha and the number of sales increases from 13 to 40 head per 100 ha as the proportion of sown pasture increases from 0 to 100% (figure 1a). With the whole property developed, there is a three-fold increase in the number of cattle sold, all 1 year younger than from native pasture.

Significantly, substantial benefits are also obtained from a relatively small proportion of the property sown to improved pasture. For example, with only 20% of the property sown, the herd size is increased by eight head per 100 ha (figure 1a) but 33% of all growing cattle and 42% of sale cattle can graze improved pasture (figure 1b).

In practice, the native and improved pastures may not be grazed by separate herds as in the example above. Rather, cattle might graze both pastures before sale in accordance with a management strategy. For example, the improved pasture may be used to finish cattle immediately before sale. In such situations, the substantial benefit from improved pasture is still present, but more cattle obtain the benefit at a reduced level.

Breeding and fattening

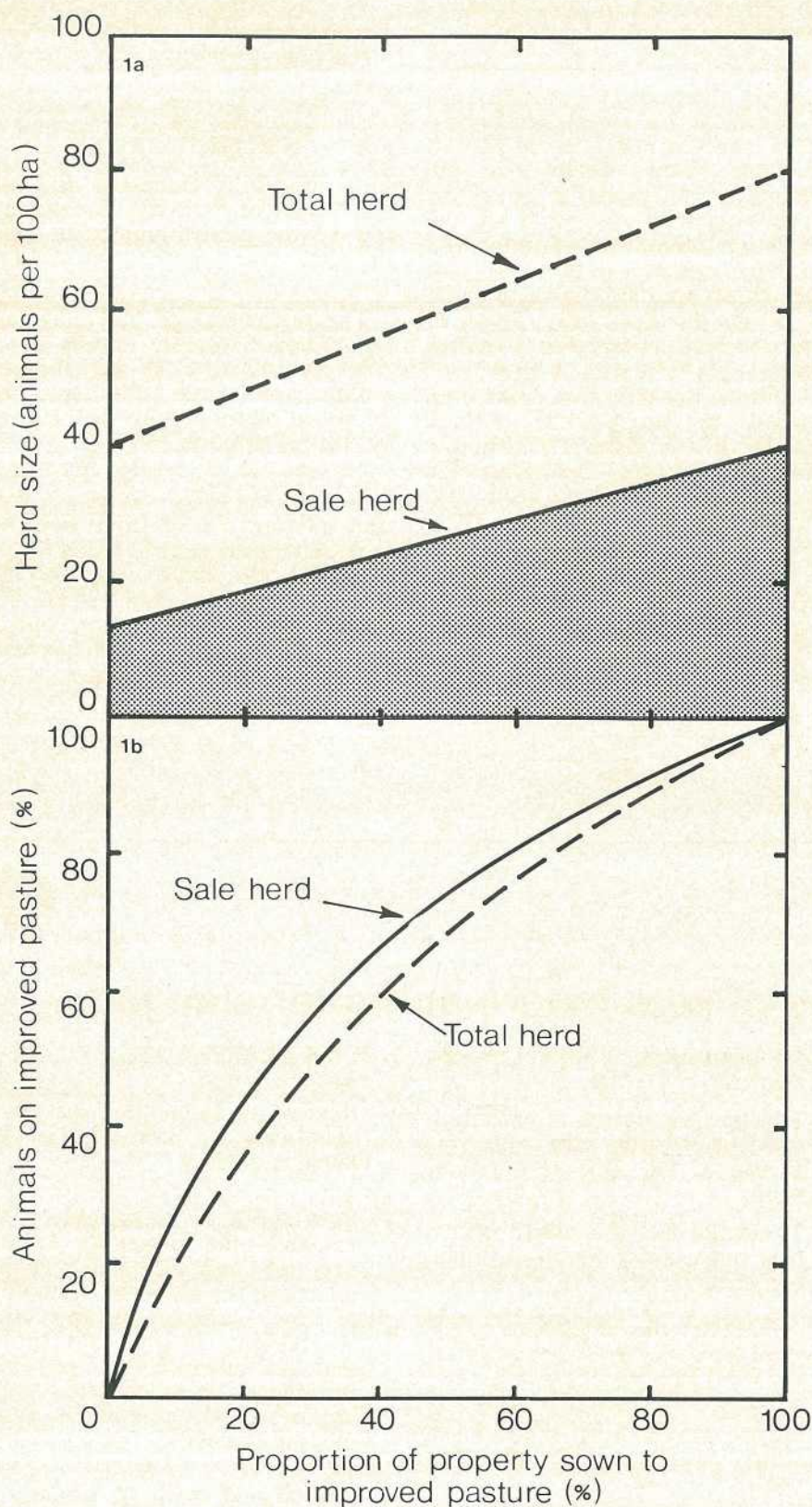
In this section the preceding example with growing cattle is extended to include a breeding herd grazing native pasture.

If the stocking rate on native pasture is one breeder to 4 ha with 70% weaning, then the production unit area for one weaner annually is 5.7 ha (= 4/0.7). In the previous example, the production unit area for bullocks on native pasture was 7.5 ha. Hence, overall 13.2 ha (= 5.7 + 7.5) is needed to fatten one bullock annually and carry the necessary followers for a breeding and fattening enterprise based on native pasture; 43.2% (= 100 × 5.7/13.2) of the property is grazed by the breeding herd. If improved pasture is used for growing and fattening, the overall production unit area is reduced to 8.2 ha (= 5.7 + 2.5).

TABLE 1

Annual Liveweight Gains and Stocking Rates Expected from Improved and Native Pastures

Age (years)	Improved pasture		Native pasture	
	Gains (kg/head)	Stocking rate (ha/head)	Gains (kg/head)	Stocking rate (ha/head)
1½–1½	160	1.0	100	2.0
1½–2½	130	1.5	100	2.5
2½–3½	..	..	90	3.0
Totals	290	2.5	290	7.5



Proportion of property	Sale herd		Total herd	
	Number (1a)	% on IP (1b)	Number (1a)	% on IP (1b)
0	13.3	0	40	0
20	18.7	43	48	33
40	24	67	56	57
60	29.3	82	64	75
80	35	91	72	89
100	40	100	80	100

Figure 1. Changes in herd size and proportion of herd on improved pasture as the proportion of property sown to improved pastures increases.

