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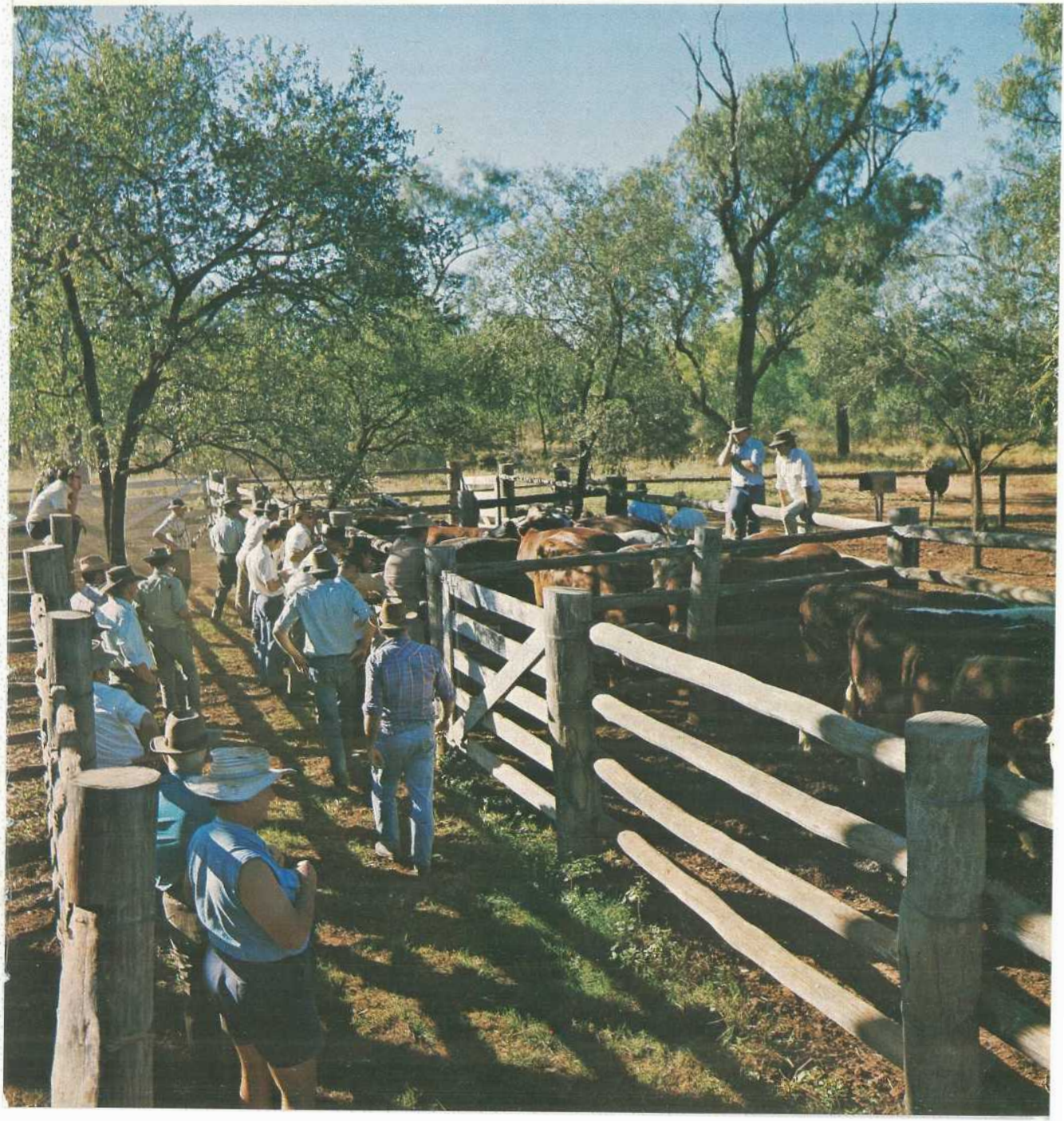

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COVER: Many Queensland saleyards are investigating the possibilities of auctioning on a liveweight basis. See 'Liveweight selling of cattle' in this issue. Photograph—J. Black.

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Editor—P. R. LEE

Contents

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Storing and spreading bulk

BULK fertilizer costs less than the more conventional bagged fertilizer, and the use of bulk has increased rapidly over the last few years.

However, under poor storage conditions, these cost savings can be lost. In fact, bulk fertilizer can be more expensive than bagged fertilizer if wastage is excessive.

Initially, the fertilizer storage methods used were primitive because some loss was acceptable in the days of cheap fertilizer. Those days are gone, and losses must now be minimized.

Storage systems

The storage systems available are:

- Short term—Uncovered paddock dumping or covered paddock dumping
- Long term—gravity feed bulk bins or sheds

The best storage system for each property will depend on:

- Length of storage (short term or long term)
- Time of year
- Locality

Length of storage

Short term storage systems such as paddock dumping are quite suitable for temporary storage. Permanent systems such as bulk bins and sheds should be used if the fertilizer is to be stored for several months or from one season to the next.

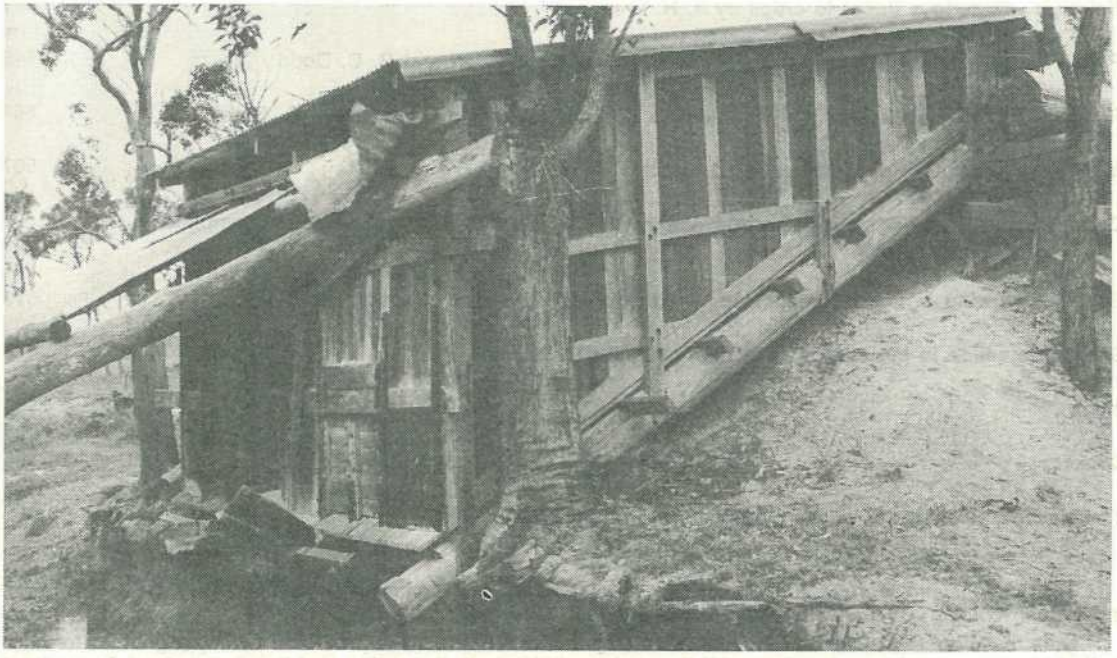


Plate 1. A 25 tonne gravity feed bulk bin—Mr R. M. Sommerfield, Maryborough district.

granulated fertilizers

by J. W. WRIGHT,
Agriculture Branch.

Time of year

Short term storage systems such as paddock dumping are suitable during the drier months of the year. Bulk bins and/or sheds are the only systems suitable for storage during the wetter months.

Locality

Uncovered paddock storage is only suitable for those areas of the State that experience a pronounced wet and dry season. Such areas are the dry tropics (the coastal and sub-coastal area from Bowen to Townsville, Cape York Peninsula, Gulf areas and inland areas).

Site selection

The selection of the dump site is extremely important and the following criteria should be considered.

- TOPOGRAPHY. Avoid areas where run-off water from adjoining areas is likely to be a problem. The crest of a ridge is an ideal site.
- DRAINAGE. A well-drained site is essential to reduce wastage from seepage.
- ACCESSIBILITY. Access to the site must be possible by heavy trucks whenever required. If access is doubtful, the site should be relocated.
- FREEDOM FROM STONES. Select an area where the soil is free from stones. If this is not possible, then some wastage will occur when loading the fertilizer into the spreader. Damage to the spreading mechanism may occur if stones enter the spreader.

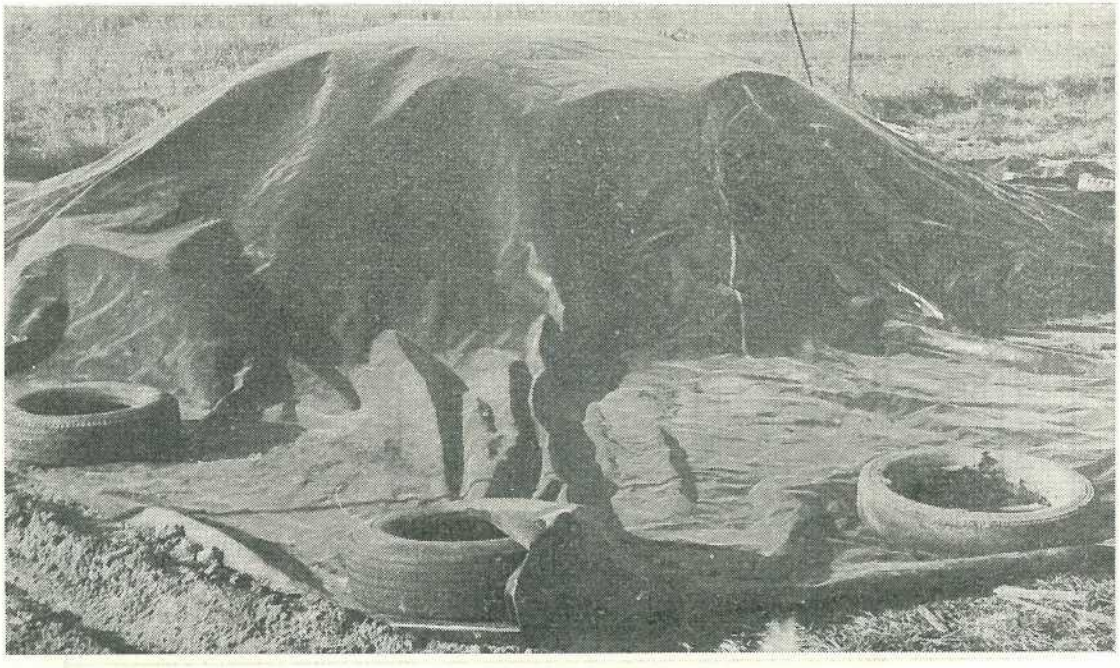


Plate 2. Paddock dump. Note the plastic sheet weighted with old tyres.

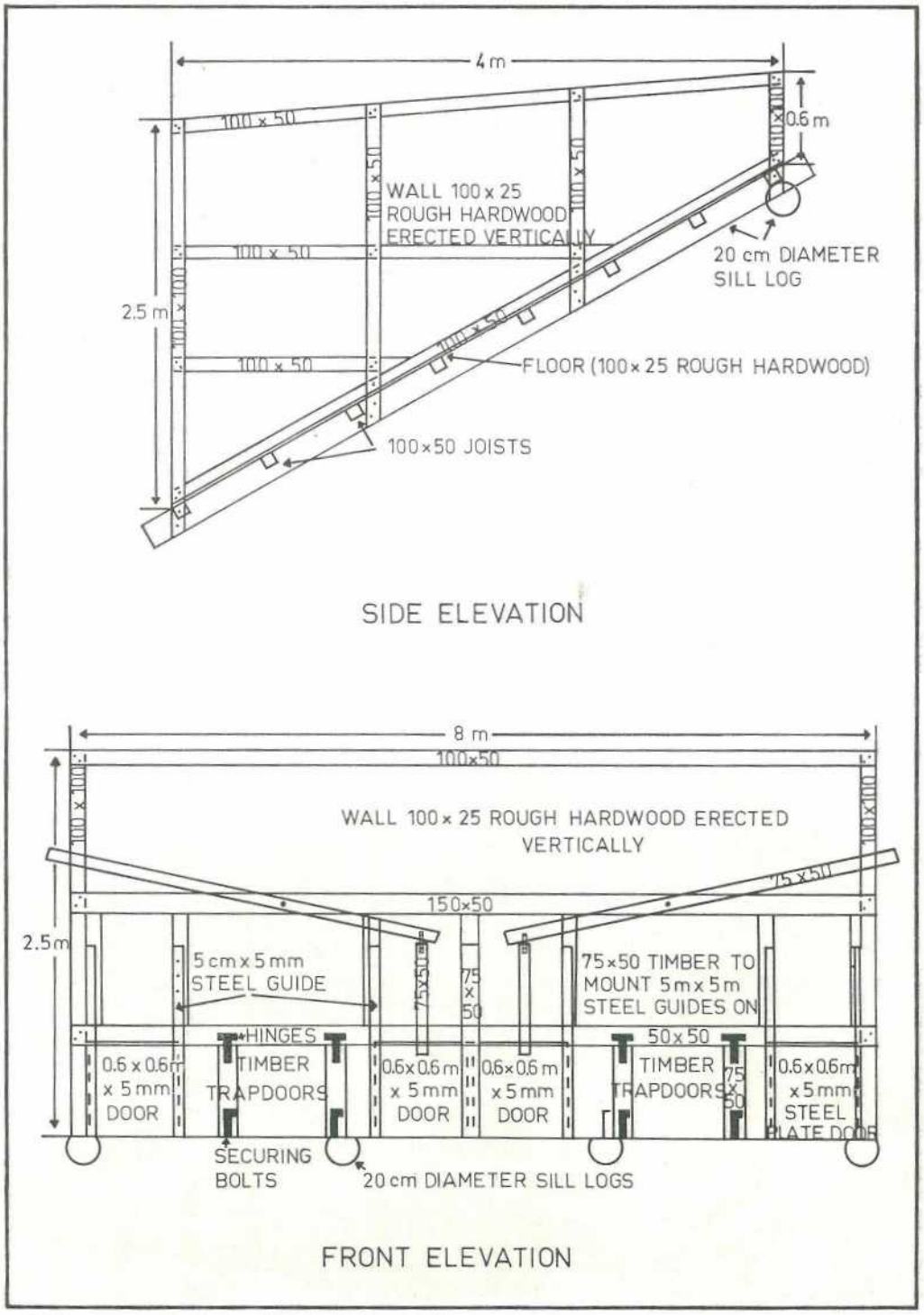


Figure 1. 25 tonne gravity feed bulk bink specifications.

Preparation of site

Poor site preparation is one of the major causes of wastage. Fertilizer is often dumped on top of grass, stones, etc. which prevent total recovery when loading into the spreader.

All grass and other contaminants should be removed from the site prior to dumping. This can be done by grading with a tractor-mounted grader blade until all vegetation is removed. The surface must be firm and level.

Uncovered paddock storage

This method is commonly used in those areas of Queensland where a monsoonal type climate with pronounced wet and dry seasons is experienced.

During the dry season from May to October, the chance of receiving sufficient rain to cause damage to the fertilizer is remote. Light rain causes crusting of the surface of the fertilizer and usually this crust will break up in the spreader. Heavy rain, however, will result in losses and in extreme cases a total loss is possible.

Covered paddock storage

This method is similar to the above in all aspects except that a plastic sheet is used to cover the dump to prevent water damage from rain. Although this method is often used for long term storage, the losses from seepage are too high to recommend its use for other than short term storage.

The plastic sheets can be purchased, but are usually hired from the fertilizer companies for a nominal charge. The current charge is 40 cents per tonne. As the sheets are easily damaged by livestock and winds, the following precautions should be taken to prevent damage.

- A fence should be constructed around the dump site to keep stock out and the sheet should be weighted with old tyres.
- A V-shaped drain should be constructed around the perimeter of the dump and continued away to a lower area. This will collect and dispose of any run-off from the cover during rain.

Gravity feed bulk bins

This storage method is not as widely used as it could be. It is suited to properties fertilizing areas in excess of 500 ha per year. The main advantage of this method is that the only equipment required is a spreader. An end loader is not necessary.

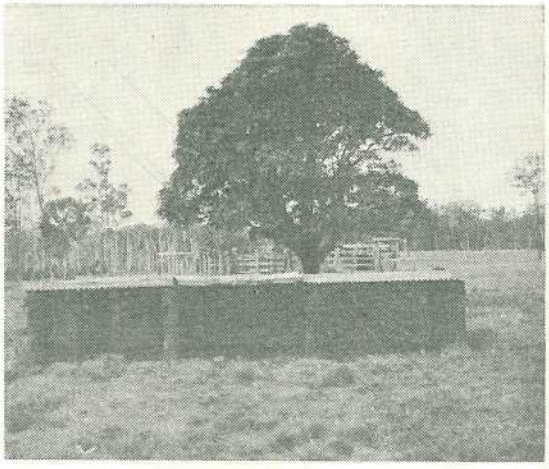


Plate 3. A 16 tonne timber bin on the property of Mr K. Miller, Maryborough.

The best site for a gravity bin is on the side of a ridge, otherwise the amount of earth moving required raises the cost. The estimated cost of building a 25 tonne bin (Plate 1) from timber is $1 150. If a concrete floor is used instead of timber, the cost is approximately $1 000.

Only a relatively small tonnage of fertilizer can be stored at any one time. If the bin is not centrally located on the property, and this is not always possible or desirable, travelling time to refill the spreader can be excessively high.

The specifications of a gravity feed bulk bin constructed with a timber floor are given in the sketch plans (figure 1).

The materials required are:

Rough hardwood ..	150 x 50	10·5 m
	100 x 100	7·5 m
	100 x 50	85·1 m
	75 x 50	36·5 m
	75 x 37	33·0 m
	100 x 25	324·0 m
20 cm diameter sill logs ..	25·5 m	
Corrugated iron ..	6 x 5 m sheets	

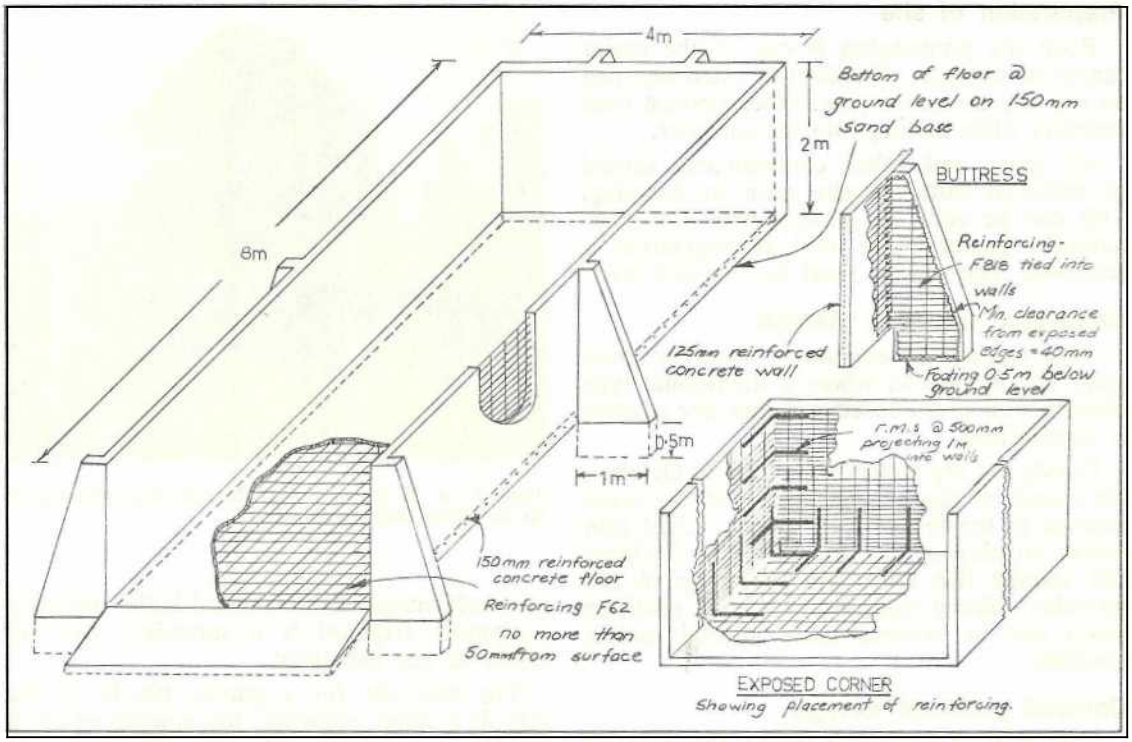


Figure 2. 50 tonne bulk fertilizer bin.

5 mm steel plate	1·25 m²
50 x 5 mm steel bar	9·6 m
12 x 112 mm bolts	100
Hinges	4
Pad-bolts	4
Excavation and preparation of site	4 to 5 hours.
Labour requirements	16 hours to cut and prepare bush timber for sills. 320 hours to cut out and erect bin. 160 hours allowed for in costing at $2.50 per hour.

Sheds

Sheds are used for storing bulk fertilizer and are commonly used for long term storage from season to season.

An 8 m x 4 m x 2 m shed or bin will hold approximately 50 tonnes of fertilizer. This would be more than big enough for most farmers. A timber bin on which this design is based is illustrated in plate 3.

The specifications of a concrete bin with a roll-on, roll-off roof are given in figure 2.

The materials required to build the concrete bin are:

Concrete (4·5:1 mix)	
Floor	4·8 m³
Concrete (5:1 mix)	
Walls	5·0 m³
Buttresses	2·1 m³
Type F62 Arc mesh reinforcement	4 sheets
Type F818 Arc mesh reinforcement	4 sheets
12 mm steel roof (reinforcement for corners)	54 m
Corrugated iron (roof)	6 x 10 m sheets

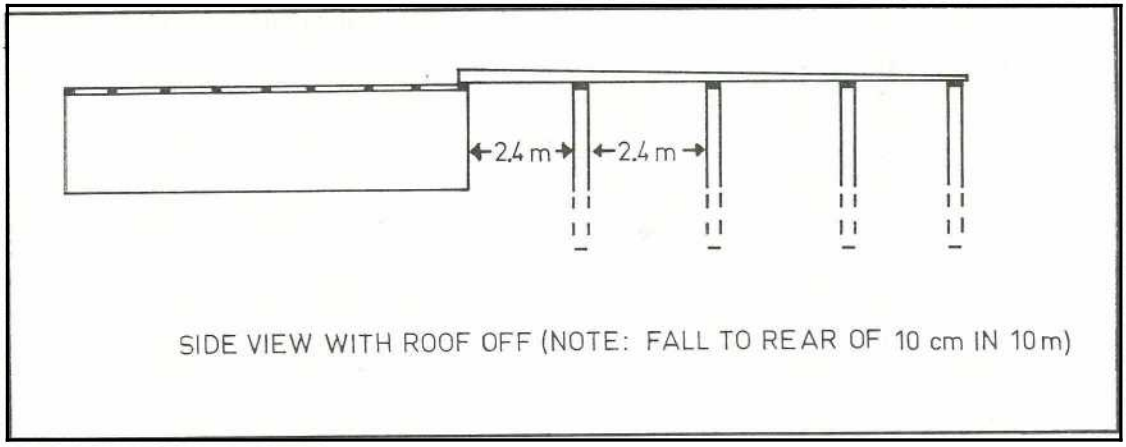


Figure 3.

70 x 50 x 6 mm angle iron for runners	4 x 8·5 m
37 mm pipe for rollers (26)	2·4 m
150 x 25 timber for boxing (4 m section of wall)	30 x 4 m lengths
150 x 25 timber for boxing (buttress)	7 x 4 m
150 x 50 timber for roof bearers	2 x 10 m
75 x 50 timber for rafters	10 x 5 m
75 x 50 timber for dropboard slides	4 x 2 m
Round posts (timber or steel pipe)	8 x 3 m

Labour requirements 200 hours (100 hours assumed to be paid in calculations)

Labour requirements are higher than 200 hours if readimix concrete is not used.

To reduce costs, the 150 x 25 timber used for formwork for the wall sections can be used for dropboards.

The roll-on/roll-off roof saves time and is easier to operate than the usual method of covering bins with loose sheets or corrugated iron.

The estimated cost of constructing this type of storage facility (see figure 3) is $1 400.

Disadvantages of using sheds with galvanized iron walls for storage are that maintenance costs are high because of the corrosive nature of fertilizer. Timber or concrete that has been acid-proofed has lower maintenance requirements. The capital cost involved in building a shed for storing fertilizer can also be high especially if the shed is larger than you require.

Spreading system

The farmer or grazier fertilizing large areas has several systems to choose from. The small farmer because of the smaller areas involved is restricted and has virtually no choice. He either buys a small 0·4 tonne spreader or hopes to be able to borrow his neighbour's spreader.

The systems available include:

- Contract spreading—
  aerial
  ground
- Owner-operated large spreader (5 tonne) from gravity feed bulk bins.
- Owner-operated large spreader (5 tonne) from shed.
- Owner-operated large spreader (5 tonne) from dump.
- Owner-operated small spreader (0·4 tonne) from dump.

Factors affecting evenness of spreading

Irrespective of the spreading system that is used to apply the fertilizer, the factors that determine whether the area is fertilized evenly are the same.

These factors are:

- BOUT WIDTH. This is the most important factor affecting the evenness of spread. The bout width is always less than the total spreading width of the machine because the application rate decreases as the distance from the machine increases. By overlapping the correct distance each time, an even distribution of fertilizer is obtained. It is usually not necessary for the farmer to have to calculate the bout width for each type of fertilizer as this information is available in the owner's operating manual supplied with the machine.

  Do not try to estimate bout widths, measure them out and use markers to maintain accuracy.

- GRANULE SIZE AND WEIGHT. The larger the granule size and/or weight, the greater the distance it will be thrown by the spreader mechanism. Granulated superphosphate will spread further than urea, nitram or muriate of potash which have a smaller granule size.

  Urea and nitram will spread approximately three-quarters as far as granulated superphosphate and muriate of potash two-thirds as far.

- WIND. Wind speed and direction are of vital importance when aerial spreading. It is claimed that skilled pilots can take advantage of wind in assisting distribution, but it is best to assume that it is a serious limiting factor in obtaining an even distribution of fertilizer.

  Ground application methods are not affected to the same extent as aerial methods, but the effect of strong winds should always be taken into consideration when determining the bout width to use.

- SPINNER SPEED. There is an optimum spinner speed for all P.T.O. driven spreaders, and this should be maintained in order to obtain the optimum spreading distance. A common mistake made by many operators is to drive the spinner at lower P.T.O. speeds than recommended. This results in a very narrow spreading width, and unfertilized strips often occur.

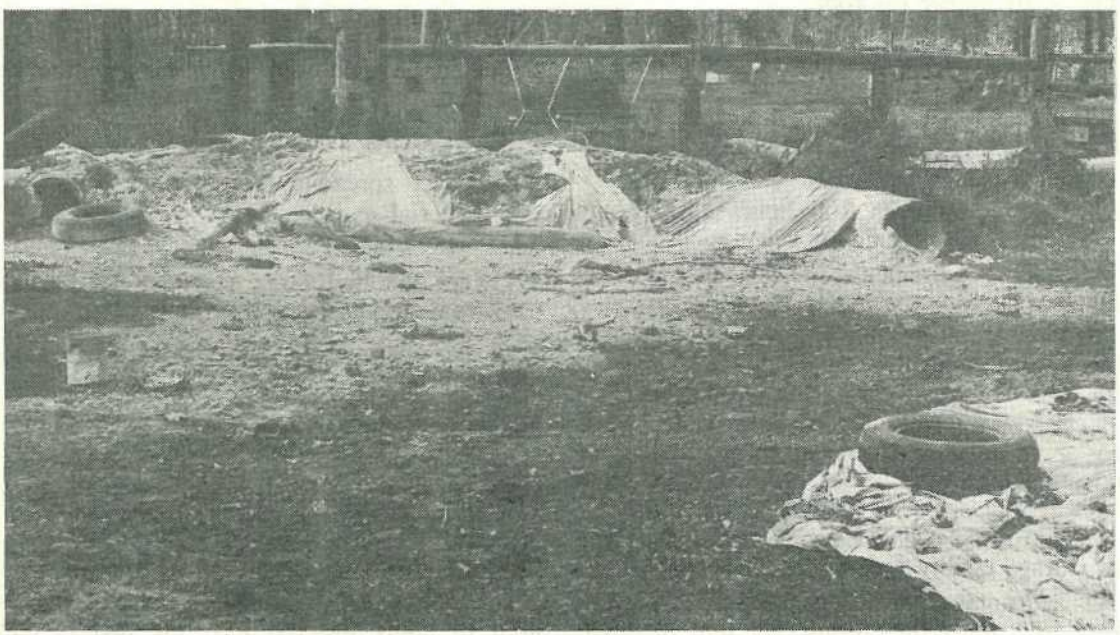


Plate 4. The results of long term storage with plastic covers. Note the tears in the plastic covers and the resulting wastage of fertilizer.

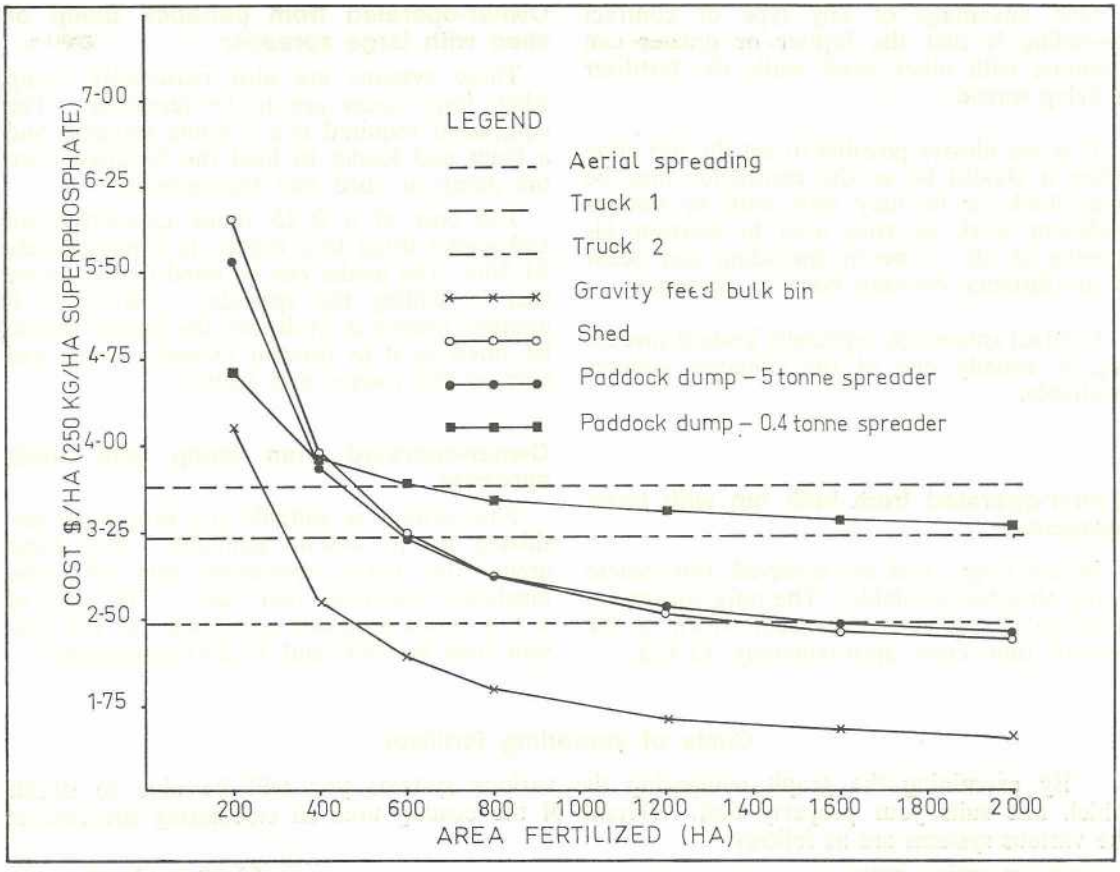


Figure 4. Costs of spreading fertilizer.

The machine has not been made that will give a perfect distribution of fertilizer. The only method that can be used to achieve near perfect distribution of fertilizer is to apply half in one direction and the other half at right angles to the first application. However, this method doubles the cost of application.

Aerial spreading

This system is the only one that can be used for fertilizing mountainous and/or timbered areas. It is essential that markers be used to prevent stripping and/or excessive overlapping. These can be made from reflective vinyl material and fitted to a frame on a vehicle. The markers have to be shifted following each run.

The cost per tonne and the hourly spreading rate are both directly related to the application rate per hectare, the distance from the airstrip, the type of aircraft being used, the type of fertilizer and the area involved. At present, prices range from $13 to $21 per tonne.

Ground spreading

Contract spreading by truck and to a lesser extent by tractor-operated spreaders has been used successfully by many farmers and graziers.

These methods will continue to be popular. A very even distribution of fertilizer can be obtained provided the operator is experienced and the distance between bouts is not excessive. The cost per tonne applied is directly related to the application rate, type of fertilizer and area involved.

One advantage of any type of contract spreading is that the farmer or grazier can continue with other work while the fertilizer is being spread.

It is not always possible to get the job done when it should be as the contractor may be unavailable or he may wait until he obtains sufficient work in your area to warrant his coming at all. Uneven spreading can occur if the distance between bouts is excessive.

Contact spreading, especially ground spreading, is usually one of the cheapest systems available.

Owner-operated from bulk bin with large spreader

Where large areas are involved, this system is the cheapest available. The only equipment required is a 5 tonne spreader which at the present time costs approximately $3 125.

Owner-operated from paddock dump or shed with large spreader

These systems are also reasonably cheap when large areas are to be fertilized. The equipment required is a 5 tonne spreader and a front end loader to load the fertilizer from the dump or shed into the spreader.

The cost of a 0·25 tonne capacity front end loader fitted to a tractor is approximately $1 200. The loader can be fitted to the tractor that is pulling the spreader. However, if another tractor is available, the loader should be fitted to it to prevent excessive wear and tear on the tractor and loader.

Owner-operated from dump with small spreader

This system is suitable for properties fertilizing up to 400 ha annually. For large areas, the lower spreading rate of these machines precludes their use. The cost of a 0·4 tonne spreader and loader at the present time is $600 and $1 200 respectively.

Costs of spreading fertilizer

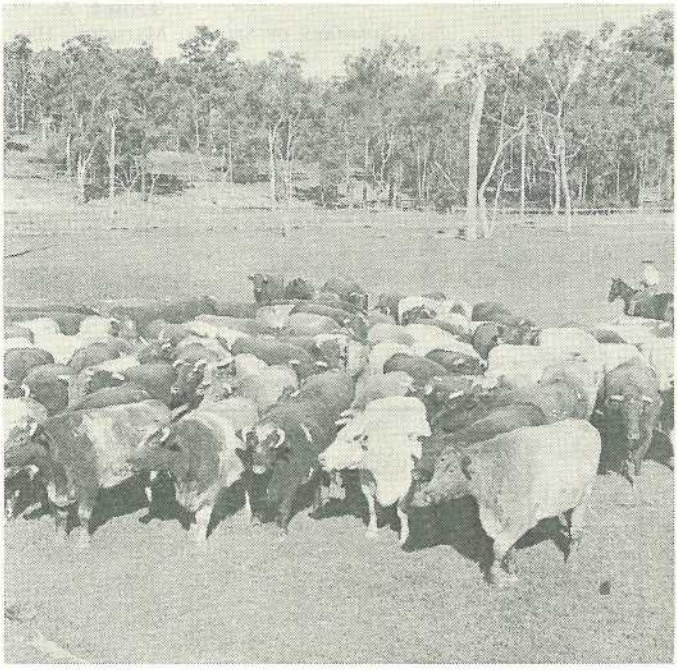
By examining the graph comparing the various systems you will be able to decide which one suits your property best. Details of the costing used in calculating the cost of the various systems are as follows:

Tractor operating costs	$2.08 per hour
Labour	$2.50 per hour
Annual D.I.R. and M.* on spreaders—10 year life	16·8%
Annual D.I.R. and M.* on bulk bins and shed—30 year life	6·8%
Annual D.I.R. and M.* on end loader—12 year life	16·3%
Loading rate of loader	7·5 tonne per hour
Spreading rates including downtime for loading, travelling and maintenance:	
5 tonne spreader	4 ha per hour
0·4 tonne spreader	2 ha per hour
Contract rates—aerial	$14.20 per tonne
Contract rates—truck—2	$9.50 per tonne
Contract rates—truck—1	$12.00 per tonne

* D.I.R. and M. = Depreciation, interest, repairs and maintenance.

Liveweight selling of cattle

by W. J. A. Hall, Beef Cattle Husbandry Branch.



Grand bullocks—how much guesswork will there be in the sale price? (Photograph—Queensland Country Life)

SELLING cattle by liveweight is still at an early stage in Australia, but it is gaining favour.

The concept of selling cattle by liveweight has created considerable debate. Supporters claim higher returns for the producer, a decrease in guesswork and the opportunity for improved price reporting.

Critics, on the other hand, argue that liveweight selling increases running costs, increases bruising, has only marginal effects on accurate pricing, introduces heavy capital expenditure to the auction system, and runs a poor second to carcass classification.

The Metropolitan Abattoir Board's saleyard complex at Cannon Hill commenced weighing cattle in late 1975. A small number of Queensland country saleyards have also installed scales and a large number of others are now considering installation.

At Cannon Hill, trading cattle by weight, that is, by cents per kilogram liveweight, has proved to be very popular among sellers and has almost replaced the open auction (price per head) method of sale (see figure 1).

Scales have been constructed in approximately 40 saleyards in New South Wales. However, in Victoria, liveweight selling of cattle is not significant.

The purpose of this article is to examine the arguments for and against liveweight selling in the context of the whole marketing system.

TABLE A

SUMMARY OF SELLING METHODS—HAWKESBURY COLLEGE

Year	No. of cattle	Open auction		Liveweight		Weight and grade	
		Net price per head	Cents per lb.	Auction net price per head	Cents per lb.	Net per head	Cents per lb.
		$		$		$	
1971	6	131.76	(13·4)	135.29	(13·8)	139.41	(14·2)
1972 (a) ..	10	..	..	128.10	(14·6)	128.57	(14·7)
1972 (b) ..	8	125.04	(12·15)	144.99	(14·10)	150.32	(14·54)
1973	7	115.29	(17·07)	102.93	(15·06)	113.75	(17·03)
1974	10	86.07	(23·6)*	88.71	(24·4)*	106.53	(29·3)*

* Cents per kilogram.

Source: 'Marketing of Beef Cattle in Australia'—presented to the National Beef Symposium, Wagga Agricultural College, 1974.