Two questions arise. Firstly, what proportion of a property needs to be sown to improved pasture to carry all sale and growing stock? Secondly, what increase in the breeding herd results from the extra native pasture available if all sale and growing stock graze only improved pasture?

Two simplifications are helpful in answering these questions. Firstly, we assume that when replacement heifers are removed from the growing herd on improved pastures they are replaced by an equal number of culled cows for fattening. Secondly, losses are ignored, assuming they are compensated for by other classes of stock not considered (bulls for example).

Therefore, in simple terms,

Stock sold annually = calves weaned annually

that is $PP/2.5 = (100 - PP)/5.7$

or $PP = (2.5 \times 100)/(5.7 + 2.5)$

where PP is the percentage of property required to carry all sale and growing stock on improved pasture. On solving this equation, $PP = 30.4\%$, the answer to the first question. Hence, 69.6% of the property is grazed by breeders.

The second question, the increase in breeder herd, can be answered by using arithmetic. With native pasture alone, 43.2% of the property was used by breeders but with improved pasture for growing cattle, 69.6% could be used by breeders. Hence, the extra portion for breeding is 26.4 (= 69.6 - 43.2) percentage units. This could give a 61.1% (= $100 \times 26.4/43.2$) increase in the breeding herd on native pasture. All growing and sale cattle could graze 30.4% of the property sown to improved pasture.

The breeding herd would also benefit from grazing improved pasture. This subject will not be discussed in this article except to say that stocking rate for breeders, and probably weaning weight and percentage, will all increase as nutrition of the breeding herd improves.

Conclusions

Both examples in this article clearly show a large benefit from a small proportion of a property developed to improved pasture. The magnitude of the benefit depends on the difference in productivity between improved and native pastures.

The examples in this article are typical of the southern speargrass region, but similar calculations can be made for improved pastures in other regions. All that is required is information on the productivity of native and improved pastures for a region. This information is usually available.

The calculations described help to indicate the impact of improved pasture on a property. They can be used to estimate the area of improved pasture required to reduce age of turn-off and increase herd size to a desired level. Alternatively, they could be used to indicate the area of improved pasture needed to maintain a desired level of beef production after a portion of a property is used for growing grain crops and not available for grazing.

They certainly support an economic appraisal of sowing improved pastures on a property.

Appendix

The impact of improved pasture on cattle numbers on a property can be expressed by simple equations. Those involved in figures 1a and 1b are given below, where P is the percentage of property sown to improved pasture, A and B are the production unit areas for improved and native pastures respectively, and NA and NB are the number of cattle on a production unit area of improved and native pasture respectively.

A production unit area is the area required to produce a bullock annually. In this case, A = 2.5 ha for improved pasture, B = 7.5 ha for native pasture, NA = two head, and NB = three head.

Then

$$\text{cattle for sale (SC)} = P/A + (100 - P)/B, (1)$$

$$\text{cattle on improved pasture (IPC)} = NA \times P/A, (2)$$

$$\text{cattle on native pasture (NPC)} = NB(100 - P)/B, (3)$$

and

$$\text{total number of cattle (TC)} = IPC + NPC (4)$$

with all results expressed as cattle per 100 ha of property. Equations 1 and 4 were used to construct figure 1a.

The percentage of the total herd on improved pasture (figure 1b) is given by $100 \times IPC/TC$ and the percentage of cattle for sale on improved pasture (figure 1b) is given by $(100 \times P)/(A \times SC)$.

In this example, cattle are sold after gaining 290 kg from weaning. Hence the average annual liveweight gain for all cattle on the two pastures is given by $290 SC/TC$. This factor is not shown, but it increases curvilinearly as P increases like the factors in figure 1b.

Back fat measurements of pigs before and after slaughter

A pig producer noticed that the routine back fat measurements taken at the meatworks with an introscope on his pigs were higher than his own measurements. He had used an ultrasonic machine on the same pigs, when alive, on his farm.

An investigation was carried out by B. McIntosh and G. Burrige, Pig and Poultry Branch; J. Beames and S. Bradley, Slaughtering and Meat Inspection Branch; and B. Ball from the Queensland Meat Industry Organisation and Marketing Authority.

Thirty-four pigs were measured on the farm ultrasonically, and the same pigs were measured, after slaughter, using both the ultrasonic and the introscope methods. Measurements were taken on both the split and the unsplit carcass.

It was found that all measurements on the dead pigs were greater than those on live animals with

either instrument. Possible reasons for this are:

- The posture, degree of excitation and tension of the skin in the live animal at the time of measurement.
- The mere fact that death occurs may make a difference—a 'relaxing' effect?
- The effect of hanging the carcass—does a 'sag' effect compact the fat at the measuring site?
- Splitting the carcass—does the lateral movement of skin and fat which occurs alter the measurement?

Overseas work has shown that hanging of pork carcasses places tension on some muscles and not on others. In the forequarter, muscle and fat moves anteriorly, whereas, in the hindquarter these tissues move posteriorly. Also, there is distortion of the vertebral column.

It was concluded that:

- Back fat thickness measured on the live pig cannot be expected to equal measurements taken on the hanging carcass.
- Both types of measurement are valuable—the former for evaluation of animals for breeding selection, the latter for evaluation of the carcass commercially. World-wide research has shown that fat measurement with the introscope is the best single indicator of the commercial value of a pig carcass.
- If producers wish to produce a pig with a certain back fat measurement (as measured at the meatworks) and consequently with a certain market value they should aim for a pig with a slightly smaller fat thickness when measured on the farm.

The Pittosporums of south-eastern Queensland

By Beryl A. Lebler, formerly of Botany Branch

Two British botanists, Sir Joseph Banks and Dr Daniel Solander, accompanied Captain Cook on his voyage in H.M.S. Endeavour. In New Zealand, they found two species of plants belonging to a new genus.

Because of the sticky resinous-coated seeds their fruits contained, Banks gave the name *Pittosporum* to this new genus. The name is a combination of two Greek words, *pitta* meaning resins and *spora* which means a seed.

Pittosporums are evergreen shrubs or trees. Their leaves are always simple and usually entire. In one species, irregular coarse teeth are found on the margins towards the tips of the leaves.

Most species have alternate leaves. Although the flowers are usually in terminal, dense, compound inflorescences, in some species they are solitary and axillary. In many species, the flowers are small and white, but some have creamy-yellow blossoms. The flowers of some species are heavily perfumed.