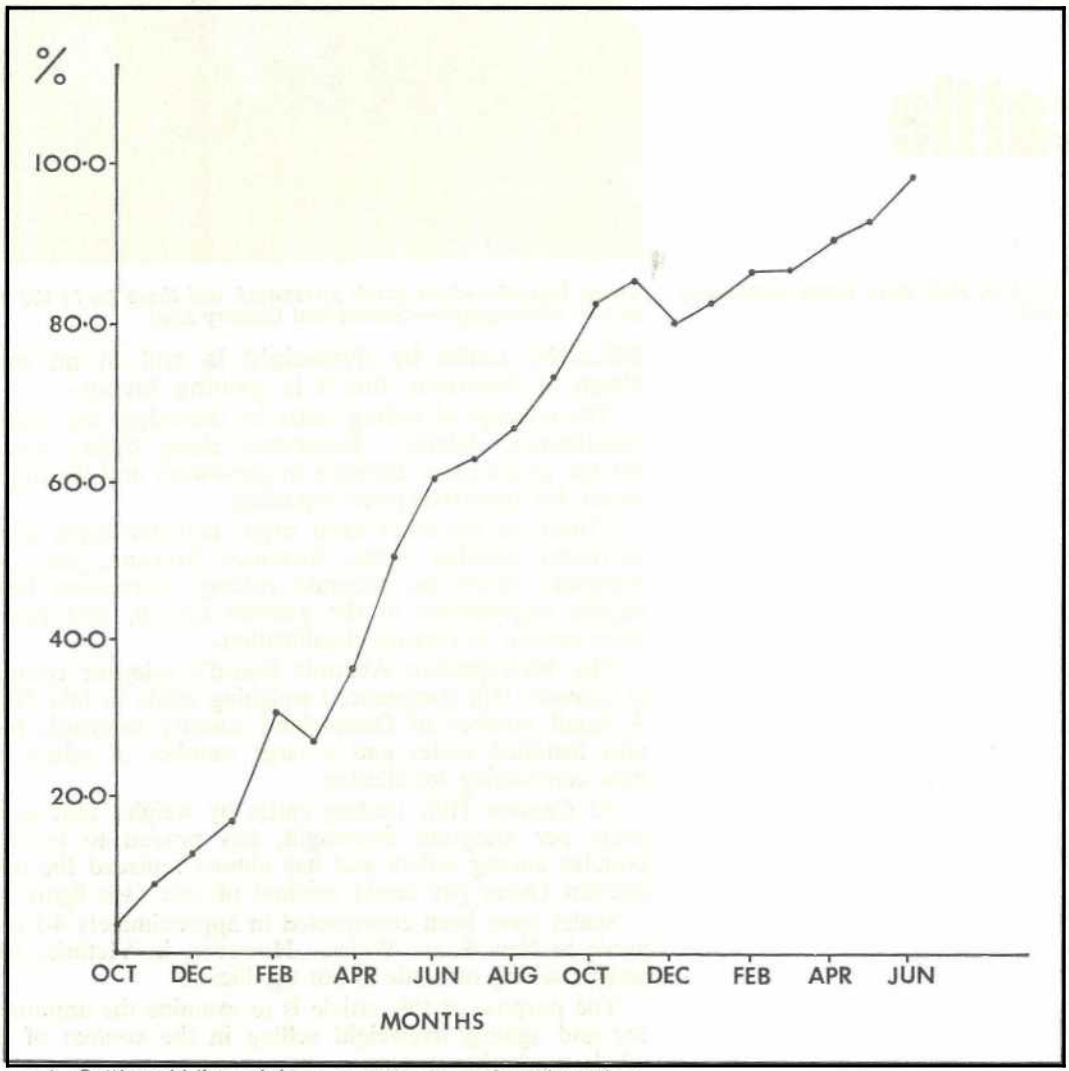


Figure 1. Cattle sold liveweight as a percentage of total auction.

Increased returns

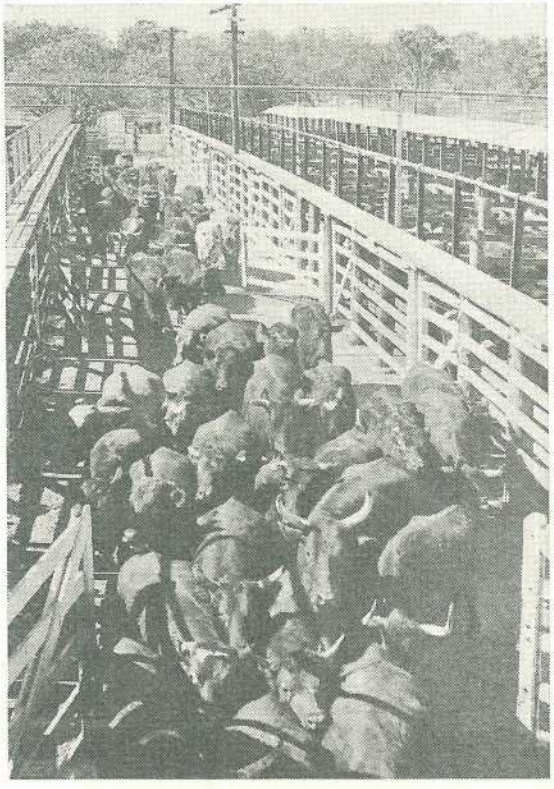
The Hawkesbury Agricultural College (N.S.W.) compared various selling methods over a 5-year period. They divided cattle into groups according to liveweight and condition score and sold each group through a different system. The pertinent results are summarized in table A.

The comparison is in terms of the net price to the producer, after marketing costs have been deducted.

The results of the Hawkesbury survey constitute an advantage of 3% selling liveweight over open auction, and an advantage of 11.3% selling weight and grade (that is, direct to meatworks) over open auction. No such detailed comparisons have been carried out in Queensland.

This does not suggest that there will not be short term variations in price between the two systems. Many cattlemen noticed a marked increase in the price of bulls at Cannon Hill. At Homebush, while overfinished stock were discounted in the open auction (that is, on a per head basis) on account of their excess fat, they attracted a premium over the scales probably because of their higher dressing percentage.

In the long term, however, it seems highly unlikely that the price paid for cattle by open auction will differ significantly from that paid for similar cattle over the scales. Buyers will soon make compensatory adjustments to their price schedules. There will of course be the extra costs associated with weighing and thus differences in the net return to producers.



Selling through the saleyards is demanding on labour and time.

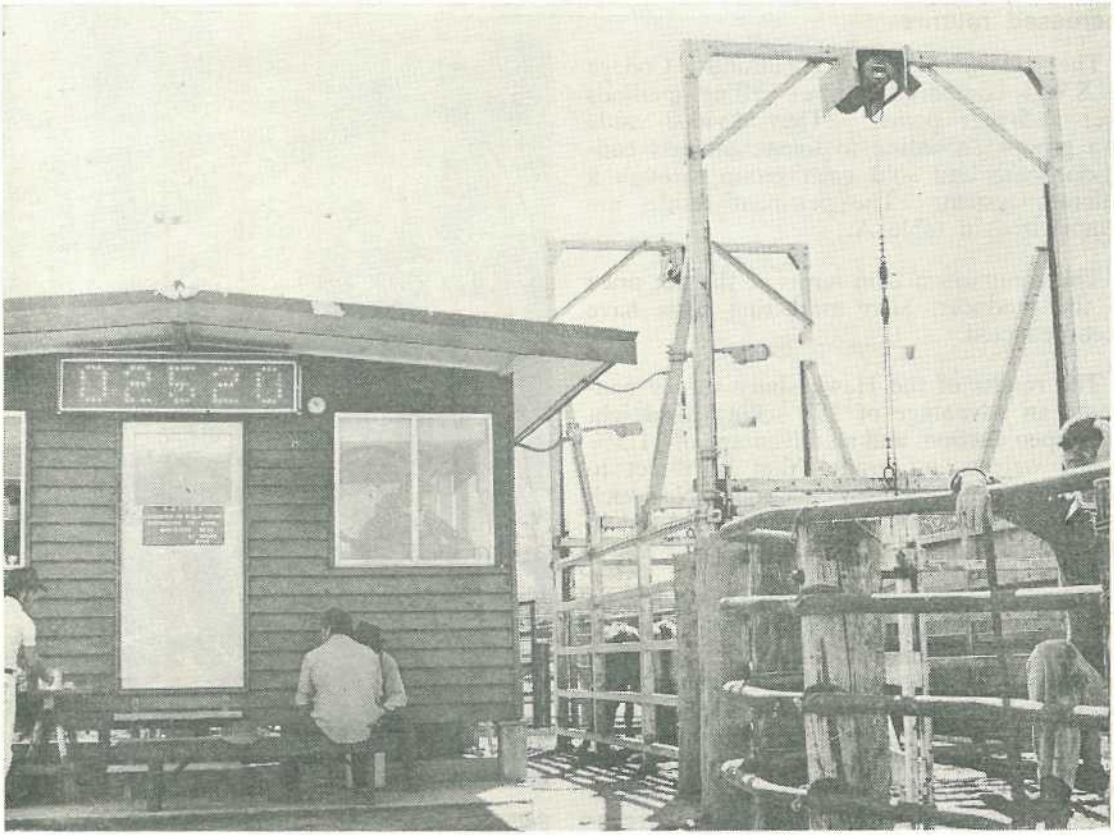
Eliminating guesswork

Liveweight selling shifts the emphasis for the buyer from estimating dressed weight to estimating the dressing percentage. Bidding is in fractions of a cent per kilogram liveweight, thus it is the variation in dressing percentage (and carcass quality) which interests the buyer most. He is likely to pay more for cattle he believes will have higher dressing percentages.

Changes in gut fill cause much of the variation in dressing percentage. Most saleyards attempt to minimize fluctuations in gut fill by applying standard fasting times (no feed or water) prior to weighing. Even then differences in overnight shrinkage according to forage, season and class of cattle have been observed.

Although many of the other factors affecting dressing percentage can be visually assessed by the buyer, (such as condition, sex, breed and liveweight—see table B) the variation in gut fill can not be assessed and is not completely equalized by the fasting period.

This variation in gut fill will be accentuated considerably if the fasting period is not policed properly.



Under a liveweight selling system, the weights should be clearly visible to all interested parties.

TABLE B

VARIATIONS IN D.P. ACCORDING TO LIVEWEIGHT AND BREED

Mixed breeds		Dressing %	Mixed Weights		
No.	Mean liveweight		No.	Breed	Dressing %
15	338·9	47·87	30	Brahman X	51·61
15	400·6	48·23	30	Friesian	47·59
45	500·8	50·18	30	Shorthorn	49·32
15	603·3	50·43			

Source: Q.D.P.I. Trial KRS–CH332–BF.

Little is known about the effects of different travelling times on the cattle but even with a 12 hour fast, different travelling times could be expected to increase the variation in gut fill rather than reduce it.

A detailed Canadian study showed that only 20% of animals sold liveweight were priced accurately by buyers according to dressing percentage. Thirty % of animals had a total price error of more than $10.00 per head. The study concluded that animals with a high dressing percentage were undervalued and animals with a low dressing precentage were overvalued.

Another American study shows a similar trend (table C.).

TABLE C

CATTLE BUYER ACCURACY IN ESTIMATING DRESSING PERCENTAGE OF CATTLE PURCHASED INDIVIDUALLY 1954 AND 1966

	1954 Regional study		1966 Ohio study	
	No. of head	%	No. of head	%
Estimated too high	234	33·0	95	37·0
Estimated correctly	73	10·3	25	9·7
Estimated too low	403	56·7	137	53·3
TOTAL	710	100·0	257	100·0

Source: Ohio Agric. Research and Development Centre Bulletin 1037.

These results show clearly that estimating dressing percentage is subject to error. This is not a reflection on the buyers' skill because much of the error is probably due to gut fill variation. If the measure of efficient marketing is that the producer is paid for exactly what he produces then liveweight selling is inferior to trading on the weight and grade of the carcass, where no estimation of either weight or dressing percentage is required.

Store selling

In both N.S.W. and Queensland, liveweight selling has been concentrated in the fatstock market. However, liveweight selling may assist in the more accurate pricing of store cattle. The scales remove the need to estimate the weight of store cattle, eliminating guesswork and reducing the uncertainty between buyer and seller.

Thus liveweight selling of stores could result in a more realistic relationship betwen the price of stores and fats and give the fattener more accurate information for estimating feed requirements and his probable fattening margin. Store selling of cattle over the scales is popular in some overseas countries.

In summary, liveweight selling of store cattle would involve less guesswork than open auction. Unlike fatstock marketing, an alternative system that is more objective does not exist.

Market reporting

The introduction of liveweight selling makes possible more accurate reporting of auction prices, although of course it cannot ensure that this happens. Regular reporting of prices based on weight and grade, or a carcass classification system, has the potential for being even more accurate.

Costs

Capital costs vary considerably depending on the degree of sophistication required and the extent of ancillary yards and raceways to be constructed. Many quotations are in excess of $100 000 although it is possible to cut this back by keeping ancillary requirements to a minimum. One saleyard has installed a set of ex-Railway Department scales. Those authorities which minimize capital investment will usually face higher running costs. Almost all the running costs are associated with labour, such as drafting, bookwork and operating the scales.

Bruising

Partially because of the large amount of drafting involved, liveweight selling increases the potential for bruising as compared to that which normally occurs under the auction system. The extent of the bruising caused from the extra drafting and weighing is not known. It will obviously vary considerably from yard to yard depending on drafting facilities, care taken by yard staff and the number of sale lots per pen. There is some evidence that ring selling, as opposed to pen selling, increases the prevalence of bruising.

Operating guidelines for liveweight selling

Fasting times

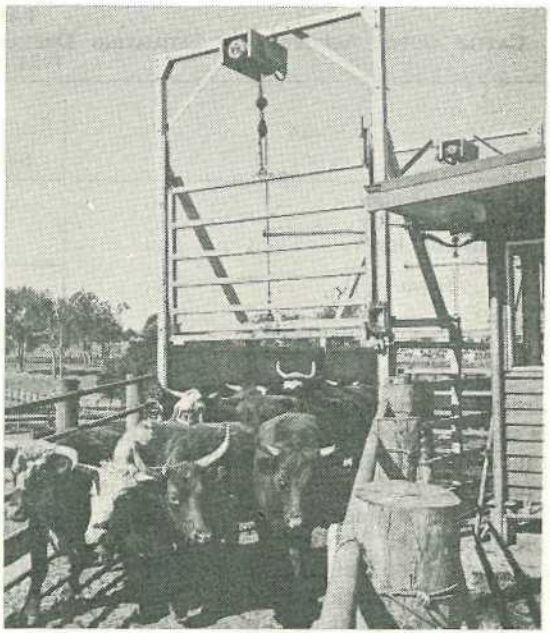
As pointed out earlier, variation in gut fill is a major source of variation in dressing percentage. In an effort to minimize this variation, most saleyards have adopted a policy of a minimum 12 hour fast prior to weighing for all cattle. (That is, no feed or water.) It is important that this policy be strictly adhered to.

Time of weighing

In N.S.W., some saleyards have adopted pre-sale weighing. It is argued that this is an improvement on post sale weighing because a knowledge of precise weight prior to sale allows for a more accurate estimation of dressing percentage. However, under a system of pre-sale weighing, cattle have to be brought to the yards early enough to allow for both the curfew and the weighing to be completed before commencement of the sale. Both Cannon Hill and Homebush have adopted post-scale weighing.

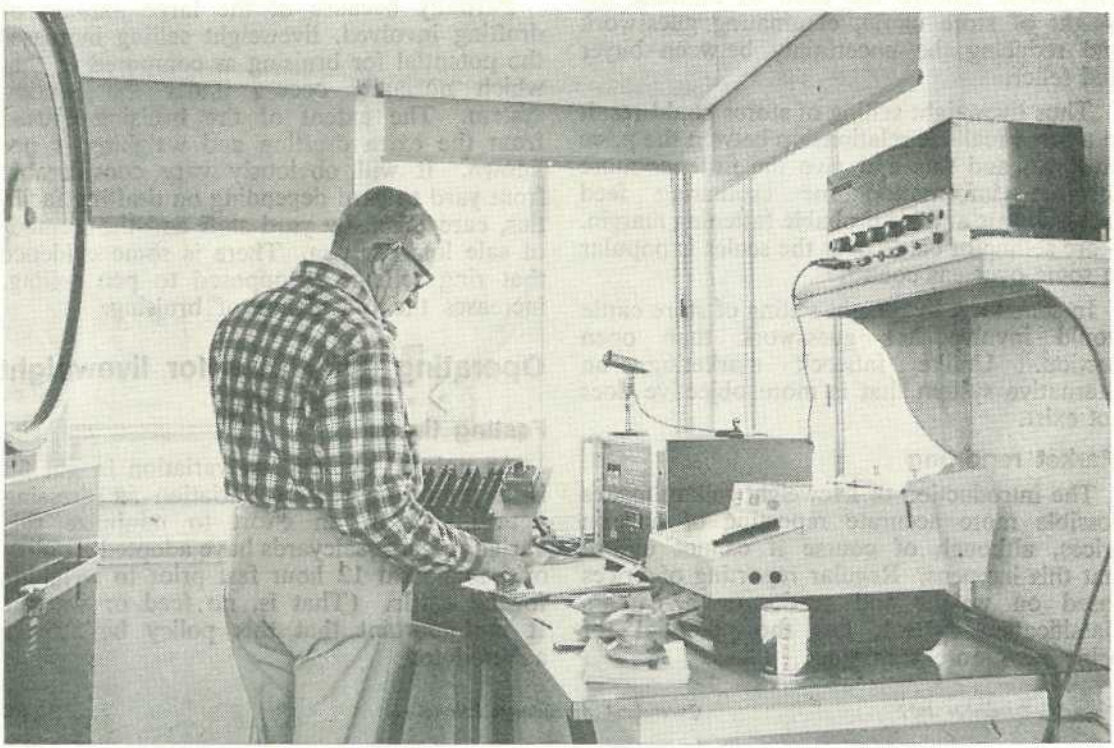
Drafting of sale lots

The weighing process is costly in terms of time and labour, largely because of the drafting of sale lots that has to take place after selling before weighing. The more sale lots per pen, the more pre-weighing drafting there is and hence the greater the potential for bruising, the greater the labour costs and so on. Unnecessary lot splitting should be discouraged. Of course, this applies to both liveweight and non-liveweight selling.



ABOVE. Does the liveweight selling system cause more bruising?

BELOW. Sophisticated equipment can be expensive, but it may save on the running costs of liveweight selling.



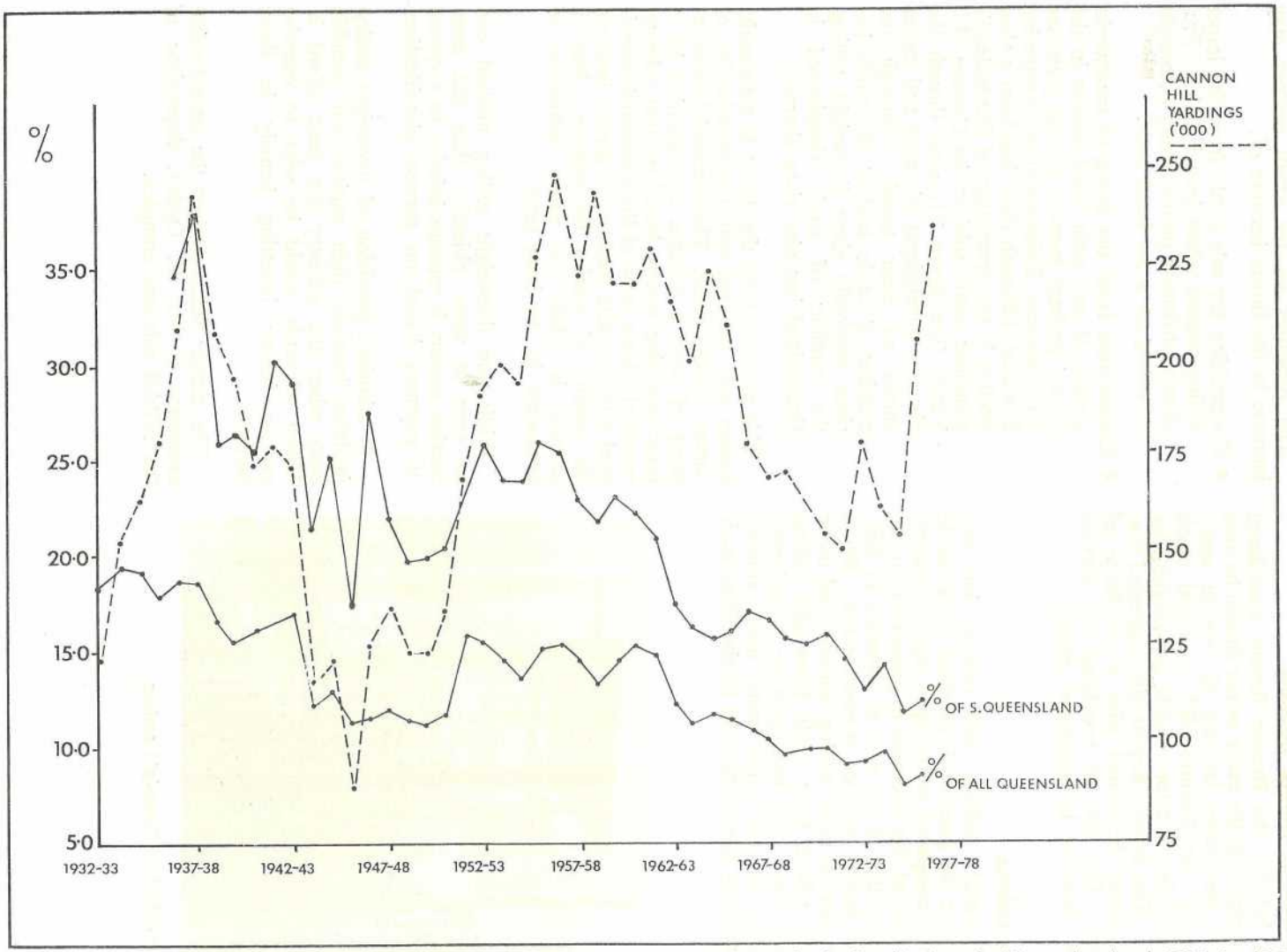


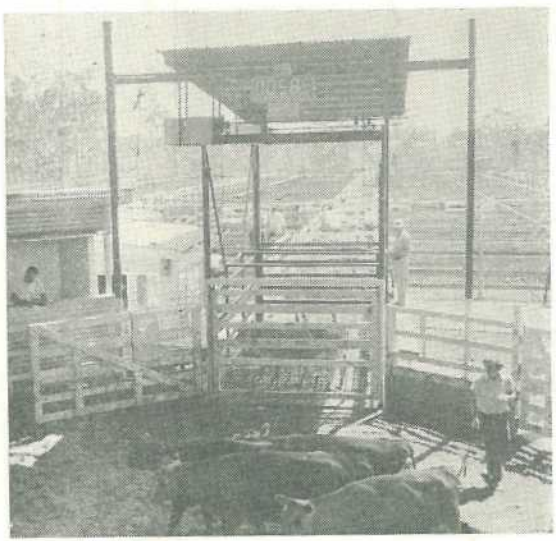
Figure 2. Cannon Hill yardings as a percentage of Queensland and south Queensland slaughterings (cattle and calves) 1932 to 1976.

Provision of weight dockets

In N.S.W., the Brewer Report considered it essential that the cattle owner should be able to see the scales indicate his weight automatically. At Cannon Hill, a digital clock provides this function outside the weighbridge office. The Brewer Report also suggested that each owner be issued with a certificate of weight. The cost of providing this service would need to be examined closely.

Conclusions

Liveweight selling will reduce, but not eliminate the guesswork involved in fat cattle trading compared to the open auction system. The cost of this decrease in guesswork to the industry, that is the cost of investing in liveweight selling facilities, is considerable. While the major fat cattle selling centres (and those centres where large scale liveweight selling of store cattle may develop in the future) may be able to cover their costs, many smaller centres may have difficulties in absorbing such costs.



Ring method of liveweight selling.

The pressures on the small centres may increase in the future because of:

- Competition for sale cattle from the larger selling centres which install scales. Producers obviously prefer selling liveweight to selling on a per head basis.
- Competition from the direct to meatworks system, if any such trend occurs in the future, perhaps because of cost pressures on producers. Evidence of this happening is scarce, although there has been a slow decline in the percentage of Queensland's slaughter cattle sold at the Cannon Hill Yards (see figure 2), even though the absolute throughput of cattle and calves shows no clear trend. Although the number of cattle sold at the yards has risen markedly since liveweight selling, the number of cattle slaughtered in Queensland has also risen sharply.

This pressure from the direct to meatworks system may increase with the introduction of carcass classification. The successful development of such a scheme accompanied by a price reporting system based on that scheme, would eliminate most of the guesswork associated with fat cattle trading and greatly improve the quality of market information. Such a scheme is likely to prove attractive to producers in the long term.

While the liveweight selling method can be seen as more objective than the open auction system, it remains inferior to a system of payment based on carcass classification.

In addition, provision of liveweight selling facilities involves high capital and variable costs when the industry can least afford it. Many saleyards would be wise to exercise caution before investing heavily in these facilities.

The author acknowledges the considerable assistance of Mr. E. Ogden, Supervisor of the MPAB saleyard complex.

Crop forecasting in the future

by I. J. S. DREW, Marketing Services Branch.

THE Department of Primary Industries' crop forecasting service could change dramatically in the next few years.

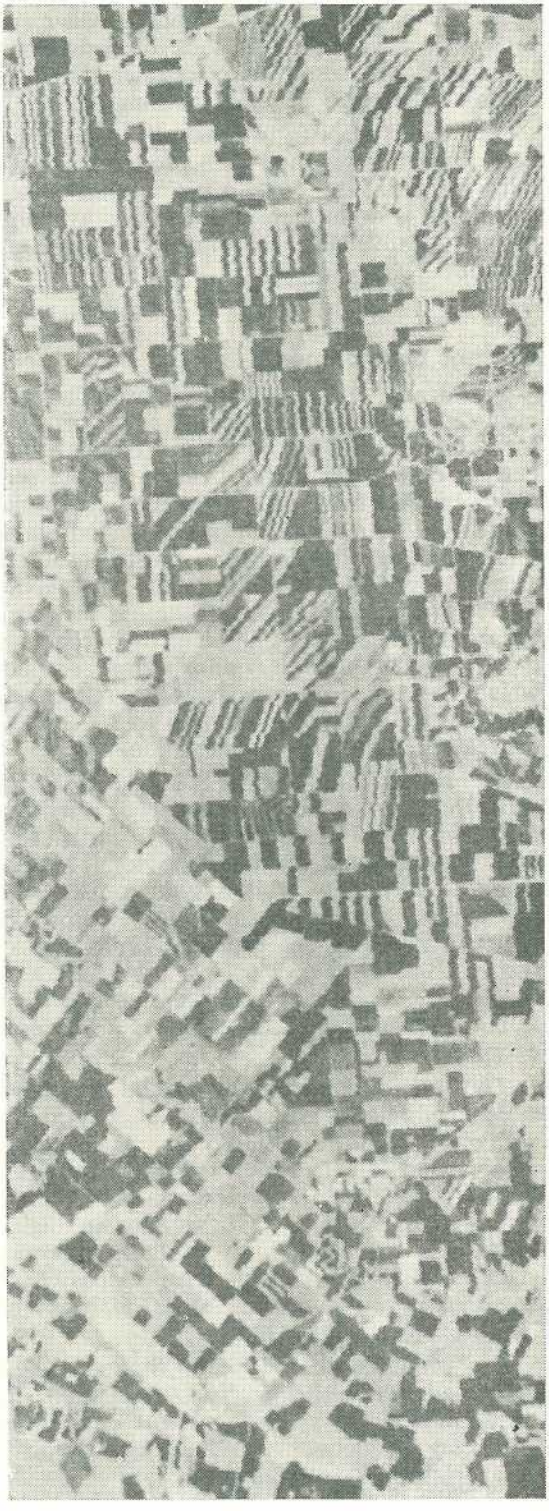
This article considers the types of improvements possible in the crop forecasting service, and the preparations which will be necessary to embody, at both the national and international level, the improved technology now available.

Marketing Services Branch provides the present crop forecasting service for the Department.

The present method

Forecasts are issued for the major grains and oilseeds as well as for peanuts, navy beans, potatoes and onions. These are made available three times during the respective growing seasons with the exception of potatoes and onions. The forecasts endeavour to provide timely information on intended plantings, actual plantings and, finally, production. In the case of potatoes, which are classified into spring and autumn crops, two forecasts are made. These refer to intended sowing and production.

The methodology is based on stratified random sampling of growers who report on specific areas of production. The dependency is on continuity of reporting and consistency of reports.



RIGHT. A LANDSAT image of the south-eastern Darling Downs area.

A lack of continuity in reporting will result in a reduced sample. A lack of consistency in reports will result in inaccuracies in estimation of change between seasons.

As the forecast is basically concerned with the area sown and with production, yield must be derived. The question that arises, therefore, is what new avenues are available or will be available to improve our present system?

Current developments

Significant developments have already occurred in the international area of crop forecasting and it would appear that the best current option lies in the field of remote sensing. In this field, the National Aeronautics and Space Administration of the United States of America has developed an Earth Resources Technology Satellite (E.R.T.S.) or LANDSAT. This experimental satellite has included, as a component of its instrument package, a tape recorder and a multispectral scanner which has a capacity to measure reflectance in four spectral bands from 0·5 to 1·1 micrometres but lacks cloud penetration.

In July 1972, LANDSAT 1 or E.R.T.S. 1 was fired into a polar orbit at a height of approximately 910 km circling the earth every 103 minutes and covering the total surface every 18 days. Its orbit is synchronized with the sun so that when it swings southwards on each of its passes over the sunlit side of the earth it is always 9.30 a.m. to 10 a.m. local time. This ensures that the ground track it takes enables the same area to be covered every 18 days.

The sensed data are formulated in frames which embrace a ground area of 34 000 km^2 with a scanning width of 185 km. The smallest area sensed is called a 'pixel' which is equal to 0·45 ha. There are in excess of 7 000 000 pixels in each frame. These data in digital form are telemetered to a land receiving station for storage on high density tapes which are used as a source for future analysis and interpretation.

At present, the United States, which developed the satellite, has furthered its research into the storage systems as well as producing techniques and hardware to assist in analysis and interpretation.

It is in this methodology that prospects for improvement in crop forecasting are brightest. Because of the array of each frame any segment or pixel can be accurately located and its reflectance value on four bands obtained. This digital information can be processed into black and white or colour composite negatives at a scale of 1:1 000 000 or larger.

Much work has been undertaken in the field of crop identification from LANDSAT imagery both in the U.S.A. and Canada, with varying degress of success. One of the major problems encountered is identification at various stages of growth up to maturity, especially between similarly structured crops such as wheat and barley. Once identification has been mastered, either sample or total crop areas can be calculated.

The basic methodology involves the accurate location on the ground of sample training areas of specific crops and the matching of these locations to satellite data. The 'ground truth' is then employed in a computer situation to identify either sample or population specific crop areas which in turn provide the area sown to crops in the forecast.

A major problem which confronts both Queensland and Australia in this dimension is that there is no receiving station for LANDSAT data in this country. However, funds have now been approved for the commencement of such an installation. Limited data were taped during passes over south-east Queensland in March, 1973 and stored on tape in the U.S.A. Because of malfunctioning of the tape recorder in this satellite, the U.S.A. decided that the one on LANDSAT B would be activated only for items of national importance. It is therefore doubtful if any sensed data from this source are available for current Queensland crops.

At present, Marketing Services Branch in conjunction with Soil Conservation Branch is working on the 1973 tape of south-east Queensland. Photographs of scale 1:1 000 000 and less have been produced from tape data, and the area of interest in the Pittsworth Shire transferred to a separate low density tape. Reflectance values have been derived for each pixel in this selected area and histograms of such compiled. Shade maps of the area have been reproduced by computer.

The farms in this area of interest have been inspected on the ground and ground truth for the crops growing at the time of sensing (March 1973) has been accurately mapped. These specific areas have been located and plotted on the shade maps and reflectance values derived for the particular crops—cotton, soybeans, grain sorghum and sunflower.

Tests are now in hand to isolate crops. When this has been finalized the total area of interest will be tested and checked against basic crop identification data. The aim of the exercise is to achieve crop identification with an accuracy of $\pm 5\%$ on a State basis.

However, there are several problems associated with this remote sensing. At present, we lack current satellite data and the State is dependent on the Commonwealth for the installation of a ground receiving station and high density data storage facilities. In order to forecast successfully, a regular supply of space sensing is essential. Facilities for initial analysis of tape data are available locally, but we are dependent on Commonwealth facilities for deeper analysis and interpretation.

At present, the only satellites which are available to us to sense and relay the required data are owned by the U.S.A. which has the sole control of the command—issuing to such vehicles. Even if Australia had a land receiving station, our programmes could only be put into effect if the U.S.A. allowed us access to its satellites. Another problem which could arise is that, while LANDSAT 1 and B are of the experimental variety only, will the U.S.A. continue the programme generating data on a continuous basis and, if so, at what cost?

There is provision for a third launch of LANDSAT C to go into orbit in early 1978 while LANDSAT D is projected for launch in early 1980. These latter vehicles will have an improved multispectral scanner as well as radiometric and geometric corrections to data before it is transferred to high density digital tapes. Better resolutions should result from this instrumentation.

Although these vehicles promise improvements in data transmission, more sophisticated ground equipment may be necessary which could result in higher costs. Storage and processing of such information may be necessary on a State basis.

In Queensland, where most crops are grown under dry land farming, planting is of necessity associated with suitable rainfall and soil moisture. This, in turn, can result in quite protracted planting periods throughout the growing areas. Much work will have to be undertaken to identify crops at various growth stages in different growing districts.

To forecast production it is necessary to forecast yields. In this field, the Federal Republic of Germany has been successful by combining the systematical evaluation of meteorological factors with allowances for certain annual yield trends, independent of weather, induced by improved husbandry, increased use of fertilizers and improved crop varieties. These results have been adjusted by the application of refinements of optimum combination and regression analysis over a set period.

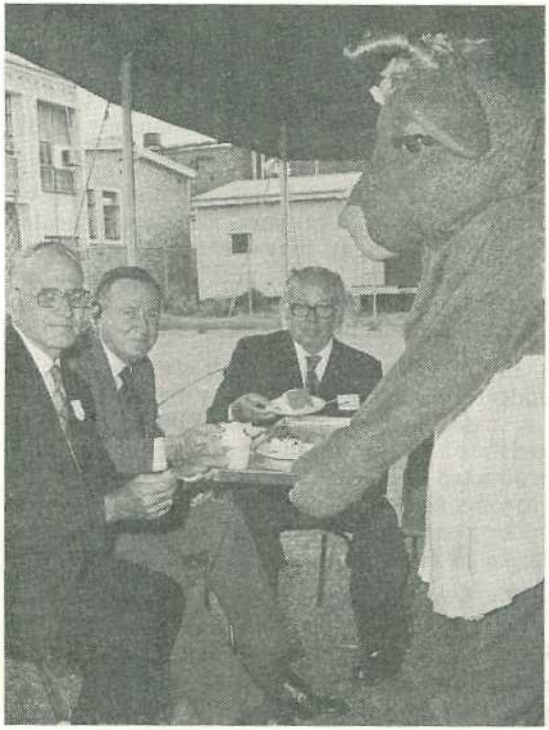
Progress has also been made in the U.S.A. in the development of yield models based on historical weather and yield data. These models are then modified by the current weather data to derive present year yields.

In the future, it could be that a combination of historical data, associated with data currently available from weather and technology satellites, will result in improved yield forecasting.

Use of symbol brands and earmarks

- An earmark may only be used on a beast which already bears a three piece or symbol brand.
- A symbol brand must be registered in conjunction with a three piece brand. However, either may be used alone to denote ownership.

Dairy Research



From left. Mr A. A. Ross, Director-General of the Department of Primary Industries, Mr K. B. Tomkins, Acting Minister for Primary Industries and Mr W. C. T. Major, Director of Dairy Research being served dairy desserts by 'Buttercup' the Dairy Research Laboratory's mascot.

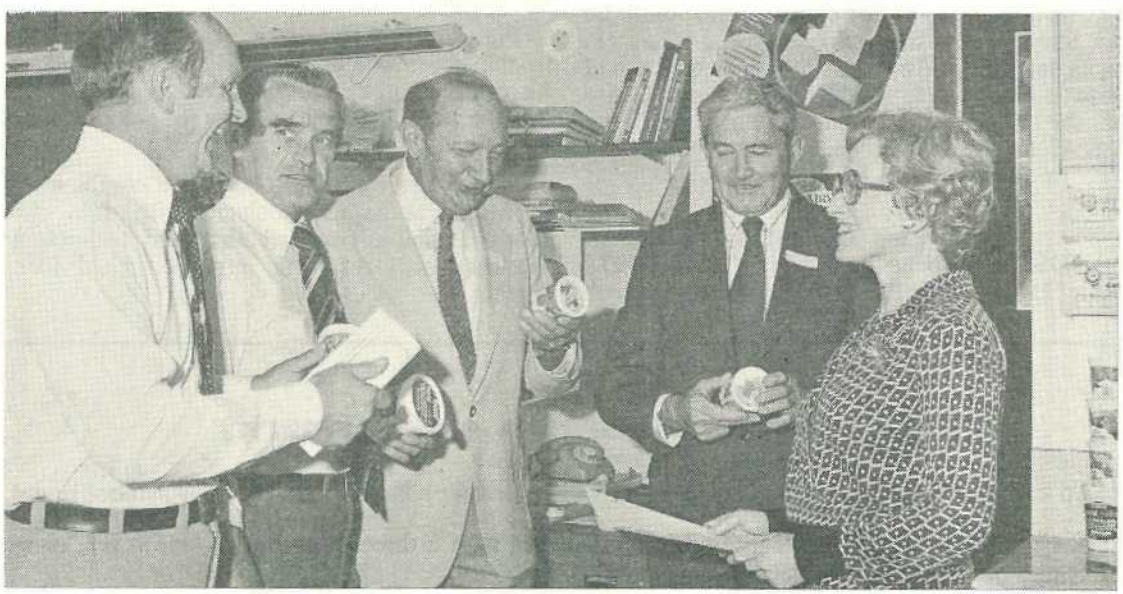
THE Otto Madsen Dairy Research Laboratory staged a series of Open Days from 27 to 29 September.

This celebrated 10 years of occupancy of the building and of work undertaken on behalf of the dairying industry. This work has benefitted dairy farmers, processors and consumers.

The Open Days provided an opportunity for all sections of the community to inspect displays representative of present activities and to hear of past achievements.

A total of 700 students from secondary schools, tertiary education institutes, members of the general public and representatives of all sections of the dairying industries but particularly from the manufacturing sector toured the laboratory complex and pilot plant.

The official opening followed by a luncheon was performed by the Honourable K. B. Tomkins, M.L.A., Acting Minister for Primary Industries and attended by 55 people. The Honourable V. B. Sullivan, M.L.A., Minister for Primary Industries was to have performed the Official opening but was unavoidably delayed in Geneva. Mr A. A. Ross, Director-General of the Department of Primary Industries, hosted both functions.

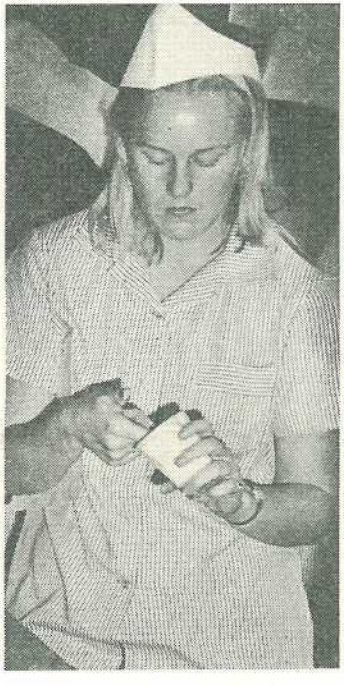


Representatives from the Darling Downs Co-operative Dairy Association discussing the nutritive value of yoghurt with Miss A. Gillies, Assistant Director of Dairy Research.

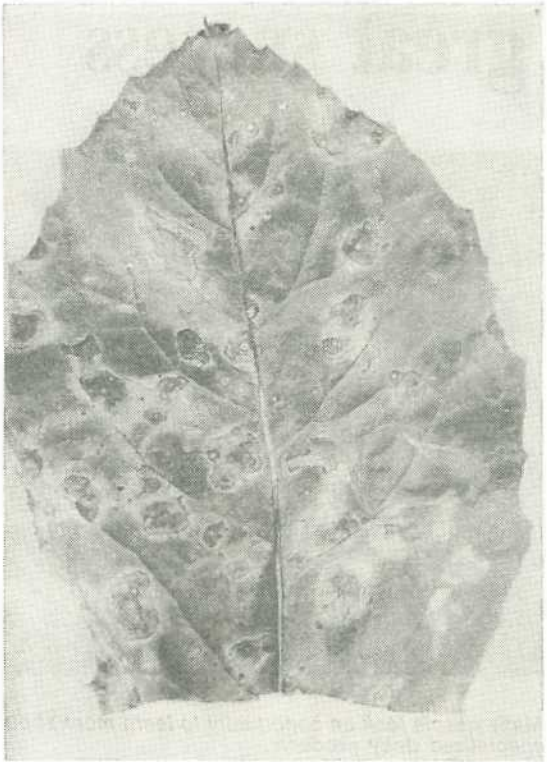
Open Days . . . a great success

Representatives from the Port Curtis Co-operative Dairy Association examined an eye-type cheese manufactured in the laboratory's pilot plant.