Pittosporum flowers consist of five free sepals, and five petals which are usually joined at the base to form a tube. There are five stamens opposite

the sepals. Usually, the ovary contains two cells but in some species there are three or five. The fruits are capsules and can be globose, ovate or obovate. They are often laterally compressed and, when ripe, split into valves. These can be either thin and leathery or thick and woody. Sticky seeds are massed along the centres of the valves.

Pittosporums are found in the warm regions of Africa, Asia, the Pacific Islands, New Zealand and Australia. Five species are native to south-eastern Queensland—*Pittosporum o'reillyanum*, *P. phylliraeoides*, *P. rhombifolium*, *P. undulatum* and *P. revolutum*.

Spiny pittosporum

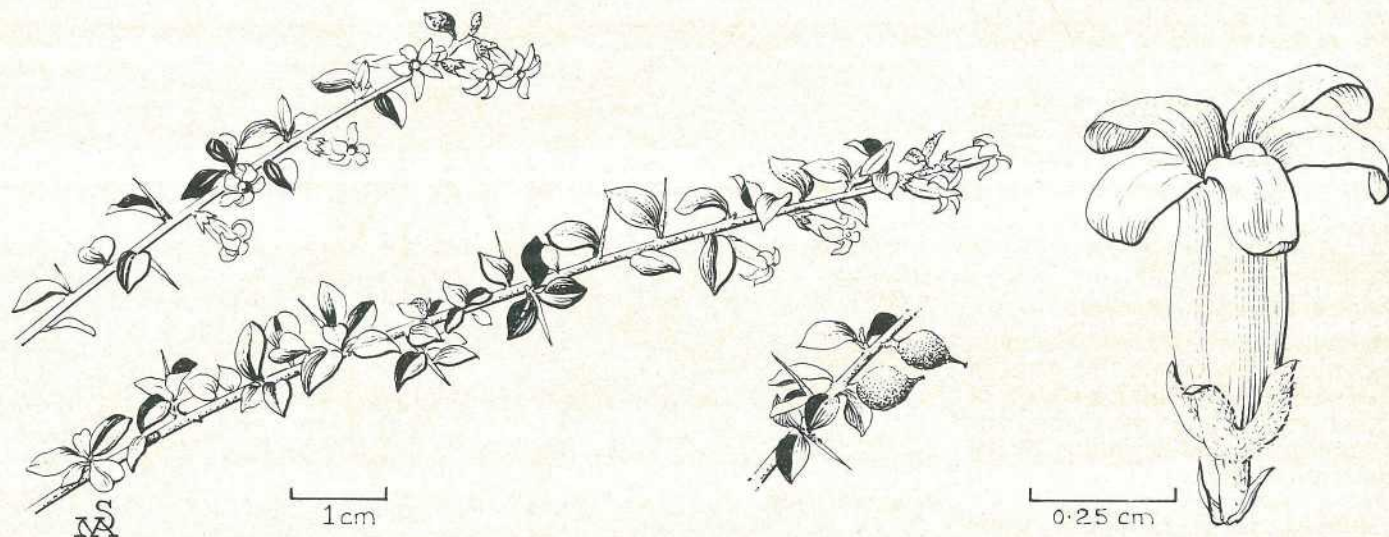
(*Pittosporum oreillyanum*)

In 1929, Mr C. T. White, the Government Botanist at that time, discovered this unusual plant which was common in the rain-forest at Mt. Hobwee in the Lamington National Park. It was unlike any of the Australian species of *Pittosporum* he already knew. In 1935, he named it in honour of Mr Thomas O'Reilly 'who, while resident in the park, freely gave to visiting naturalists all possible help and guidance'.

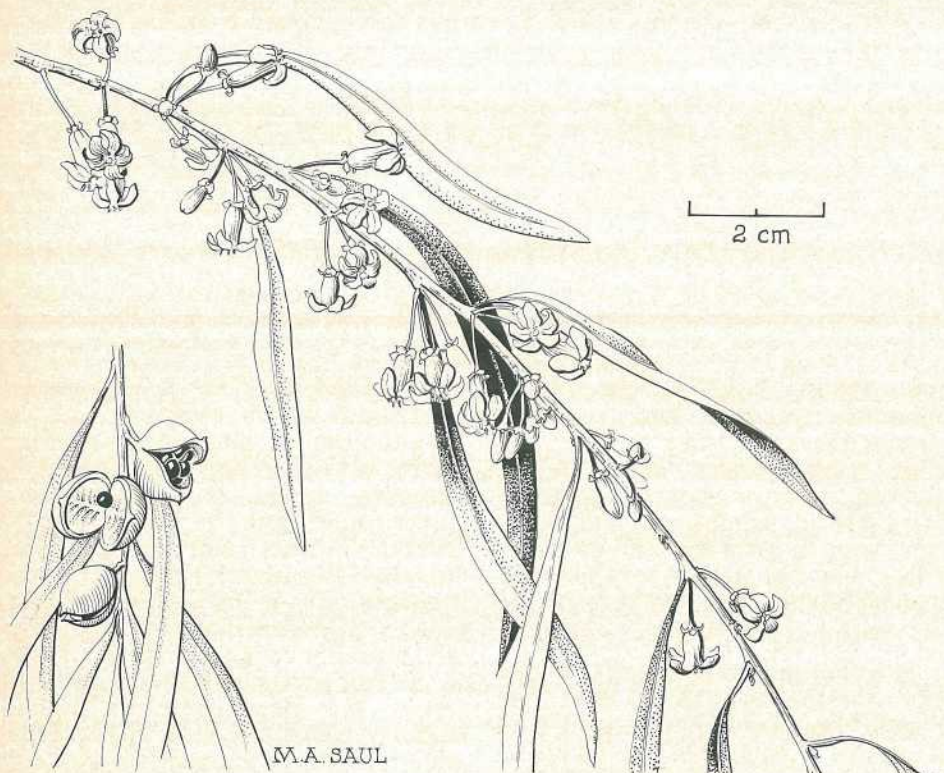
DESCRIPTION. This is a slender, rigid shrub which seldom exceeds 2 m, although the plant found by Mr White was 4.5 m high. Many twiggy branches armed with numerous spines spread from the slender stems. Lateral branches seldom exceed 10 cm, and the lateral twigs on these branches are spine-like. A dense growth of mosses, lichens and liverworts usually covers the plant giving it a compact appearance. When sterile, the plant could easily be confused with *Citriobatus pauciflorus* which belongs to the same family.