Many people took an opportunity to learn more about specialized dairy products.



Staff and students of Newmarket High School sampled the pilot plant's products. Their verdict—great!



ABOVE. Alternaria leaf blight lesions on a safflower leaf.

BELOW. Alternaria leaf blight lesions on safflower seed leaves (cotyledons).

Safflower diseases in Queensland

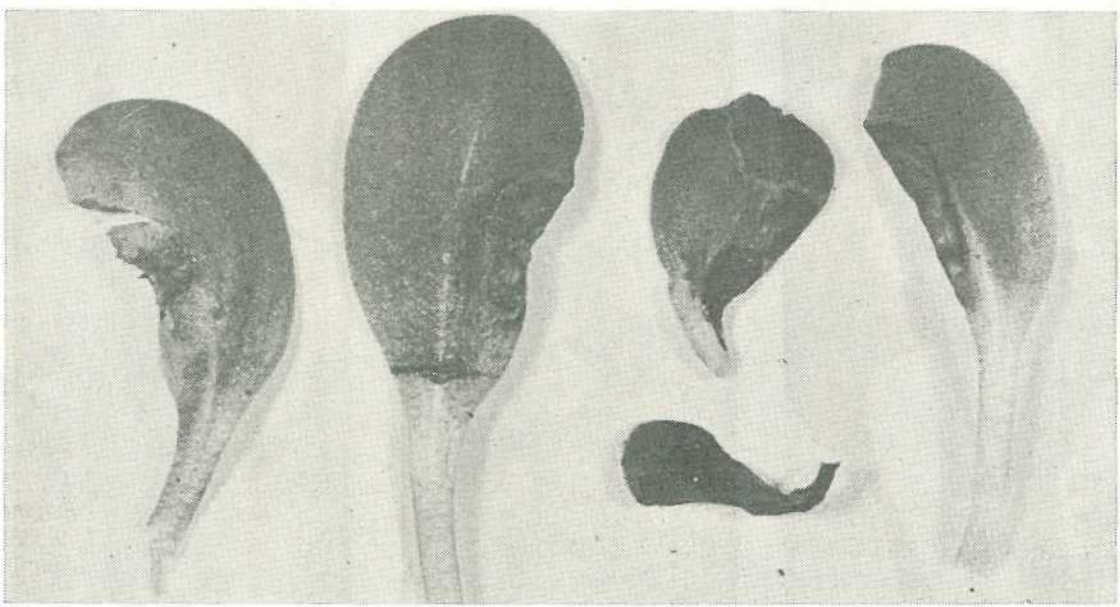
by J. A. G. IRWIN, Plant Pathology Branch and K. J. JACKSON, Agriculture Branch.

SAFFLOWER is an important winter crop in Queensland, 32 000 ha being planted in 1975.

The most serious diseases affecting safflower crops are leaf blight, root rot and rust. Of lesser importance are damping-off, wilt, stem rots, leaf spot, petal blight and virus diseases.

Alternaria leaf blight

Alternaria leaf blight, caused by the fungus *Alternaria carthami,* was first observed in commercial crops in 1973 and 1974, when it had little effect on yield. However, in 1975, yields of all crops severely diseased at flowering were markedly reduced.



Symptoms

Alternaria leaf blight is seed borne. Symptoms first appear on the cotyledons of seedlings as brown spots up to 5 mm in diameter. When stems of the emerging seedlings are infected, a brown discolouration appears just above ground level. Although stem infection can cause the complete collapse of a plant, seedling losses are usually not important.

The fungus spreads by spores from the diseased cotyledons to the leaves of the growing plant, producing the characteristic leaf blight symptoms. These remain confined to the lower leaves until flower buds form. If a wet period occurs at or immediately after flowering flowers rapidly become blighted, causing severe yield losses.

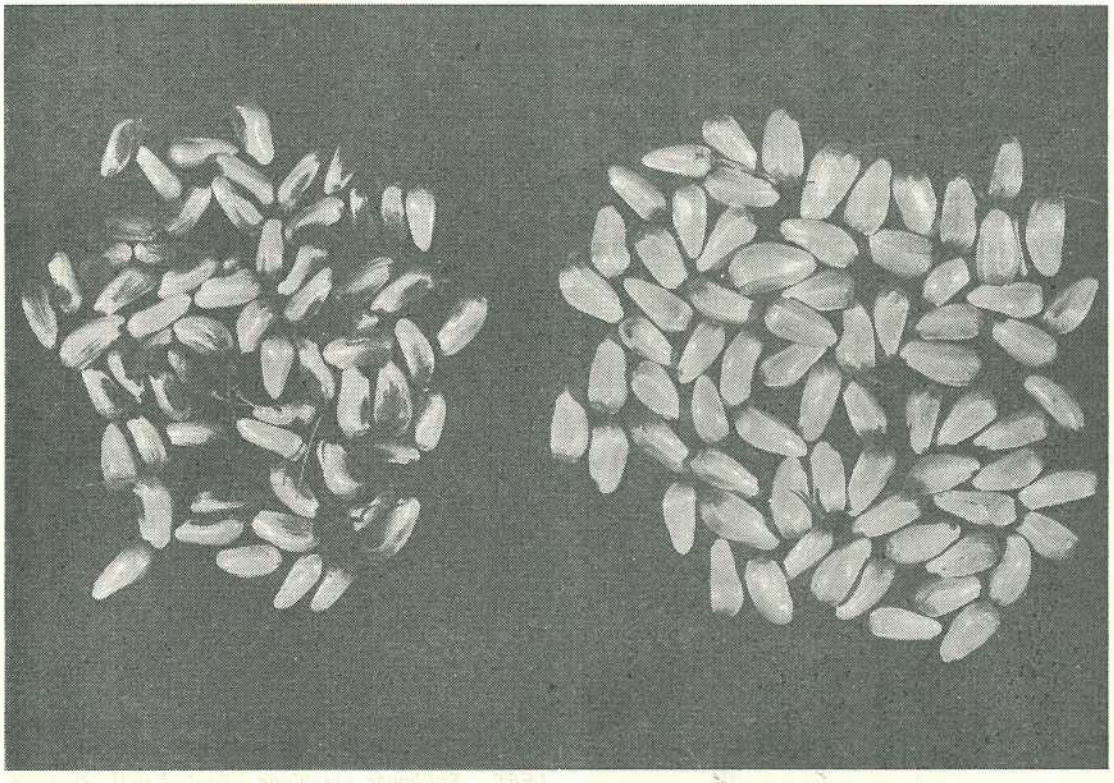
Severely diseased crops mature prematurely and seed has low volumetric weight and reduced oil content. The fungus produces dark, sunken lesions on the seed coat.

Although saffron thistle has been shown to be susceptible under glasshouse conditions, the disease has not been found in the field on plants other than safflower.

Alternaria carthami requires moist conditions for spores to germinate and infect plants and leaf blight is more noticeable after wet weather.

Control

Resistance offers the most practical means of controlling leaf blight. Unfortunately, all cultivars tested at the Biloela Research Station have proved highly susceptible. Resistance has been reported in some American cultivars and it is proposed to test these in Queensland.



Safflower seeds. Those on the left have lesions caused by Alternaria carthami.

Since blight is seed borne, growers should endeavour to obtain seed from clean crops. No seed treatment to eliminate infection has yet been found.

As *Alternaria carthami* can survive on crop debris for at least 2 years, growers should practise crop rotation.

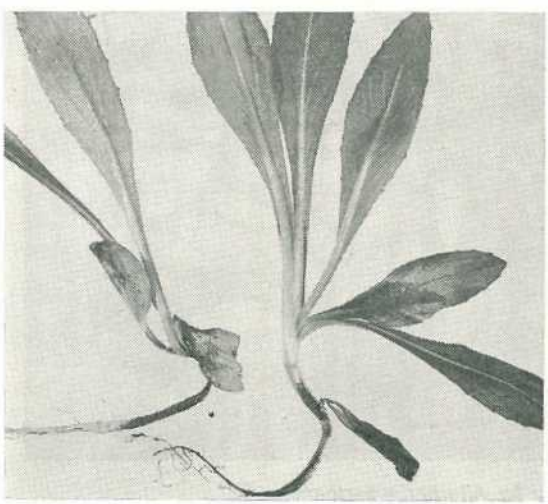
Phytophthora root rot

Phytophthora root rot of safflower, caused by the soil borne fungi *Phytophthora drechsleri* and *P. nicotianae* var. *parasitica* was first recorded in Queensland in 1972. It is regarded as next in importance to Alternaria leaf blight, especially if large areas of safflower are grown under flood irrigation.

Symptoms

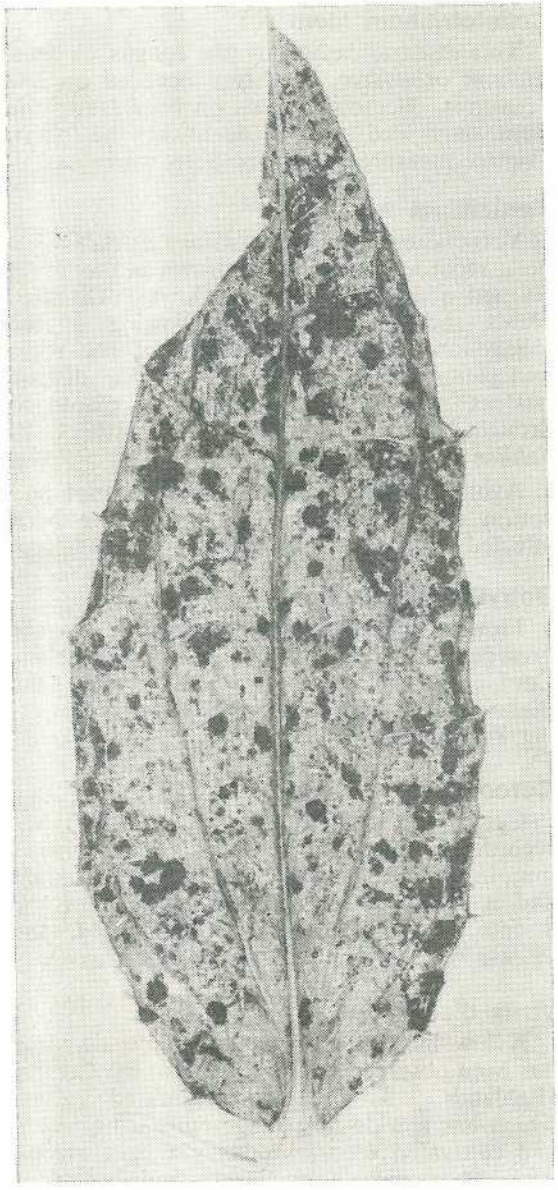
Plants can be affected at any stage of growth. On seedlings, the lower stem collapses leading to wilting and death. On older plants, black necrotic lesions are produced on the roots, and a black discolouration often extends up the stem. Affected plants turn yellow, wilt and die.

High soil moisture and high temperature favour the development of Phytophthora root rot. The disease first becomes evident in poorly drained areas where water lies after rain or irrigation but usually does not cause serious losses until the crop is approaching maturity and soil temperatures are increasing.



ABOVE. Rust lesions on the stem base of a safflower seedling indicate that the seed was infested.

LEFT. Safflower seedlings affected with Phytophthora *root rot.*



Rust pustules on a safflower leaf.

Control

Good drainage is essential to reduce losses from Phytophthora root rot. Where safflower is grown under flood irrigation, it is important that the land is level as ponding of water for even short periods provides conditions favourable for root rot. Severe losses have also been observed under dryland conditions on land with pronounced gilgais.

The cultivar Gila is highly susceptible to both species of *Phytophthora* which cause root rot. However Biggs, which is resistant to *P. drechsleri* in North America, has shown resistance in Queensland. If large areas of safflower are to be grown under flood irrigation, it may be necessary to incorporate this resistance into new commercial cultivars.

Rust

Rust, caused by the fungus *Puccinia carthami,* has been known in Queensland for more than 20 years and is now present in most safflower plantings, especially in wet seasons.

Symptoms

The rust fungus is seed borne. When infested seed is planted, the first symptoms of the disease are large pustules at the base of the stem. Affected seedlings collapse and up to 15% loss of plants has been observed. Spores from the stem pustules initiate leaf infection which has less effect on yield than the seedling phase.

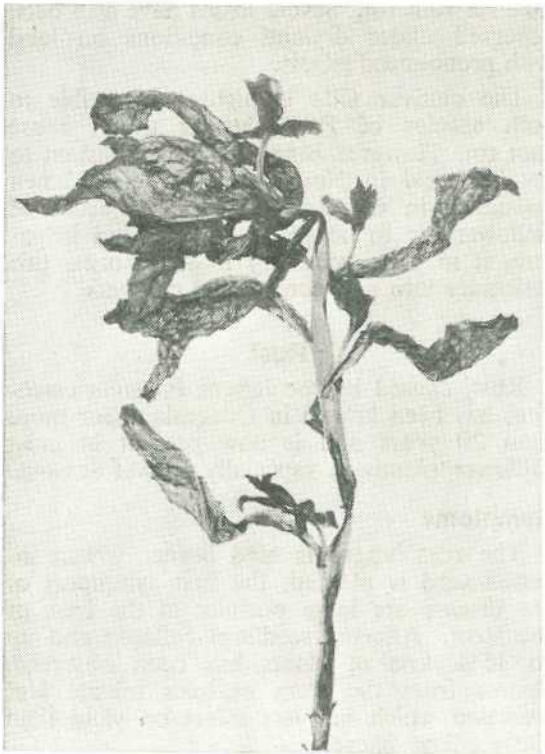
As well as being transmitted on seed, rust spores survive from one season to the next on crop residues. Moisture is necessary for germination and plant infection.

Control

In North America, dusting of safflower seed with dithiocarbamate fungicides has almost eliminated seed borne rust. These fungicides have not been tested against rust in Queensland but do not give satisfactory control of seed borne *Alternaria.* Efforts are therefore being made to find a fungicide to control both diseases.

Seedling damping-off

Apart from seedling death caused by leaf blight, *Phytophthora* root rot and rust, soil fungi such as *Rhizoctonia solani, Pythium* spp. and *Sclerotium rolfsii* cause pre and post-emergence damping-off. Generally, losses are minor and occur when seed is sown in soil containing large amounts of undecayed plant residues. Control measures other than thorough ground preparation have generally not been justified.



Safflower affected with Colletotrichum *stem rot.*

Sclerotinia stem rot

Sclerotinia stem rot (*Sclerotinia sclerotiorum*) is likely to occur where *Sclerotinia* has been common in other crops, particularly sunflower.

The first symptom of the disease is a white, cottony growth on the base of the stem, followed by the formation of black, resting bodies of the fungus (sclerotes) on and within the stem. Affected plants wilt and die.

Safflower should not be grown where previous crops were severely affected by *Sclerotinia*.

Colletotrichum stem rot

This disease, caused by the fungus *Colletotrichum orbiculare* has been recorded on few occasions. Necrotic lesions on the base of the stem may lead to the death of the plant. Control measures have not been warranted.

Verticillium wilt

Verticillium wilt (*Verticillium dahliae*) has been recorded on safflower grown in the South Burnett and on the Darling Downs. Diseased plants show an irregular yellowing of the foliage and the internal tissues of the roots and stems are brown in colour. The disease hastens maturity and predisposes plants to drought stress. Common weed hosts of *V. dahliae* include noogoora burr.

Avoid planting safflower after peanut and cotton crops, particularly if these have been affected by *Verticillium* wilt.

Botrytis flower blight

Flower blight can be recognized by the presence of a grey, furry mould on the petals. Cool, showery weather which favours the disease rarely occurs when safflower is flowering in Queensland.

Cercospora leaf spot

Cercospora leaf (*Cercospora carthami*) was recorded at Kingaroy in 1964. Spots 1 to 7 mm in diameter, with a grey-brown margin and a white centre are characteristic of the disease. Unlike Alternaria leaf blight, the disease remains confined to the older leaves.

Virus diseases

A low incidence of cucumber mosaic virus has been observed at Biloela and in the Central Highlands. This aphid-transmitted virus, which has a wide host range embracing weeds and cultivated crops, produces a light green–dark green mosaic on leaves and bracts of safflower. These symptoms fade as the plant matures leaving no obvious effects on the plant.

Two other aphid-transmitted viruses—lettuce necrotic yellows and broad bean wilt have been isolated from a few plants with mosaic symptoms.

Dipping Brahman crossbreds in S.E. Qld. . . . does it pay?

THIS article reports the results of a trial carried out under commercial conditions to find out how Brahman crossbred cattle in south-east Queensland are affected if they are not dipped to control ticks.

Control of cattle ticks by dipping represents a major cost of beef production in ticky areas.

The cost includes not only the chemical but also labour for mustering and dipping.

Taking into account the costs of topping-up and/or replacement of the dip, an average cost of dipping has been calculated to be 20 cents per beast.

The labour cost of dipping has been calculated to be 60 cents per beast.

Thus, the cost of chemical and labour per beast dipped is about 80 cents.

Many cattlemen are aware that Zebu crossbred cattle carry fewer ticks than British breed cattle and have introduced Zebu blood into their herds. However, it is still common practice to dip these cattle six to eight times a year.

Trials in central coastal Queensland at the National Cattle Breeding Station, 'Belmont', and also on privately-owned commercial properties have shown that dipping non-pregnant, non-lactating Zebu crossbred cattle to control ticks had no significant effect on their liveweight gain. This finding suggests that frequent dipping of crossbreds is unnecessary.

by M. A. BURNS, Beef Cattle Husbandry Branch, J. F. KEARNAN and J. BIGGERS, Veterinary Services Branch and K. B. W. UTECH, C.S.I.R.O.

Design of the trial

The trial was conducted at 'Eskdale' in the Brisbane Valley, a commercial property approximately 25 km north-west from the town of Esk. The average annual rainfall is about 760 mm of which 65 to 70% of the annual total generally falls in the 6 warmer months (October to March) and the wettest months are December to February.

In November 1975, 45 mixed-sex first-cross Brahman x Hereford weaners aged 10 to 12 months were divided into two groups on the basis of liveweight and sex. Eleven steers and 11 heifers (average liveweight 184·5 kg) were assigned to the 'dipped' group and 12 steers and 11 heifers (average liveweight 181·1 kg) to the 'not dipped' group. Both groups were run together for the duration of the trial in a 60 ha paddock of which 12 ha were degenerated introduced pasture (Green panic, Rhodes grass and Siratro) and the remainder native pasture and creek frontage.

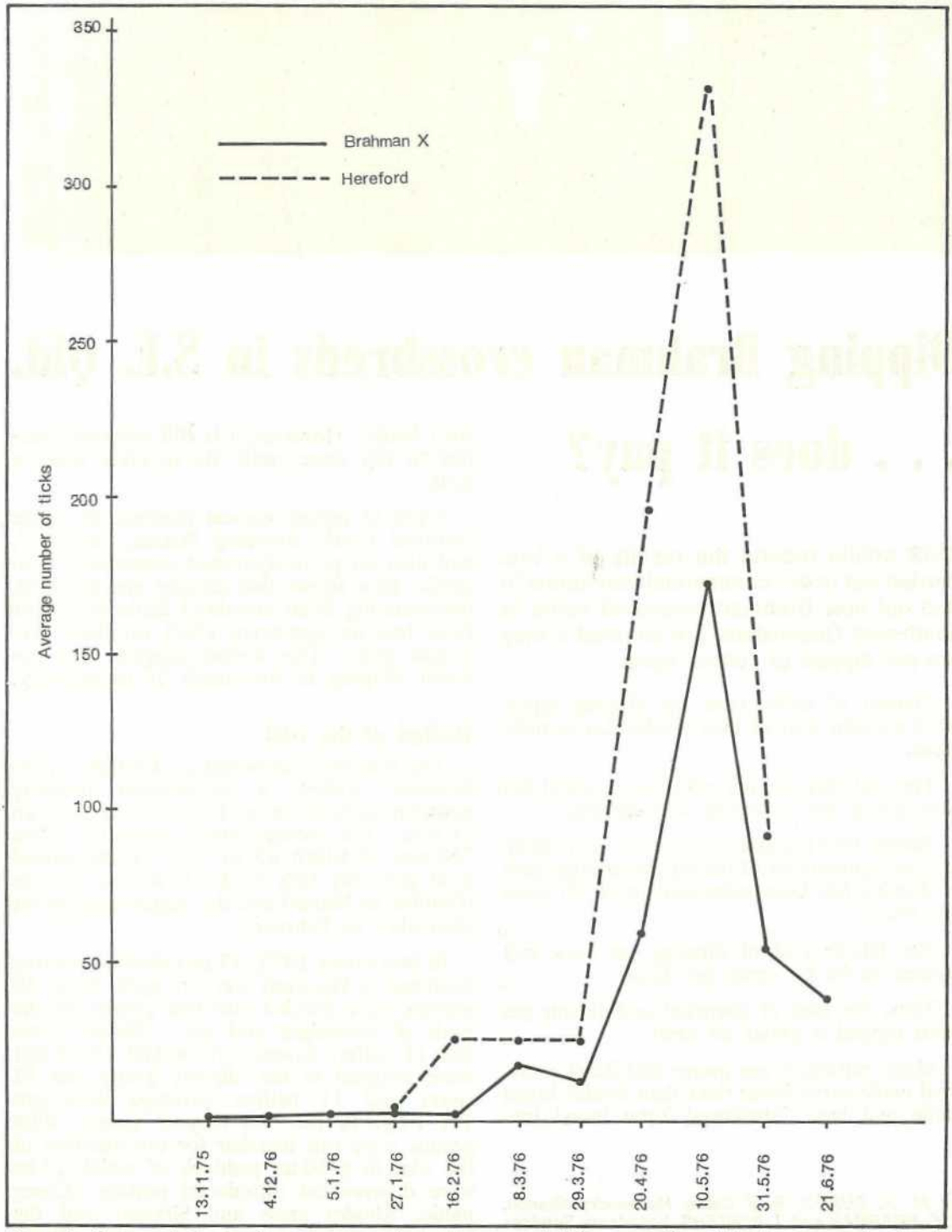


Figure 1. Seasonal changes in average numbers of engorged ticks on undipped Brahman crossbred and Hereford cattle.

The trial cattle were mustered at an average interval of 22 days and the numbers of semi-engorged female ticks from 4·5 to 8 mm in length were counted on one complete side of each animal to determine the level of tick infestation. At each observation, the dipped group of animals was dipped in a plunge dip charged with Promacyl ('Promicide'). The cattle were weighed at the beginning of the trial on 13 November 1975 after fasting and at the end of the trial on 21 June 1976 again after fasting. The cattle also were weighed unfasted on 20 April and 31 May 1976.

An extra five yearling Hereford heifers were run with the trial groups from 5 January 1976. These were not dipped and were used to monitor the presence of ticks in the trial paddocks.

Unfortunately, nine heifers in the not dipped group and four in the dipped group were spayed between the last two observations on 31 May and 21 June 1976.

Results

Liveweight changes are shown in table 1. The greatest difference in performance, 6·3 kg in favour of the dipped group, occurred in the period 20 April to 31 May when tick counts were greatest. This also corresponded with the time when the nutritive level of the pasture was declining.

After taking the effect of spaying into account, the dipped group gained only 8·4 kg more liveweight than the not dipped group over the whole period of the trial. This was not significant statistically.

Seasonal changes in average numbers of engorged ticks on undipped Brahman crossbred and Hereford cattle are shown in figure 1. The level of tick infestation was low up to the end of March 1976 but tick burdens increased markedly during April and May when tick counts as high as 160 and 323 engorging females per side were recorded on some Brahman crossbred animals in the not dipped group. As would be expected, the dipped group carried practically no adult ticks.

The marked rise in tick numbers during the autumn period follows the normal pattern of south-east Queensland. This also corresponds with the time of the year when the level of tick resistance, even in resistant cattle, wanes. The highest average count for the not dipped herd was 86·5 in May, about half the average count of 166 on the Hereford cattle. This is equivalent to 173 and 332 engorged ticks per animal on the Brahman cross and Hereford cattle respectively (figure 1).

Practical implications

Results from this trial suggest that non-lactating crossbred cattle carrying at least 50% Zebu blood are not greatly disadvantaged if they are not dipped to control ticks. This evidence is supported by results from a similar trial conducted by the D.P.I. and C.S.I.R.O. in central Queensland where it was found that there was a liveweight advantage of only 5 kg in favour of dipped Brahman crossbred steers over a period of 312 days (see *Queensland Agricultural Journal* November–December, 1976).

These findings offer possible, worthwhile cost savings to cattlemen in tick-infested areas who are prepared to adopt tick-resistant cattle coupled with a minimal dipping programme.

There are, however, some important points to remember when undertaking a minimal dipping programme:

- All crossbred cattle are not highly tick-resistant. About 20% of a crossbred population have only a moderate to low resistance and may need more frequent dipping. These should be segregated from the resistant cattle and culled if possible.
- In south-east Queensland, a change from frequent to minimum dipping should be started in spring because at that time of the year tick resistance is highest in crossbred cattle. A few dippings after the wet season in March–April might be necessary to help against increasing tick numbers in pastures and loss of resistance in cattle.
- Resistance to ticks is lowered during periods of stress such as poor nutrition, pregnancy and lactation. Therefore, under adverse conditions, it would be desirable to prevent a build-up of ticks by strategic dipping in the early autumn.

- Very ticky cattle, or cattle which show evidence of recent heavy tick burdens are unattractive. It is therefore advisable to ensure that cattle do not carry excessively high tick burdens for 2 months or so before intended sale.

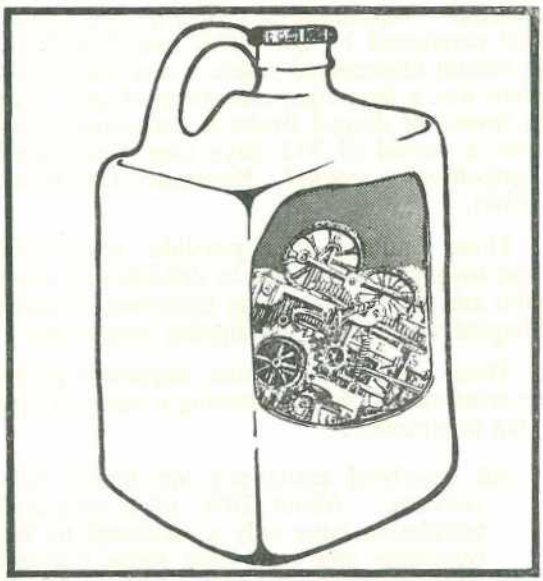
Acknowledgement

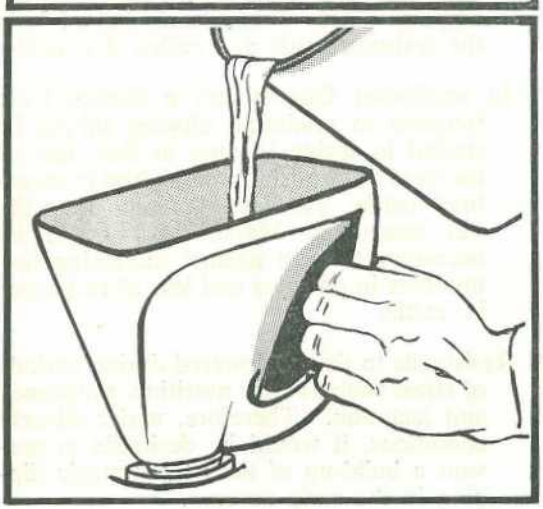
The assistance of the management and staff of Eskdale Station in providing cattle, facilities and labour for this trial is greatly appreciated.

TABLE 1

EFFECT OF DIPPING ON LIVEWEIGHT GAINS AND ENGORGED TICK BURDENS

Period	Average liveweight gain (kg)		Average numbers of engorged ticks per day on undipped cattle
	Dipped	Not Dipped	
13.11.75 to 20.4.76 (149 days)	134	131	10
20.4.76 to 31.5.76 (41 days)	2	−4	116
31.5.76 to 21.6.76 (21 days)	−19	−18	48
13.11.75 to 21.6.76 (211 days)	117	109	35





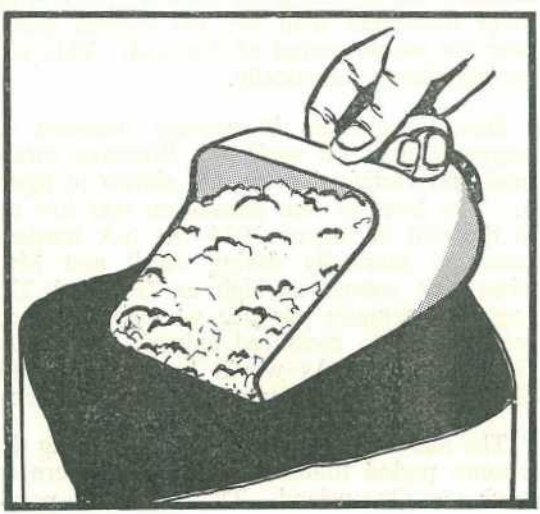
Useful gadgets

WITH an empty plastic container, a pocket knife and a little ingenuity some handy items can be created for use around the farm.

A 4 or 5 litre container makes an excellent holder for loose parts when a hole is cut in one side for access, and it will not rust.

The perfect funnel for pouring chemicals is made by cutting the bottom out of a plastic bottle and it can be discarded when the job is finished.

One hundred and one uses can be found for a scoop—also easily made from a plastic container with a handle.



Sown pastures and fertilizer practices in the Julatten district

by B. A. Middleton, formerly of Agriculture Branch and J. W. Wright, Agriculture Branch.

THE Julatten district is situated some 90 km north-north-west of Cairns. It is close to beef markets, has a good road system, and enjoys a frost-free climate with a high and reliable rainfall.

The lowest and highest annual totals since recording commenced are 835 mm (1966) and 2 725 mm (1950) respectively. Average monthly rainfalls (mm) for the years 1927 to 1973 were:

Jan	Feb	Mar	Apr	May	Jun	Jul
341	361	338	106	55	51	31

Aug	Sep	Oct	Nov	Dec	Total
26	21	25	70	124	1 541

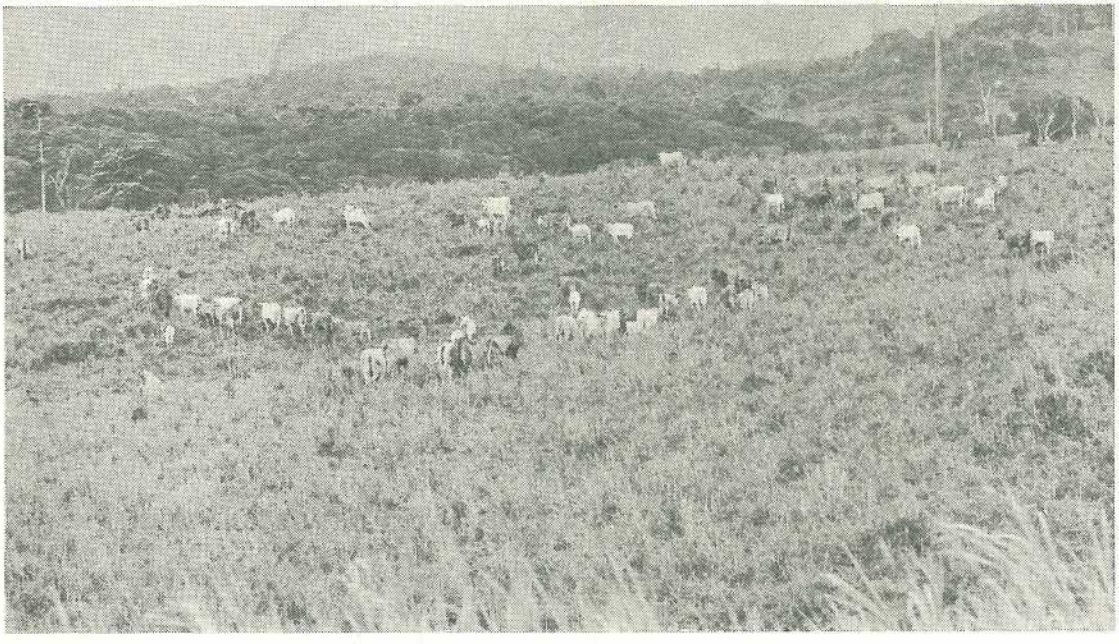
Vegetation

The original vegetation over most of the district was tropical rain-forest. Most of this has been cleared since the rain-forest areas were first settled in 1915. Open forest country is found in the southern section between Mt. Molloy and Julatten. To date, very little pasture development has occurred in the open forest areas.

Topography and soils

The area consists of hilly country draining into several small streams, the main ones being Devil Devil, Bushy and Hunter Creeks. These flow into Rifle Creek which is the largest right bank tributary of the Mitchell River in the locality (see map).

The best soils in the district are the coarse-grained alluvials of Bushy and Hunter Creeks. These are derived from granite. Clay loams of good depth and good water holding capacity occur in the rain-forest to the north and east of Julatten.



Brahman herd on R. and E. Jenkins' property, 'Devil Devil', 1976.

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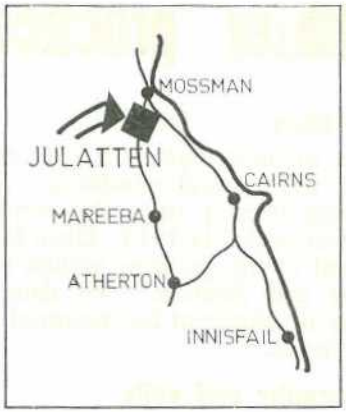
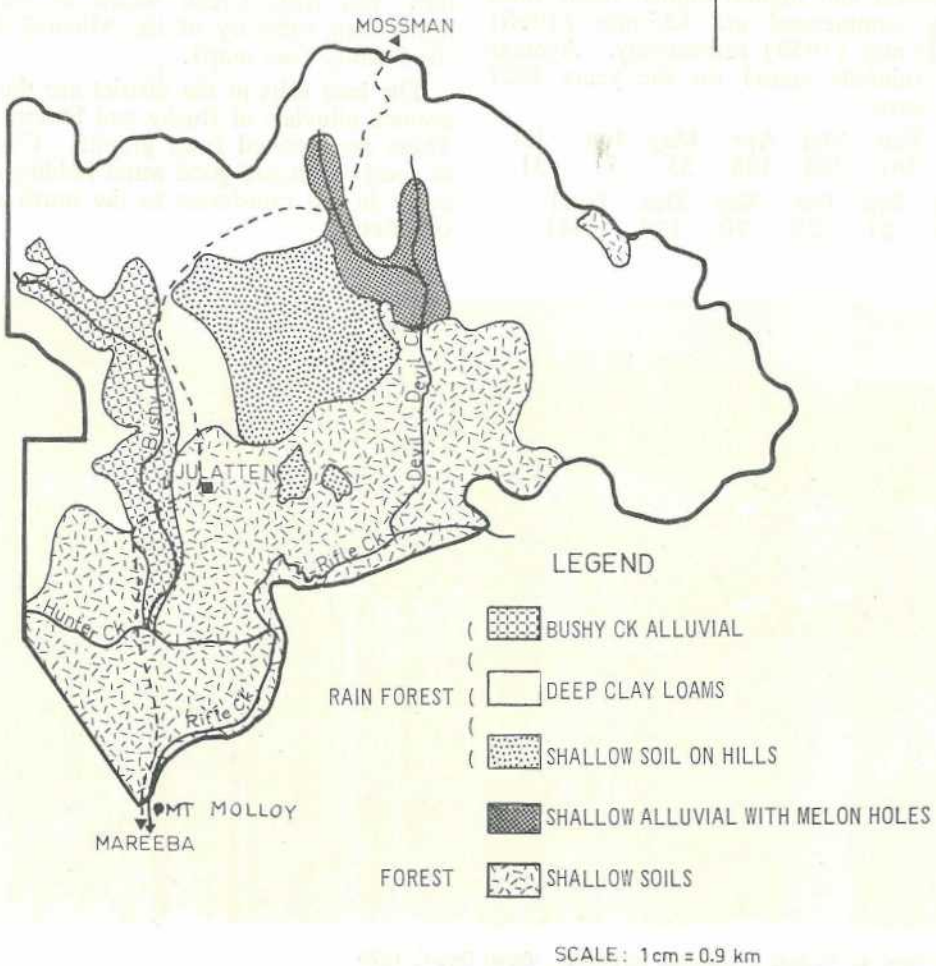


JULATTEN LOCATION AND MAJOR SOIL TYPES



Herd bulls grazing the 1968 pasture demonstration area.

Soils are shallow in the forest area and in an area of steeper rain-forest occurring north-north-east of Julatten. In the upper reaches of Devil Devil Creek there is an area of shallow, silty alluvium with heavy melonhole development.

The fertility, water-holding capacity and internal drainage of the shallow soils is low, and regular rainfall is required to maintain pasture production on them.

The dairying days

The first major agricultural enterprise in the district was dairying, which commenced shortly after World War I. A butter factory was established at Bushy Creek and was operational from 1924 to 1950. Dairying remained viable until the 1950s when production costs increased while returns remained low. Since then, there has been a steady swing from dairying to beef production. The change-over was virtually complete by 1965.

Pasture decline

The pastures used during the dairying era consisted of Rhodes (*Chloris gayana*), paspalum (*Paspalum dilatatum*), guinea (*Panicum maximum*) and molasses (*Melinis minutiflora*) grasses established by hand broadcasting seed into the ashes of the freshly felled and burnt rain-forest. At first, these 'grass only' pastures were highly productive because of the high fertility of the virgin soil. In time, however, they became run-down and

were invaded by poor quality grasses and weeds. The carrying capacity of these run-down pastures can be as low as a beast to 4 hectares.

Pasture improvement

Following successful research with pasture legumes at South Johnstone Research Station, grass/legume trials were commenced in the Julatten area in 1953. Pastures based on the legume centro (*Centrosema pubescens*) sown with guinea or para grass (*Brachiaria mutica*) showed good establishment and persistence.

However, centro and para grass were only suitable for the Bushy Creek alluvials. Establishment failures were still common in most of the district.

Following a survey in 1966 to determine current land use and possible reasons for pasture failures, four trials were established to examine the response to fertilizers, particularly phosphorus and potash in grass/legume pastures.

From the results of these trials, local graziers saw the true potential of their district with fertilizer promoting the establishment and persistence of improved pastures.

Grazier response was positive. Fertilizer use increased dramatically from 10 tonnes of superphosphate in 1965 to 275 tonnes in 1971. The area under improved pastures trebled and there are now over 1 500 hectares in the district.

By 1970, Julatten was a sound and prosperous beef producing area, and carrying capacities are now 1.5 beasts per hectare using proven pasture species and recommended fertilizer practices.

Prior to 1966, most of the improved pasture development had taken place on the Bushy Creek alluvials and scrub soils of the hilly areas.

In 1968, a further demonstration was planted to show that even on poorly drained forest soils of low fertility, high stocking rates can be achieved provided the correct pasture species are used and adequate establishment and maintenance fertilizer is applied.

As a result of the investigations and demonstrations in the Julatten district, sound pasture and fertilizer recommendations are available.