The leaves are ovate-lanceolate, dark green and shiny on the upper surface, and dull and much paler beneath. They are never more than 2 cm long and 0.5 cm wide and are usually much smaller when the spiny lateral twigs are short. The leaves are in clusters at or near the bases of the twigs. On longer twigs, they are scattered along the stem.

The flowers are solitary on short, thick pedicels in the leaf axils near the tips of the lateral branches. In the bud stage, the outside of the corolla is a dull purplish-red. The open flowers have a corolla tube about 0.5 cm long which ends in creamy-yellow lobes which spread widely. When the corolla tube is split open, the ovary



Pittosporum oreillyanum



Pittosporum phylliraeoides

DESCRIPTION. This is a glabrous slender tree which can grow to a height of 10 m. The bark is grey with many lenticels which are paler in colour. Branches are pendulous and the alternate leaves also droop. They are rather thick in texture and discoloured with shiny upper surfaces. They can be up to 12 cm long and linear-oblong to narrow-elliptic in shape.

Pale creamy-yellow flowers on slender pedicels more than 0.5 cm long are scattered on the old wood. They are either solitary or in clusters of up to four flowers and are perfumed. The sepals are free and about 0.2 cm long and the petals are about 1 cm long with the lower portion united to form a tube. When the flower first opens, the free lobes spread widely from the corolla tube but, as the flower ages, they become recurved. The staminal filaments are as long as the tube so that the deep, yellow anthers protrude and surround the flattened stigma.

The fruit is a flattened yellow capsule about 1.5 cm long. It usually splits into two valves exposing the orange-red seeds. In this fruiting stage, the tree is very ornamental.

can be seen to be covered with golden hairs. It ends in a glabrous style with a globose stigma. When ripe, the brown capsule splits open revealing bright red seeds on the golden-yellow inner surfaces of the valves.

FLOWERING TIME. This *pittosporum* blooms in mid spring.

HABITAT. It is common in temperate rain-forests with Antarctic Beech.

DISTRIBUTION. This species is found on the McPherson Range, growing in the Lamington National Park but can also be found to as far south as Bar Mountain near Kyogle.

GENERAL REMARKS. It closely resembles some of the very small-leaved species found in New Zealand.

Weeping pittosporum

(*Pittosporum phylliraeoides*)

A French botanist, Louis Theodore Leschenault, discovered this plant in Western Australia during a voyage of exploration by the French vessel the 'Naturaliste' at the beginning of the nineteenth century.

Phillyrea is a European evergreen shrub or tree with small, white, fragrant flowers. This Australian

plant was thought to resemble the European plant and was given the specific epithet *phylliraeoides* alluding to the resemblance. When the name was first published in 1824, an error was made and the plant was described as *Pittosporum phylliraeoides*.

FLOWERING TIME. Flowers appear early in spring.

HABITAT. This plant grows in open eucalypt forest, brigalow scrub and dry sclerophyll forest. It is often found near creek banks.



M.A. SAUL

Pittosporum undulatum

DISTRIBUTION. This plant is found in all the mainland States. In Queensland, it grows to as far north as the Charters Towers district. In south-eastern Queensland, it is not a common plant but has been collected near Tarampa and at Peak Crossing south of Ipswich.

Native daphne

(*Pittosporum undulatum*)

This very attractive plant was first found by Sir Joseph Banks in New South Wales. The specific epithet is a Latin adjective meaning wavy or slightly waved. It describes the leaf margins. This character is most noticeable in young leaves.

DESCRIPTION. This is a tree which, under favourable conditions, can grow to a height of 13 m. Minute, spreading white hairs are scattered on the young twigs. These are usually clustered at the ends of the branches. The leaves are ovate-oblong to lanceolate in shape and up to 15 cm long. They are leathery in texture with shining upper surfaces. Their most striking feature is their undulate margins. Often the terminal leaves are almost whorled.

The inflorescences in the axils of the terminal leaves contain as many as 10 to 15 flowers. With magnification, minute white hairs can be seen scattered over the peduncles and pedicels as well as the sepals. The sepals are about 0.8 cm long, pale green, pointed and are joined together in the lower half. As the flowers age, the sepals become reflexed. The petals are 1 cm long and have rounded tips. In young flowers, the petals spread widely from the end of the corolla tube but as the flowers age they become recurved. The staminal filaments are thick and white. They are as long as the style so that the anthers are easily seen. White, silky, appressed hairs cover the green ovary which ends in a thick green style and a stigma with two lobes.

The white flowers have a very strong, sweet perfume. They are followed by clusters of attractive globose orange to brown capsules which are usually less than 1 cm long. Ripe fruits split into two hard, leathery valves revealing deep yellow inner surfaces and many sticky brownish-orange seeds.

FLOWERING TIME. Native daphne begins to flower at the beginning of spring.

HABITAT. It can be found in open eucalypt forest, wet sclerophyll forest or rain-forest.



Pittosporum rhombifolium

DISTRIBUTION. This plant grows in all the eastern mainland States to as far north as the Conondale Range near Maleny.

GENERAL REMARKS. Native daphne is grown in many parts of Australia because of its perfumed flowers and attractive fruit. Some trees in cultivation are branched from ground level and develop a very pleasing shape. Around Brisbane, the leaves of native daphne suffer unsightly disfigurement by insect galls.

White holly

(*Pittosporum rhombifolium*)

Allan Cunningham first found this plant in the 'forests of the Brisbane River' in 1829. The specific epithet refers to the leaves which are rhombic-ovate.

DESCRIPTION. White holly is a tree normally 8 to 15 m tall. However, the plants Allan Cunningham observed reached 18 to 24 m. This

pittosporum is completely glabrous. Its leaves are quite distinctive. They are rhomboid-oval in outline, up to 10 cm long and are tapered to the base. Their texture is firm and leathery, their upper surfaces are glossy and the margins are coarsely and irregularly toothed in the upper part. A network of pale, green veins is prominent on the upper surfaces.

The flowers are greenish-white and less than 1 cm wide. They are massed into dense terminal inflorescences which can be up to 10 cm or more wide. The petals are linear-oblong, up to 0.5 cm long. Unlike the flowers of other species in south-eastern Queensland, the petals of this pittosporum are free practically to the base and spread out around the ovary. They are linear-oblong and up to 0.5 cm long.