Current recommendations

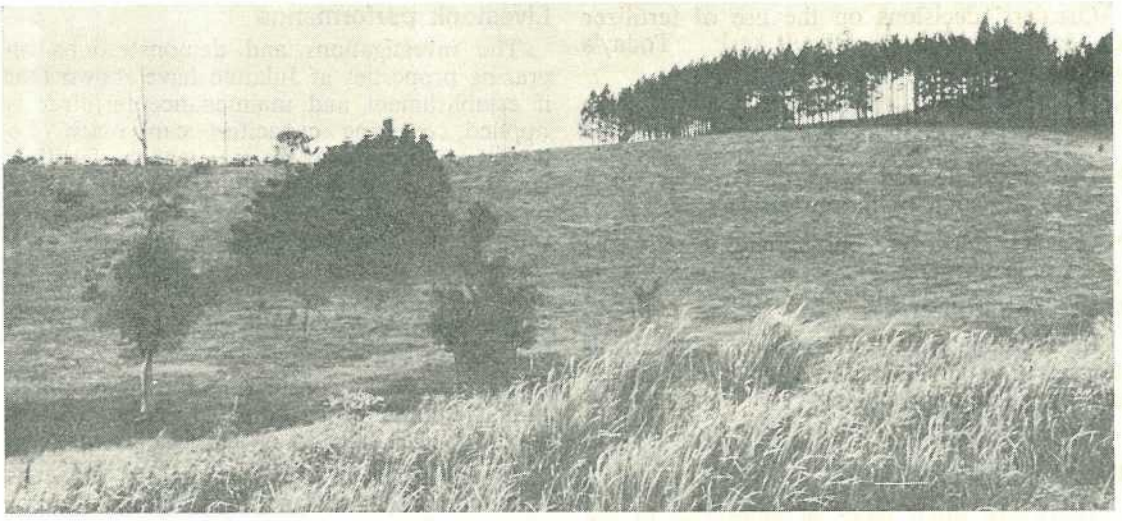
Pasture species		Sowing rate of seed (kg/ha)
Hillsides		
Grasses	Hamil (*Panicum maximum*)	2–4
	Riversdale guinea	2–4
	Makueni guinea	2–4
	Molasses (steep areas only)	0.5–1
Legumes	Cook, Endeavour or Schofield Stylo (*Stylosanthes guianensis*)	2–3
Bushy Creek Alluvials (Well-drained)		
Grasses	Riversdale guinea	2–4
	Makueni guinea	2–4
	Hamil	2–4
	Signal grass (*Brachiaria decumbens*)	4–5
	Para grass (runners or seed	2
Legumes	Cook, Endeavour or Schofield style	2–3
	Centro	4–6
	Hetero (*Desmodium heterophyllum*)	0.5–1
	Cooper or Tinaroo glycine (*Glycine wightii*)	1–2
Low flats (poorly-drained)		
Grasses	Signal grass	4–5
	Para grass (runners or seed)	2
	*Pangola (runners)	
Legumes	Cook, Endeavour or Schofield stylo	2–3
	Hetero	0.5–1

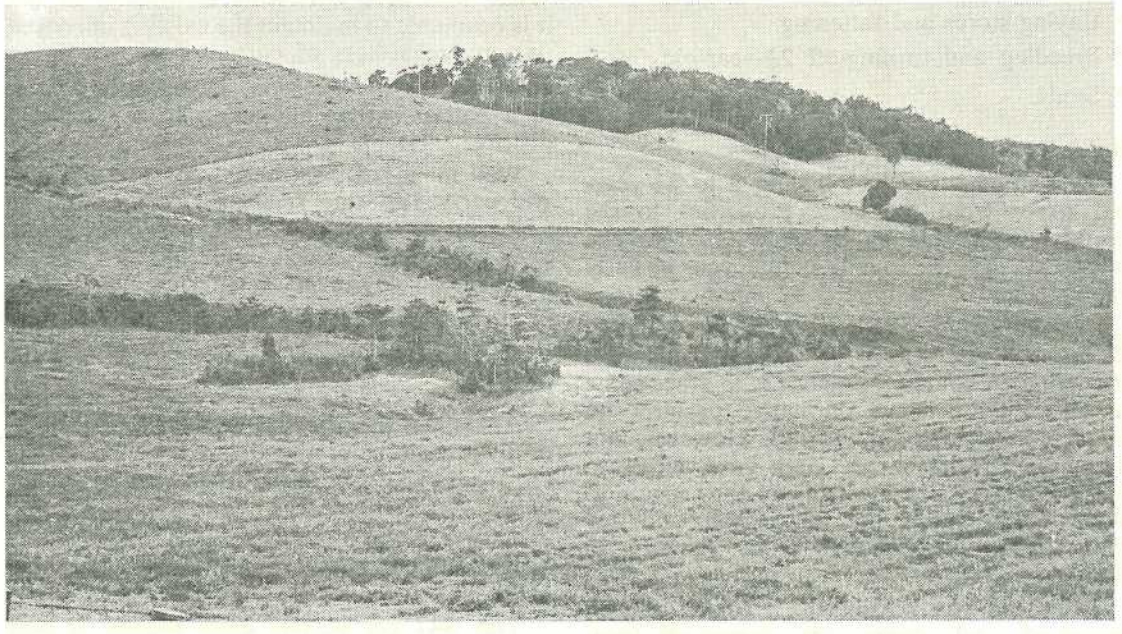
*Note: Pangola is subject to attack by pests and diseases and these may reduce the amount of grazing that can be obtained to a low level.

Fertilizer

For establishment

25 to 50 kg phosphorus per hectare. Where centro or glycines are used, Mo 12 superphosphate is necessary plus 60 kg potassium per hectare on forest soils.





TOP. Pine trees planted for shade and windbreaks. Top right—Caribbean pine (Pinus caribbea). *Mid left—hoop pine* (Araucaria cunninghamii).

BOTTOM. New pasture plantings on H. Vains' property, January 1968.

FOR MAINTENANCE

30 kg phosphorus per hectare every second year. On a pure grass pasture, apply 125 kg nitrogen per hectare per year in addition to phosphorus. The nitrogen is applied as split applications. At the present time, the use of nitrogen is not economic and should only be considered for pastures used for special purposes such as bull paddocks, weaner paddocks etc.

Maintenance fertilizer strategy

A good fertilizer programme is based on a consideration of the plant/animal/soil relationship in association with the ever changing economics of rural production.

Graziers' decisions on the use of fertilizer are currently a very difficult task. Today's options are:

- Continue to use recommended rates of fertilizer on all pastures.
- Use recommended rates of fertilizer on a smaller area of the pasture.
- Use less fertilizer, but spread it over the whole property.
- Use no fertilizer.

In deciding which strategy to adopt, it is necessary to consider the type of enterprise and livestock performance.

Types of enterprise

There are three types of enterprise in the Julatten district, and they are:

- Buying stores and fattening.
- Breeding and turning-off 2½-year-old fats.
- Studs.

Buying stores and fattening

This strategy involves buying 2 to 2½-year-old stores from the large properties to the north-west of Julatten or from the Mareeba sale-yards. Buying usually commences in early January, and is completed by April.

The improved pastures are stocked lightly during the wet season in order to minimize trampling. A common practice is to graze some or all of these steers on native pastures on forest country for this period. However, not all of the graziers in the area have access to forest country, and the strategy they use is to stock lightly during the wet season, and buy their stores progressively from January to April.

After the wet season the stocking rate is increased and steers are turned-off progressively as they reach fat condition. This usually takes 6 to 8 months, and allows the stock to be marketed when premium prices are being paid for local trade cattle.

Breeding and turning-off fats and studs

These enterprises are not as flexible as the store fattening one, but similar grazing management practices are used to minimize trampling of improved pastures during the wet season if property size permits.

Livestock performance

The investigations and demonstrations on grazing properties at Julatten have shown that if establishment and maintenance fertilizer is applied, carrying capacities can reach 1.5 beasts per hectare. If no maintenance fertilizer is applied, carrying capacity reverts to 1 beast to 3 hectares, that is, the use of recommended rates of maintenance fertilizer allows 4 to 5 times the stocking rate possible when no fertilizer is used.

Is a fourfold increase in stocking rate worth the cost of applying fertilizer?

We are really considering the first option, that is, should we continue to apply maintenance fertilizer fully to all existing pastures?

At this stage, it must be admitted that it is uneconomic to clear land and establish pastures when beef prices are as low as at present. What does need answering is whether or not it is economic to maintain the existing improved pasture, regardless of current beef prices.

To decide the question, let us have a look at a partial budget applicable to the Julatten district.

Well managed, fertilized, improved pastures will carry 1.5 store steers per hectare, giving a liveweight gain of 250 kg per hectare per year. Poorly managed, unfertilized pastures will very quickly revert to carrying only 1 store steer to 3 hectares giving a liveweight gain of only 55 kg per hectare per year. The difference is 195 kg liveweight gain per hectare per year.

Assuming the dressed weight to be 60% of liveweight gain, the dressed weight difference is 117 kg per hectare per year in favour of the fertilized pasture.

At a net price of 40 cents per kg dressed weight, this is equal to $47 per hectare per year.

This $47 per hectare extra income is only achieved when maintenance fertilizer is applied.

Costs saved may include weedicide sprays and supplementary feed. These two costs may have to be met by graziers who decide to let their pastures deteriorate by not applying maintenance fertilizer.

Well managed, fertilized pastures should not have to be sprayed with weedicide, and supplementary feeding should be almost negligible. Consequently, the cost of these items is saved. But what extra costs are involved?

Costs

These will be for maintenance fertilizer based on district trial results.

Items	$/(ha year)
300 kg/ha superphosphate every 2 years @ $85.60 per tonne ..	13.00
Average application cost @ $4.60 per ha* every 2 years by tractor (labour costs included) ..	2.30
	$15.30

* Note: If bulk superphosphate is used, a saving of $7 per tonne is made.

Another cost will be the interest on money borrowed to buy maintenance fertilizer. Assume 10% of $15.30 per ha per year, approximately $1.50.

Total extra cost = $15.30 + $1.50
= $16.80

Summary

Revenue (+) $/(ha year)	Expenses (−)
Extra Income = $47.00	Extra Costs = $16.80

Extra revenue of $47 per hectare per year more than outweighs the extra cost of $17.

The abovementioned costs would not apply with a breeding herd, since the dressed weight output per hectare is usually much less than for fattening. But, if a grazier has a valuable breeding herd developed over many years, he would naturally be looking for the cheapest way to keep it. Good pasture management including adequate maintenance fertilizer would meet this requirement.

A well managed, fertilized pasture in the Julatten district should last at least 10 years. If maintenance fertilizer is not applied, the pasture will deteriorate rapidly.

The current emphasis, therefore, is not on making more money, but in avoiding large capital expenditure in the future by preserving improved pastures—an asset which graziers already have.

Useful, new cacti publication

THE Land Administration Commission has recently released 'Cacti naturalized in Australia and their control' by J. Mann.

This informative, well-presented publication also contains colour photographs.

Personal copies of this book are available for $3 from the Accountant, Land Administration Commission, P.O. Box 168, North Quay, Brisbane 4000.

Successful A.I. courses in central

by A. MURRAY, Dairy Field Services Branch.

A.I. Training Courses are proving a great success in central Queensland.

During the past 18 months, 5 day courses have been held at Ubobo, Mt Larcom, Rockhampton and Dululu.

Many farmers who have continued with A.I. are recording first conception figures between 70% and 80%. This is at least as good as those of commercial inseminators.

The 5 day courses are provided by the Department of Primary Industries' Wacol A.I. Centre. Farmers are trained on their farms on the basis that they provide empty cows for training work.

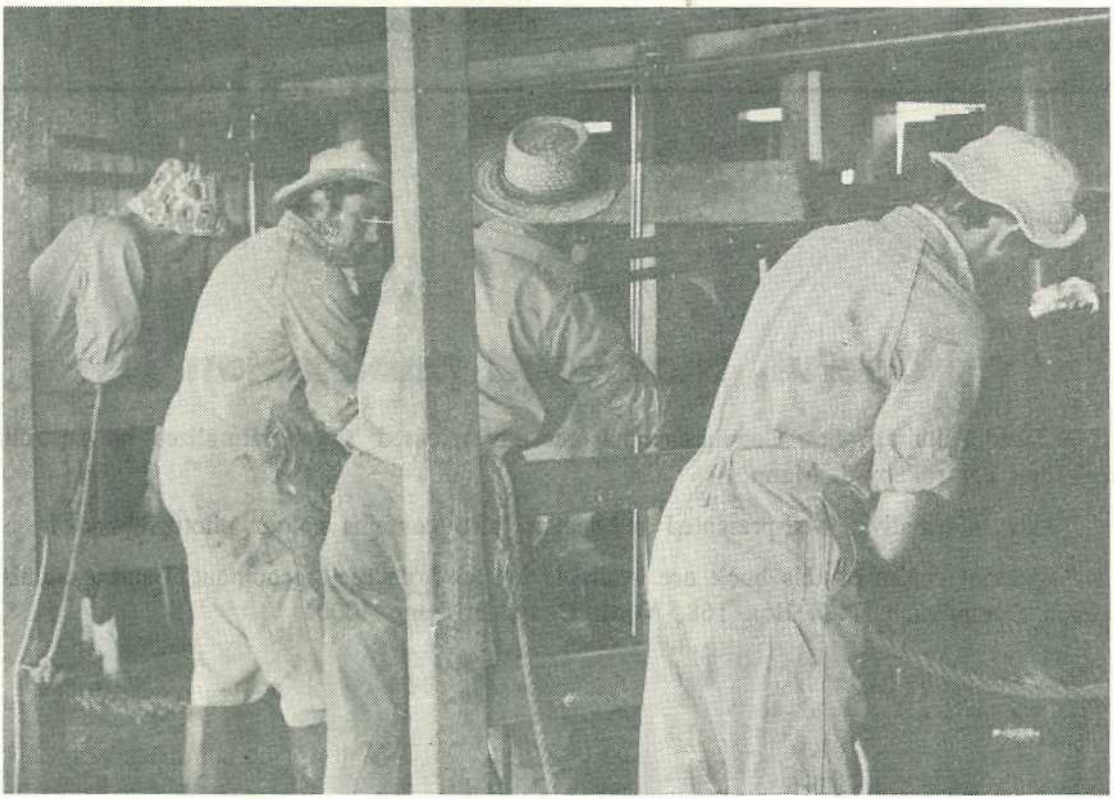
The cost of the course is $35.00 plus another $50.00 for basic equipment. If farmers continue with A.I. after training, a liquid nitrogen container is required to store semen. This costs between $350 and $450.

The comments on the photographs are typical of those given by central Queensland farmers trained at the courses.

Farmers in the past were unable to take advantage of A.I. because they could not spare the time to leave their properties for training.

This is now overcome by having the courses at local properties with minimal interference to normal farming operations.

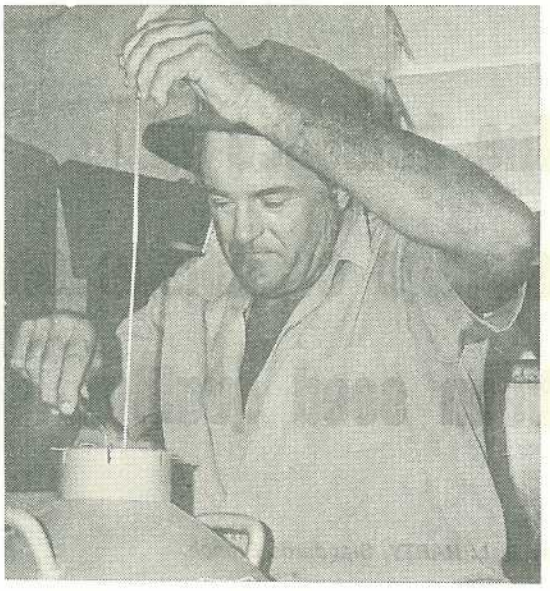
Therefore, if a minimum of six to eight farmers in an area want to learn A.I., they should contact their local D.P.I. office. The main requirement is for each farmer to provide 10 to 12 empty cows.



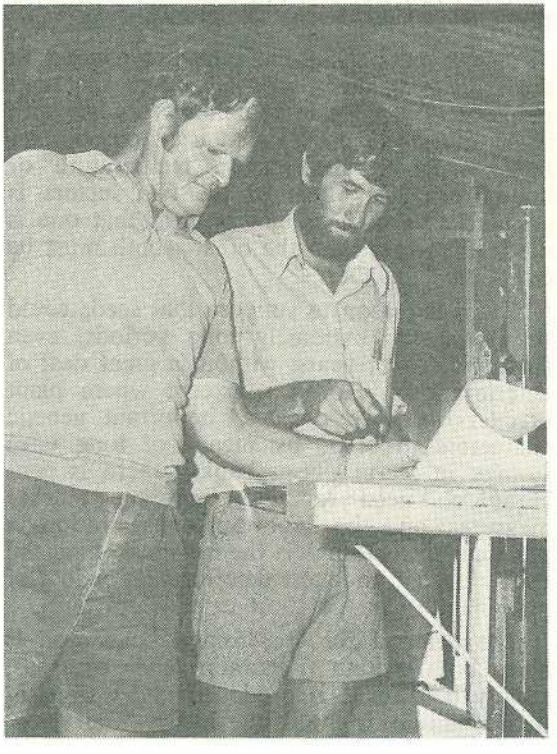
A farmer group being taught A.I.

Queensland

ABOVE.—'The Department's course gives me the opportunity to use bulls which are proven performers,' Reg. Shields, Marmor.



'I don't keep bulls for the cows anymore. A.I. is a great help in stopping infertility diseases,' Kev. Zimpel, Mt. Larcom.



RIGHT. 'I was trained by the Department 18 months ago. I'm very pleased with my first conception figures of 72%,' Dave Fuller, Ridgelands.

The influence of storage conditions on bean seed quality

by R. L. HARTY, Standards Branch.

THE seed of most agricultural and horticultural crops can be kept in storage for long periods without appreciable deterioration.

This is possible if the moisture content of the seed is below a safe level and the temperature of storage is kept low. Studies with bean seed have shown that seed deteriorates faster with an increase in temperature or humidity. The effect of the two factors is additive so that it cannot be said that one is more important than the other—both must be considered together.

There is reason to suppose that seeds could be stored for extremely long periods, even for hundreds of years, without a great deal of deterioration. However, except where plant breeders wish to preserve important genetic characters in seeds by means of long term storage in 'germ plasm banks', there is generally no need to adopt extreme storage measures, and the important consideration in practical seed storage is the minimum financial outlay needed to arrest deterioration or loss of germinability in the short or medium term.

The demand for Queensland bean seed is high both within Australia and overseas, mainly because it is produced under disease-free conditions in the Burdekin Irrigation Area. There are no problems of over-supply and consequently seed needs to be stored for only one season. With bean seed we are dealing with a short-term storage requirement of at most 12 months. Factors which will determine the behaviour of the seed in this period are the initial moisture content of the seed at harvest, and the temperature and relative humidity of the storage environment.

Bean seed moisture equilibrium values

All seeds are hygroscopic—they absorb moisture from a damp atmosphere and they give up moisture to a dry atmosphere. The dampness of the atmosphere is measured by its relative humidity and this varies greatly from place to place. Seeds stored in non-moisture proof containers at Cairns (annual relative humidity 76%) or Ayr (72%) would become considerably higher in moisture than seed stored in dry localities such as Cloncurry (39%) or Cunnamulla (46%).

In open storage, with the seed freely exposed to atmospheric moisture, bean seed moisture will tend to a constant value. Many determinations have demonstrated the likely values which will differ slightly according to temperature. For example, bean seed with an initial moisture content of 9·9% was found to arrive at the following moisture contents after equilibration at various temperatures:

Storage temperature	11°C		21°C			27°C		
Relative humidity %	52	80	65	73	81	66	73	80
Seed moisture content % ..	10	17	12	14	15	13	14	16

Open storage in Queensland

A knowledge of the moisture equilibrium values for bean seed does not help us in predicting the likely effects of storage in a particular area unless we know something about the rate at which seed deteriorates under different conditions. It has been estimated that maximum safe seed moisture content for storage for 1 year would be:

Storage temperature ..	21°C	27°C
Maximum safe moisture content	11%	8%

In Queensland, the main problem storage period is between October and March. The average daily temperature over this period varies from about 26°C in north Queensland (Ayr) to 24°C in south Queensland. So it would appear that a moisture content of about 10% would be a suitable level of seed moisture for storage of beans in Queensland, provided the average storage temperature does not exceed 26°C.

It must be stressed that the measurement of storage temperature should be carried out within the seed stack. Air temperature within a building is variable. In north Queensland, seed stacked high in an un-insulated storeroom could be exposed to temperatures in excess of 40°C during the summer months.