As the flowers mature, the tips of the petals curve downwards. The small, green ovary and spreading stamens can be easily seen. The

stamens are about as long as the petals and have thick, white filaments with yellow anthers which rapidly turn brown. The flowers are sweetly perfumed. This is a beautiful ornamental plant whether sterile, flowering or in fruit.

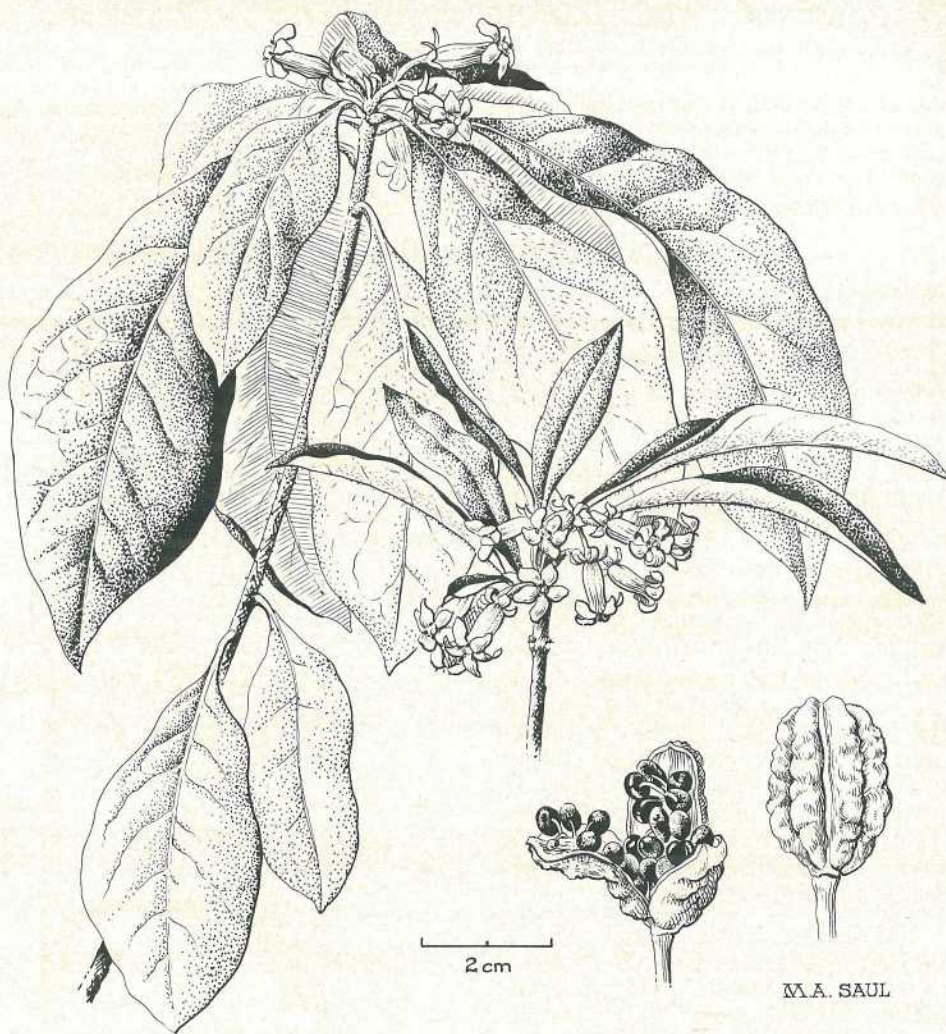
It flowers profusely and the flowers attract many insects especially beetles. The fruits are slightly glossy orange-coloured capsules about 0.5 cm in length. They have thin, woody valves which are red on the inner surface. Usually they contain only two black seeds.

FLOWERING TIME. This plant begins to bloom late in spring with later flowering plants flowering as late as midsummer.

HABITAT. It can be found on rain-forest margins, in light rain-forest and in brigalow softwood scrub.

DISTRIBUTION. It grows naturally from as far south as the Clarence River in New South Wales to as far north as Proserpine in Queensland.

GENERAL REMARKS. This very attractive plant has been in cultivation for many years. In the early stages, it is slow growing but develops into a valuable addition to any garden.



Pittosporum revolutum

Yellow pittosporum

(*Pittosporum revolutum*)

This is another pittosporum discovered by Sir Joseph Banks in New South Wales. It was introduced into cultivation in England by him in 1798. The specific epithet means rolled or curved back at the edges. It describes the margins of the leaves which can become strongly recurved particularly when they are dried.

DESCRIPTION. This is a shrub which, in northern rain-forests, reaches a height of 5 m but in south-eastern Queensland grows only to 2 or 3 m. Usually it is sparsely branched and not very leafy. There is a marked tendency towards the development of branches in false whorls at the ends of the stems, with additional whorls at the ends of the branches.

Young shoots are grey-brown with a dense covering of appressed hairs. On the upper surfaces of young leaves there are a few scattered

golden-brown hairs, and on the lower surfaces the hairs are dense. As the leaves age, they become glabrous. The leaf margins are slightly recurved, and in some leaves the margins are also slightly undulate. There is great variation in leaf size. This is probably governed by the soil moisture at the time of leaf development. On flowering twigs, the leaves are between 5 cm and 15 cm. They are ovate-elliptical to ovate-oblong in shape.

The flowers are in terminal clusters and are only faintly perfumed. The pale green sepals are about 0.5 cm long and the corolla tube is about 1 cm long. The corolla is deep creamy-yellow with the spreading petals about half the length of the tube. The stamens and the style are both longer than the corolla and the anthers surround the peltate stigma.

The fruit is brown, woody and rough and can be 2.5 cm long and

2 cm in diameter. When it splits open into two or three valves, they curve backwards towards the stems revealing their bright orange-yellow, shining surfaces with a mass of sticky, bright scarlet seeds down the middle of each valve.

FLOWERING TIME. This species flowers in spring.

HABITAT. Although it is common in rain-forest and wet sclerophyll forest, it also grows in open eucalypt forest.

DISTRIBUTION. It is found in all the eastern mainland States to as far north as the Clohesy River, north-east of Mareeba. This plant also grows in the Northern Territory.

GENERAL REMARKS. This has also been brought into cultivation but is not as commonly grown as the other species despite the fact that its fruit are the most spectacular.

Field key to the Pittosporums of south-eastern Queensland

1. Lateral branches spinescent; leaves up to 2 cm long and 0.5 cm wide. Flowers solitary, corolla tube reddish-purple, lobes cream. Fruits brown, seeds red *Pittosporum oreillyanum*
Lateral branches not spinescent; leaves more than 2 cm long and 0.5 cm wide 2
2. Leaves linear-lanceolate or rhomboid-ovate 3
Leaves oval-oblong, lanceolate or ovate-elliptical to elliptical-oblong 4
3. Slender shrub or graceful tree to 10 m with pendulous branches, leaves linear-lanceolate, to 10 cm long. Flowers creamy-yellow. Fruits orange, seeds red *Pittosporum phylliraeoides*
Tree to 24 m. Leaves rhomboid-ovate to 10 cm long and 6 cm wide, with coarse irregular teeth in the upper half. Flowers small and white in dense terminal inflorescence. Fruit orange-yellow, seeds black *Pittosporum rhombifolium*
4. Tree to 12 m, young shoots glabrous. Leaf margins undulate, upper surfaces shining. Flowers white, very sweetly perfumed. Capsule valves leathery, seeds black *Pittosporum undulatum*
Shrub to 3 m, young shoots rusty, hairy. Leaves rusty, hairy beneath, margin recurved. Flowers creamy-yellow slightly perfumed. Capsule valves thick and woody, seeds bright red *Pittosporum revolutum*

New Bread Industry Committee Chairman

The Minister for Primary Industries, Mr Mike Ahern, announced the appointment of a new Chairman to the Bread Industry Committee.

He is Mr T. G. Matthews, a legal officer with the University of Queensland and a Royal National Association Councillor.

Mr Ahern said Mr Matthews' administrative ability and experience in community affairs makes him an ideal choice for the position of Chairman. Mr Matthews

replaces Mr I. M. Suter, who recently retired because of ill health.

Mr Suter chaired the initial inquiry into bread industry trading practices, which led to the formation of the Bread Industry Committee. As Chairman of the original Committee, he had a difficult job in directing its policy of stabilizing bread marketing. His forthright manner and knowledge gained him the respect of all sections of the bread industry.

Barley Marketing Board election

Counting of votes for election of four growers' representatives on The Barley Marketing Board has been completed.

The results were: J. K. Browne (Dalby) 1 217, D. H. Comben (Dalby) 1 300, W. E. K. Dalzell (Cambooya) 1 455, E. R. Grundy (Jondaryan) 1 414, D. C. Wright (Toowoomba) 1 358.

As a result of the ballot, Messrs Comben, Dalzell, Grundy and Wright, together with the Department of Primary Industries' Director of Marketing, would comprise the new Board to hold office for a 3-year term commencing 24 April, 1981. One sitting member, Mr Browne, was defeated in the election.

Maize Marketing Board election

A postal ballot of maize growers to elect a new Atherton Tableland Maize Marketing Board for a 3-year term beginning 1 April 1981, was held recently.

The results of the ballot were: I. R. Allen (Tolga) 95, R. Baillie (Ravenshoe) 22, A. J. Beattie (Atherton) 75, R. G. Dalip (Atherton) 20, T. P. Johnson (Kairi) 85, F. J. Liston (Atherton) 105, P. Murat (Mareeba) 61, J. W. Panigas (Kairi) 81, D. W. Pensini

(Atherton) 130, F. I. Rockley (Atherton) 58, D. J. Wilkie (Herberton) 32, E. G. Willetts (Atherton) 96.

Messrs Allen, Johnson, Liston, Pensini and Willetts had been elected and would form the new Board together with the Department of Primary Industries, Director of Marketing. Messrs Johnson, Liston, Pensini and Willetts were members of the previous Board. The remaining member of the previous Board, Mr A. J. Beattie, was defeated.

The low cost alternative . . . hen meat



Having a liking for poultry meat in all its shapes and forms I find it interesting seeking out, developing and tasting new recipes. This applies particularly to foods based around chicken and hen meats.

Much has been said about chicken and its versatility but little has been written of hen meat preparation and its use in basic and not so basic recipes. With the cost of living today becoming so important for most families, the use of hen meat as an alternative to red meats in stewing dishes needs to be considered seriously.

Several methods of preparing hens and hen meat have been reported but I find the following method to be the most satisfactory.

I hope that you will try out these recipes and share some of the pleasure I had in tasting the dishes.

Good cooking,

J. A. Gordon, Pig and Poultry Branch

Preparation method

- Thaw hen overnight, if frozen.
- Place hen or hen pieces in boiler or large pot.
- Add 1 cup water, $\frac{1}{2}$ teaspoon salt, a few celery leaves and a bit of bay leaf and a small onion for each pound of hen to be boiled.
- Place close-fitting lid on boiler, cover, and bring to a rapid boil.
- Skim if necessary and reduce heat to simmering point.
- Add water if necessary to avoid drying and sticking.
- Cook slowly until meat is fork tender.
- Allow $1\frac{1}{4}$ hours per kg for cooking time.
- Remove hen meat from broth and place both in fridge in separate containers.
- Allow to stand in fridge overnight so that fat can be removed readily from broth. (Hen can be eaten hot without standing overnight if desired).
- To pressure cook, reduce water by half. Follow manufacturer's directions and cook at 15 pounds pressure for 30 to 40 minutes.

Hen broth can be used as stock for many dishes or as a plain broth. Remember to allow the broth to stand in the fridge overnight to allow fat to come to top of container and be removed easily. Hen fat is widely used in barbecue hot plate preparation.

Savoury hen

- 1 boiled hen
- $\frac{1}{2}$ cup chutney
- $\frac{1}{2}$ cup whole kernel corn
- $\frac{1}{2}$ cup orange juice
- $1\frac{1}{2}$ cups mayonnaise
- $\frac{1}{2}$ cup chopped celery
- $\frac{1}{2}$ cup raisins

Heat orange juice, add raisins and let stand for $\frac{1}{2}$ hour. Remove all meat from hen and cut into large pieces. Mix together raisins, chutney, celery, corn and hen, toss gently through mayonnaise and season with salt and pepper. Serve with avocado slices and shredded lettuce.

Curried hen and almonds

Melt 1 tablespoon butter, add 1 cup chopped apples, 1 finely chopped onion, $\frac{1}{2}$ cup chopped celery. Cook gently (not brown). Add 2 level tablespoons flour, 1 level tablespoon curry powder, salt and pepper to taste. Remove from heat and mix well. Add 1 cup of milk and 1 cup chicken broth. Stir until it boils and thickens. Add grated rind of lemon, 3 cups of cooked hen cut into 2 cm cubes and $\frac{1}{2}$ cup halved, blanched almonds. Reheat without boiling. (Serves 4 to 6)

Easy hen salad

- 1 lettuce
- 1 large can whole kernel corn, drained
- 4 sticks celery, chopped
- $1\frac{1}{2}$ cups rice
- garlic bread
- 1 boiled hen $1\frac{1}{2}$ to 2 kg
- 1 large can pineapple pieces, drained
- $\frac{1}{2}$ bunch shallots, chopped mayonnaise

Cook rice, drain and cool. Chop hen meat into chunks, add corn and pineapple, celery and shallots. Fold ingredients into cooked rice and add salt and pepper and mayonnaise to taste. Serve on lettuce leaves accompanied by garlic bread.

Hen in cheese sauce

- 1 hen ($1\frac{1}{2}$ to 2 kg)
- 60 gm butter
- chopped parsley
- 150 ml cream
- 100 gm grated mature cheese
- 220 gm rice
- 30 gm cornflour
- 300 ml milk
- salt and pepper
- 1 small tin of asparagus

Boil and dice the hen. Cook rice in the hen stock with water added. Heat milk, and when boiling, stir in the cornflour blended with a little cold milk. Stir until thickened, add the butter, chopped cheese, salt and pepper. Stir until the cheese has melted. Remove and stir in cream and chopped asparagus. Arrange rice around the hen, and top with cheese sauce and sprinkle with parsley.

Hen and almonds

1 hen (1½ to 2 kg)

Boil the hen or cook in a pressure cooker until tender. Add some celery and onion to the cooking water to provide your stock. Separate the hen flesh from the bone and dice the meat. Cut up 3 celery stalks into 2 cm pieces. Slice a quarter of a pound of mushrooms into 2 cm squares, leaving the smaller mushrooms whole. Fry ½ cup of shelled almonds in oil or butter until they are golden and starting to go brown on the tips. Prepare 1 cup of chinese cabbage by chopping it. (As second choice to Chinese cabbage, use a young, tender English cabbage.)

Heat 2 tablespoon of vegetable oil in a frying pan (with lid) or saucepan or wok. When oil is thoroughly hot add hen, mushrooms, celery and chinese cabbage. Stir lightly until they have taken up the heat (about 2 minutes). Add hen stock. Put on lid and keep over a low to moderate heat for 5 minutes. Thicken with a dessert-spoon of cornflour blended with a little hen stock. Keep stirring until the juice is thickening. Add almonds. Heat for a few minutes and serve piping hot.

Asparagus and hen soup

250 g boiled hen meat
4 medium-sized spring onions
4 cups chicken stock
315 g can asparagus tips
½ cup cream
salt and pepper

Cut the hen meat into small pieces. Dice the spring onion finely. Bring the chicken stock to the boil. Add hen meat, undrained asparagus and spring onion. Cover pan and simmer gently for about 5 minutes. Add cream and stir. Keep warm but do not boil once cream is added. Check for seasoning. (Serves 6)

Hen and sweet corn soup

750 g boiled hen meat
1 onion, roughly chopped
1 medium-sized carrot, roughly chopped
1 stick celery, diced
4 peppercorns
½ teaspoon salt
5 cups hen broth
315 g can cream style sweet corn
Finely chopped parsley

Place hen broth in a pot. Add vegetables, peppercorns, salt and hen stock. Bring to the boil, remove any scum which may form on the top. Cover and simmer gently for about 15 minutes. Strain stock and discard vegetables and peppercorns. Cut hen meat into small pieces and add to broth. Bring stock to the boil. Add the undrained can of sweet corn. Simmer 5 minutes. Serve sprinkled with finely chopped parsley. (Serves 6)

Hen a la king

This is good for left-over hen. Quickly brown ¼ cup diced green capsicum in 1 tablespoon butter or margarine until tender. Add 1 tablespoon plain flour. Cook 1 minute. Add contents of 450 gm can of cream of mushroom soup, and 1½ tablespoons milk. Stir until boiling then stir in 1 beaten egg yolk. Add 1½ cups cubed hen. Heat slowly, stirring constantly. DO NOT BOIL. Serve over rice or toast. (Serves 4)

Hen and bacon pie

500 g cooked hen
60 g butter
4 rashers bacon, rind removed and diced small
1 onion, finely diced
125 g mushrooms, cut in halves or quarters
2 tablespoons flour
1 cup milk or
½ cup milk and ½ cup hen stock
1 teaspoon french mustard
Pinch of English style mustard
Salt and Pepper to taste
250 g shortcrust pastry
1 beaten egg, or a little milk

Cut cooked hen into small pieces (you need about 2 cups of cooked hen for the pie). Melt 30 g butter. Add bacon pieces, onion and saute until onion is softened and bacon fat is transparent. Add mushrooms and toss for 1 minute. Remove from pan. Melt remaining 30 g butter. Add flour and fry until foaming. Add milk, or milk and stock and cook, stirring constantly until thickened. Season with mustards, salt and pepper. Add bacon, onion and mushroom mixture with hen to the sauce. Butter a 20 cm pie dish and place hen mixture into this. Roll out pastry thinly and cover the top, crimping on to the edges. Glaze with egg or milk and make a small incision in the centre for steam. Bake 30 minutes in a moderate oven (180 to 190°C) or until crust is golden and chicken heated through.

Hen Hawaiian

1 green capsicum
2 tablespoons soy sauce
1 tin pineapple pieces
2 tins condensed chicken soup or 1 pint hen broth
2 tablespoons of oil
2 cups chopped cooked hen
¼ cup sliced almonds

Slice capsicum finely and fry gently in oil until tender. Blend pineapple juice and soup and add to pan. Add hen pieces, pineapple and soy sauce and simmer until the mixture is heated throughout. Serve on a bed of rice. Garnish with almonds.

Beef and hen stew

500 g stewing beef (chuck is suitable)
1.5 kg cooked diced hen meat
60 g butter
1 onion, diced finely
2 rashers bacon, diced
1 tablespoon tomato paste
3 cups water
1 teaspoon salt
2 large tomatoes, peeled and cut in pieces
2 medium-sized potatoes, peeled and cubed
1 cup lima beans. Use either frozen or tinned beans
1 cup whole kernel sweet corn
1 teaspoon sugar
Pinch of cayenne pepper
3 tablespoons finely chopped parsley
3 tablespoons finely chopped spring onions

Cut stewing beef into small cubes. Remove most of the fat or the finished dish will be too fatty. Melt butter and add onion and bacon. Saute until onion is softened and bacon transparent. Remove. Add beef and turn up heat. Stir until the beef has changed colour. Add tomato paste, water and salt and return onion and bacon to the pan. Cover and simmer gently for about 45 minutes. Add diced hen meat and cook for another 10 minutes. Using a slotted spoon, remove the meats. Both should be quite tender. Test by fork. Add tomatoes, potatoes, drained lima beans and corn to the liquid and cook until potatoes are tender. Add sugar and cayenne to the stew, return beef and hen meat and heat gently again. Before serving, sprinkle the top with parsley and spring onion. This dish reheats most successfully. (Serves 6)

Hen curry with sultana rice

1 large hen, boiled
1 green pepper
2 tablespoons curry powder
1 teaspoon salt
1 tablespoon sugar
2 large onions
60 g butter or substitute
3 tablespoons plain flour

1/2 teaspoon pepper
3 cups hen stock

Discard skin and bones from hen, chop meat into medium-sized pieces. Chop onions and green pepper, saute in melted butter for 5 minutes. Add curry powder, flour, salt and pepper, fry for 2 minutes. Add sugar, stock and stir until thickened. Add chopped hen and simmer 10 minutes. Serve with sultana rice.

SULTANA RICE

1 cup rice
1/4 cup sultanas
1 teaspoon salt
3 tablespoons chopped parsley

Boil 8 cups of water rapidly. Add 1 cup rice and salt, and sultanas. Boil 12 minutes. Drain well, then lightly mix through chopped parsley. (Serves 4 to 6)

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Pests of legumes

compiled by officers of Entomology Branch

Corn earworm (*Heliothis armiger* (Hubner))

The corn earworm is an important pest of navy beans and soybeans. Bean crops are invaded by adults at the commencement of flowering and the peak of egg laying usually coincides with peak flowering. White spherical eggs are laid on terminals, buds, petioles, stems and leaves; the larvae feed on leaves, flowers and developing seeds in the pods. During summer, the life cycle takes 5 to seven weeks. Only one generation is usually completed in any one bean crop.

Damage to pods and seeds reduces yield and quality. On navy beans, good control of corn earworm is important if high quality seed is to be produced. During a wet harvest, water enters the feeding holes and stains undamaged seed.

The closely related budworm can infest soybean crops during the early growth stages. It feeds on terminals and leaves. The terminal damage can cause excessive branching and result in low pod set and harvesting difficulties.

Green vegetable bug (*Nezara viridula* (Linnaeus))

The green vegetable bug is an important pest of soybeans and navy beans. The females deposit rafts of 20 to 150 eggs on the lower surface of leaves. The nymphs are initially orange-brown. As they grow, they develop black, yellow and red patterns, but green predominates in later instars.

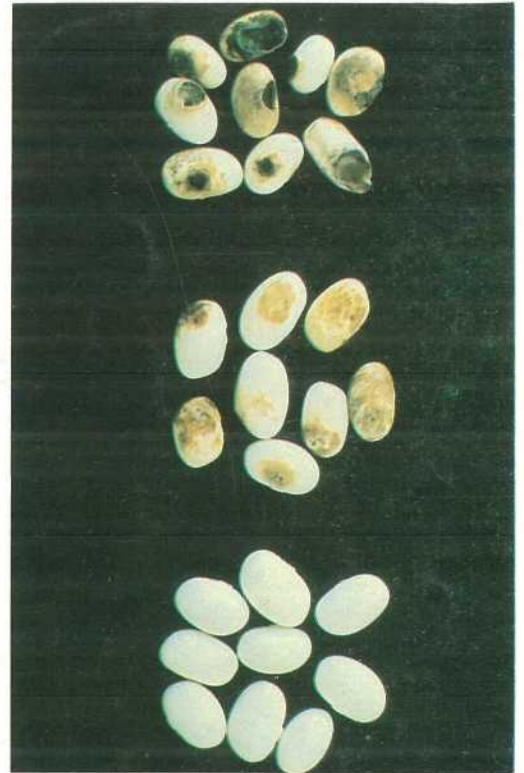
The life cycle takes about 5 weeks in summer. Both the juvenile and adult stages feed by piercing and sucking the developing bean seeds. This causes young seeds to abort and partly grown seeds to shrivel. Fully expanded seed exhibits a black spot in a depressed area at the puncture point. Bug feeding reduces yield and quality on both soybeans and navy beans.

Bug populations are very patchy, so thorough crop inspections are important. A large proportion of bugs move to the top of the canopy and 'bask' in the sunlight between 7 a.m. and 9 a.m. Crop inspections are best done at this time.

Pests of legumes



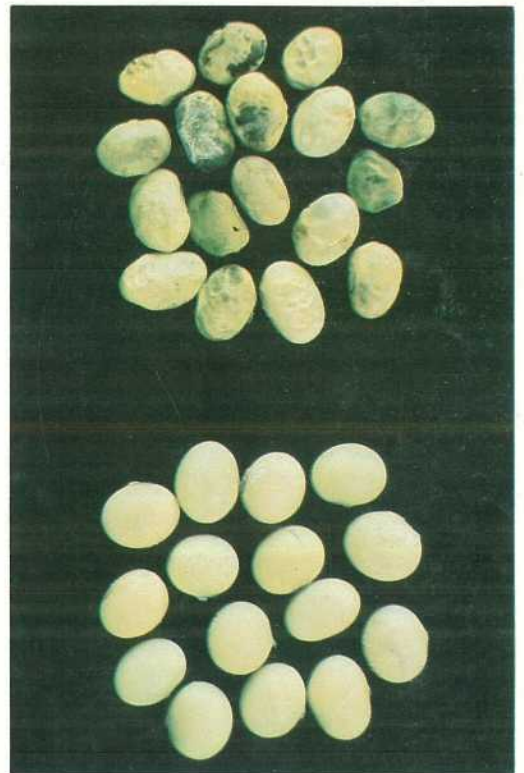
Young corn earworm larva on soybean flower (x2).



Navy bean seed damaged by corn earworm (top), undamaged seed (bottom), seed stained by water entering the pod following insect damage (centre).



Green vegetable bug adults and nymphs on beans (x3.3).



Bean seed damaged by green vegetable bug (top), undamaged seed (bottom).