Effect of storage in steel bins

Although seed may be placed in storage at a safe level of moisture, the average relative humidity prevailing throughout the year in coastal areas of Queensland is such that seed would normally be expected to absorb water from the atmosphere. The mean relative humidity at Ayr during the summer months (October to March) is 73% and as we have seen previously this could result in a seed moisture equilibrium value of about 14%.

However, a study in 1974/75 of moisture content of seed stored in lidded steel bins at Brandon indicated that little variation occurred throughout the season.

Thirteen lines of bean seed were tested for moisture content in October 1974 and March 1975:

Variety	Moisture % (Oven Method)	
	October, 1974	March, 1975
Apollo	10·3	10·7
Apollo	10·1	10·3
Apollo	13·2	12·1
Canyon	12·0	11·7
Canyon	11·9	12·2
Gallatin 50	11·4	11·1
Gallatin 50	9·7	10·4
Gallatin 50	10·2	10·0
Providor	9·8	10·8
Borlotti	10·8	10·4
Borlotti	11·2	11·6
Greenleaf	12·5	12·1
Pioneer	12·0	12·7

Storage containers can therefore markedly influence the rate of moisture uptake of bean seed and it is obvious that sealed storage should be combined with low initial seed moisture content to provide the best storage conditions.

Artificial drying of bean seed

There are some years when wet harvests occur in north Queensland and initial seed moisture content can be too high. This occurred in 1973 and will no doubt occur again. Provision should exist for drying of bean seed when necessary but it should be noted that beans are classified as slow drying and should be handled in batch driers or drying bins. Bean seed should not be exposed to temperatures higher than 32°C during drying.

Storage—effects on seed vigour

Vigour differences in seed are known to be attributable to storage conditions. A comparison of favourable with unfavourable storage was carried out some years ago in Idaho. Favourable storage was a naturally dry warehouse and the unfavourable conditions were 19°C and 57% relative humidity. After 4 years of storage, plants from the better storage reached flowering and fruiting stages earlier and gave significantly higher yield than those from unfavourable storage.

However, an observation of more practical significance for Queensland bean seed producers is that deterioration of stored bean seeds is known to occur much more rapidly for lots with low initial percentages of normal seedlings. Abnormal seedlings in bean seed are attributable initially almost entirely to harvest or cleaning damage, and this in turn is closely associated with dry conditions at threshing. In other words, low seed moisture content at harvest tends to decrease vigour whereas the reverse is the case during storage.

Producers should therefore aim at seed of maximum germination potential at the start of the storage period by avoiding mechanical damage as much as possible. This combined with adjustment of seed moisture level should ensure the maintenance of good vigorous seed during the storage period. Unless storage temperature can be kept moderately low by insulating the storage area, some form of cooling would clearly be of benefit.

Heliothis . . . serious agricultural pests

by R. H. BROADLEY, Entomology Branch.

TWO moth species, *Heliothis armigera* (Hubn.) and *Heliothis punctigera* Wall. are most important field pests of agricultural crops in Queensland.

They cause extensive damage to a wide range of crops, and growers are experiencing increasing difficulty in achieving control.

Heliothis larvae show a preference for feeding on the flowering and/or fruiting parts of crop and ornamental plants, causing direct yield losses and unacceptable market blemishes. In addition, they can also destroy growing terminals prior to flowering, and the ensuing loss of plant uniformity can have serious consequences in many crops.

Larval feeding habits often make effective control with insecticides difficult and recent studies have shown that one species of *Heliothis* is now highly resistant to several insecticides. Further development of insecticide resistance could have serious implications as insecticide control of the pests is presently essential to the production of a wide range of agricultural and horticultural crops.

Common names

Many names have been applied to the larvae of these pests. For the most part, they aptly refer to the crop attacked, and describe the most important injury caused by larvae. For instance, the name cotton bollworm refers to the liking of the *Heliothis* worm or grub for the bolls and squares of the cotton plant.

Other names regularly used by growers to describe one or both of the pests concerned include tobacco budworm, tomato grub, corn earworm, bean pod borer, flower caterpillar, native budworm, and lucerne budworm. Some of these names, based on host crop, are often referred to entirely different insect pests thus causing a degree of confusion. This could be partially eliminated by adoption of *'Heliothis'* as a preferred common name.

Distribution

Available information indicates that *Heliothis armigera* and *Heliothis punctigera* are common pests in the eastern, coastal and subcoastal regions, from the south Queensland border to Cape York Peninsula. They also occur in inland areas where regular cropping is practised (for example, St. George and Emerald Irrigation Areas) though the exact limits of their western range have not been defined.

Occasional vagrant moths, which are capable of moving large distances, are probably responsible for initiation of infestations in areas of discontinuous cropping or in districts far removed from other centres of agricultural production.

Heliothis identification

A similarity in external appearances of both adults and immature stages of the different *Heliothis* species causes some difficulty. Practical identification by primary producers basically centres on collections of adult moths, as eggs and larvae are virtually indistinguishable in the field, and pupae are generally formed in inaccessible sites beneath the soil surface. Readers may like to consult pages 520 to 522, Vol. 99 (1973), of the *Queensland Agricultural Journal* for details of *H. armigera* and *H. punctigera* adult and pupae identifications.

If identification is attempted, it should be remembered that moths exhibit considerable colour variation, and that older specimens may be poorly marked following loss of wing scales. Newly emerged moths offer the best opportunities for proper identification.

Species identification has become important to Queensland primary producers since DDT resistance was first recorded during 1972 in one of the major pest species, *H. armigera,* but not the other, *H. punctigera.* In essence, the advent of DDT and other insecticide

in Queensland

resistances in *H. armigera* has limited the number of chemicals which can be used for its control in some areas.

Heliothis life cycle

The following discussion of the *Heliothis* life cycle is centred on *H. armigera* but the same basic pattern is found in *H. punctigera.*

There are four distinct life stages—moth, egg, larva and pupa.

- MOTH—*H. armigera* adults are drab, night-flying moths, with a 35 to 40 mm wing span. They often 'rest' on crop plants during the daylight hours, with wings folded over the abdomen.

Moths are attracted to light of certain wavelengths (especially on dark nights) and can be caught by light traps. While suitable for monitoring changes in moth activity, light traps will not effectively control *Heliothis* (see page 99, Vol. 102 (1976) of the *Queensland Agricultural Journal*), the reason being that only a small proportion of moths can be caught by this method.

The primary activities of moths are mating (to ensure fertilization and production of viable eggs), dispersal (location of suitable host plants) and egglaying.

Mating occurs in the early hours of the morning following a period of inactivity lasting several hours. Feeding and most egglaying, on the other hand, occurs in the evening, particularly during the 3 to 4 hours during and immediately after sunset.

Moths cause no real plant damage, as they merely feed on nectar. Ample supply of nectar substantially increases egg production, and its availability may partially explain why *Heliothis* patterns of oviposition co-incide with the flowering cycles of crops such as cotton, maize, sorghum, peanuts, beans, sunflower and tobacco.

For example, in sorghum, eggs are laid on the flowerhead shortly after it emerges from the flag leaf, but few eggs are laid on maturing grain. In maize, the rate of oviposition is low before tasselling and reaches a peak during the maximum silking period. In tobacco, higher numbers of eggs are found on flowering than on non-flowering plants.

- EGG—Individual moths have been known to lay over 3 000 eggs, but the average is approximately 1 200. In a single 24 hour period, up to 450 eggs have been recorded from one moth. These figures show that the pest has a high capacity for increase if allowed unrestricted development.

Eggs are deposited singly on selected parts of the host plant, particularly on fruits, flowers, flower buds and terminal growth but eggs may also be laid on leaves and stems. The small, globular, upright eggs are pearly white when first laid, but later develop an encircling, irregular brown band. The dark head capsule and grey body of the developing larva can be seen through the translucent egg shell prior to hatching.

- LARVA—Larvae leave the eggs by chewing an exit hole in the upper side of the confining egg shell. Newly hatched larvae are about 1·2 mm in length, with a greyish-white body and black head capsule. Being small in size, larvae are difficult to locate on the plant, and may be easily overlooked. If disturbed, young larvae sometimes drop from the plant and hang suspended on silken threads.

Heliothis larvae exhibit considerable colour variation. Younger larvae (5 to 10 mm in length) are often a basic brown colour with indistinct, white striations along the top of the body. Superimposed are a series of dark, spiky body hairs, which partially ring the abdomen and sometimes obscure the underlying pattern. Large larvae are more colourful and have distinct, longitudinal stripes suffused with variable coloured markings. Overall pigmentation may be either green, fawn, pink, yellow or brown.

Each larva has 3 pairs of legs at the fore-end of its body, plus 4 pairs of 'false' legs in the middle and 1 pair of 'false' legs at the hind end of the body. The arrangement allows larvae to move in an undulating fashion

over the plant surfaces, thus distinguishing them from the 'looping' action of unrelated looper and semi-looper larvae.

Feeding begins shortly after emergence from the egg, and continues until larvae are fully grown, when they attain lengths up to 35 mm. During development, larvae moult 5, 6 or 7 times. A moult is characterized by a shedding of the complete larval skin and head capsule.

Heliothis larvae can often be observed moving over the plant surfaces, apparently searching for suitable feeding sites. Once these have been located, movement may be considerably reduced, and it is quite common for larvae to be found partially burrowed into flowers, seed capsules or fruit. Exhaustion of the food supply may precipitate further movement.

Cannibalistic behaviour usually ensures that few larvae reach maturity when feeding occurs in a confined space (for example, the tip of a corn cob).

- PUPA—Fully grown larvae move off the plant and transform into pupae in specially constructed chambers in the soil. When first formed, pupae are light green and soft-bodied. However, pupal cases rapidly harden and turn dark brown.

Moths usually emerge from the pupal stage after a short period of development. However, when conditions are unfavourable (for example, during a cold winter period), several months may be required before pupal development is completed. At this stage, the moths tunnel to the soil surface, expand their wings, disperse and recommence the cycle.

The minimum time from the egg stage to adulthood is 23 to 24 days. This comprises 2 days for hatching of the eggs, 9 days for larval development and 12 days for incubation of pupae. Consequently, regular field checking is a pre-requisite for the early detection of *Heliothis* larval infestations. Such infestations are heralded by an egglaying peak.

The best opportunities for *Heliothis* control exist when eggs and young larvae are present on the plants. Small larvae have had little chance to cause substantial damage, and generally are easier to kill with insecticides than are large larvae. Thus, timing of insecticide application is critical.

Seasonal development

Heliothis are capable of year-round development in the northern parts of the State, and can be found on suitable hosts during the winter months. Population levels, however, are considerably lower than those experienced during the warmer, summer months. By contrast, *Heliothis* adults and larvae are not usually found in south-east Queensland in the cooler winter period, the pests surviving during this time as overwintering pupae.

The build-up in *Heliothis* activity in north Queensland is quite rapid and overlapping generations usually produce egglaying cycles every 14 days. In southern Queensland, on the other hand, population development is less clear cut. *Heliothis punctigera* is the more common pest species in spring and early summer with *Heliothis armigera* becoming troublesome in November–December and being the more serious pest in January to March. However, activity during these periods and into autumn seems to depend on seasonal conditions.

Crop damage

The wide host range of *Heliothis* species results in a range of economic responses to larval feeding. Generalizations, therefore, are difficult and damage is best discussed on a crop basis.

- TOBACCO—Both *H. armigera* and *H. punctigera* are major pests of tobacco. The most serious damage is caused when larger larvae destroy plant terminals prior to flowering. Eggs and newly hatched larvae on pre-flowering plants are mainly located on the middle and upper leaves; spray coverage of these leaves is, therefore, important for control of the pests.

- MAIZE AND SWEET CORN—*H. armigera* is a common pest of sweet corn and is found regularly on maize. Eggs are laid in the vicinity of the silks and tassels and larvae move to the developing grain at the tip of the cob. Feeding also occurs on the leaves but this is of lesser significance. Cannabalism ensures that few larvae on the silks and cobs reach maturity. While spraying of maize is rarely an economical proposition, insecticide application every 2 to 3 days dur-

ing the short period of silking on the primary cobs is usually necessary for maximum returns in sweet corn production.

• SORGHUM—Significant egg laying in sorghum commences at emergence of the flowerhead from the flag leaf. Young larvae feed on flowers and grain up to the soft dough stage; mature grain being generally unsuited for larval growth. 'Closed headed' varieties appear to be more heavily infested than 'open headed' ones.

Recent Queensland experiments indicate that it is economically sound to spray for control when an average of more than one larva per head occurs, assuming that there are reasonable agronomic expectations of good yield.

• COTTON—This crop is attacked by both species and a large proportion of eggs are deposited in the upper parts of the plant, often on the terminal growth. Larvae feed on squares, flowers, and bolls. Several problems are associated with *Heliothis* control in cotton not the least of which are difficulty in penetrating the leaf canopy with insecticide sprays and the existence of insecticide resistances in *H. armigera* populations in some districts.

• LUCERNE—*H. punctigera* sporadically attacks lucerne with larvae tending to concentrate feeding on young leaves prior to flower bud initiation. High populations can be damaging but are often drastically reduced by naturally occurring disease outbreaks. The result is that insecticide control is not often warranted.

• SUNFLOWERS—Both *H. punctigera* and *H. armigera* are found on sunflowers. Larvae attack leaves, flowers, soft grain and the back of the seedhead. Although the crop has the ability to withstand substantial insect damage, the development of secondary rots in the flowerhead is often associated with pest attack. Control of such rots by the application of insecticides is largely impracticable.

• LINSEED—*H. punctigera* is the species usually encountered on linseed in southern Queensland, although *H. armigera* has been recorded on it in central Queensland. The reproductive parts of the plant and the terminal are usually the sites for pest feeding. Early planting where practicable is a means of pest escape.

• NAVYBEANS AND SOYBEANS—*H. armigera* is the more common species encountered although *H. punctigera* has also been recorded. They are of relative unimportance during the pre-flowering period of both crops. Major pest activity coincides with flowering and pod formation, insecticide control when required, therefore, should be concentrated over these periods. The species are major pests of navybeans and appear to be of increasing significance in soybeans.

• PEANUTS—Both species are recorded from peanuts. The timing of significant *Heliothis* populations in the South Burnett is such that feeding is usually confined to the young leaves and as peanuts can tolerate substantial damage to the leaves, insecticide control is usually not warranted.

• SAFFLOWERS—*Heliothis* eggs are usually laid on the fruiting parts. Excessive larval numbers may occasionally warrant insecticide use but the crop can usually be produced without special measures to protect it from *Heliothis* attack.

• TOMATOES—*H. armigera* is a major pest of this crop with eggs being laid on or near the flowers. Larvae feed on the blossoms and developing fruit although attack on the foliage and stems has been recorded. The habit of larvae of penetrating the outer skin of the fruits to gain access to the fleshy pulp inside causes most concern. Insect damage to fruit also facilitates the entry of soft rot organisms.

• FRENCH BEANS—Beans destined either for the fresh or canning markets receive higher prices when unblemished. For this reason, *Heliothis* excavation (and associated frass) of both younger and older pods frequently causes concern. *Heliothis* larvae also damage flowers.

- PEAS—*H. punctigera* appears to be a dominant pest of peas grown in the Lockyer Valley, though *H. armigera* has also been recorded.

- CUCURBITS (WATERMELON, PUMPKIN, ZUCCHINI, ETC.)—Cucurbits occasionally suffer from the activities of *Heliothis* larvae. Damage is mostly confined to the floral parts and developing fruit.

- LETTUCE AND CABBAGE—Infestations of *H. armigera* coincide with the formation of a definite 'heart' in the plants. Larvae feed initially in the basal areas of the outer leaves, before moving to the protected 'heart' to continue development. Larvae are extremely difficult to control once they have reached the inner zone of leaf tissue.

- POME FRUIT, CITRUS, MACADAMIA NUT, PAPAW, BANANA, STRAWBERRY, ETC.—*Heliothis* cause intermittent problems on these at or around flowering time.

- FLOWERS (GLADIOLUS, ROSE, CARNATION, SNAPDRAGON, ETC.) AND GARDEN ORNAMENTALS—Heliothis can be a problem to both the cut flower trade and the home gardener. For example, young *Heliothis* larvae bore through the petals of young rose buds to feed on the developing ovary. One larva may damage several flowers. Control of protected larvae feeding inside flower buds is quite difficult, and spraying should be timed to coincide with hatching. Hand picking of larvae may be feasible where small numbers of plants are involved.

- GREEN MANURE CROPS (COWPEAS, ETC.)—These are attacked by *Heliothis,* but damage is rarely of significance except where seed is being produced.

Insecticides for Heliothis control

Three situations are commonly encountered in *Heliothis* control, and these are categorized as follows:

- CATEGORY 1—Crops which have a high profit margin per hectare, and require regular applications of insecticides for a large part of the growing season (for example, cotton, tomatoes, tobacco). Spraying is often based on a predetermined schedule, irrespective of whether *Heliothis* are, or are not, active. Pesticide applications based on frequent crop inspections, however, are strongly recommended.

  Refinements such as insect scouting systems used in cotton and a pest activity prediction service operating for tobacco growers in the Mareeba-Dimbulah area are highly advantageous. Fewer (hence money saving) strategic insecticide applications result.

- CATEGORY 2—Crops which commonly require a limited number of insecticide applications for *Heliothis* control. These have the ability to tolerate substantial damage at certain growth stages (for example, sorghum) or are cultivated during the winter when Heliothis activity is low.

- CATEGORY 3—Crops which uncommonly require an insecticide application to control an existing *Heliothis* infestation.

Recommendations for chemical control are given in table 1 on p. 545.

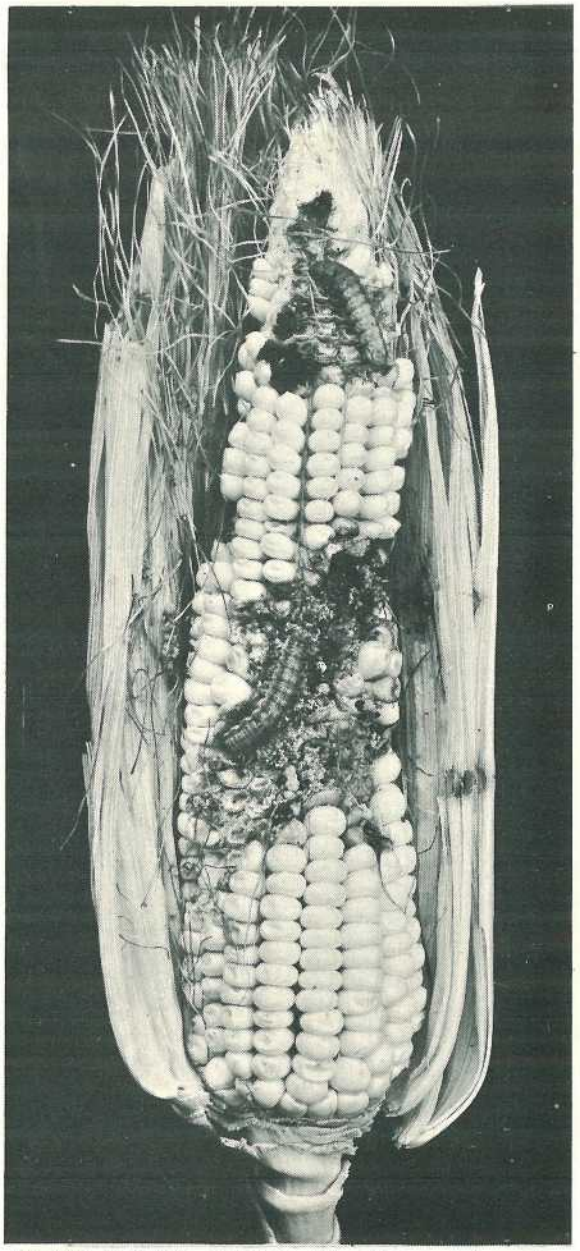
Other control procedures

Although *Heliothis* control currently centres on the insecticidal method, growers should be aware that cultural techniques may assist in minimizing *Heliothis* damage. These include good husbandry to ensure speedy and uniform crop development, destruction of plants which could be used as *Heliothis* breeding sites, timing of planting dates to avoid peak periods of *Heliothis* activity, and a reduction in flowering and fruit development times to lessen periods of crop susceptibility.

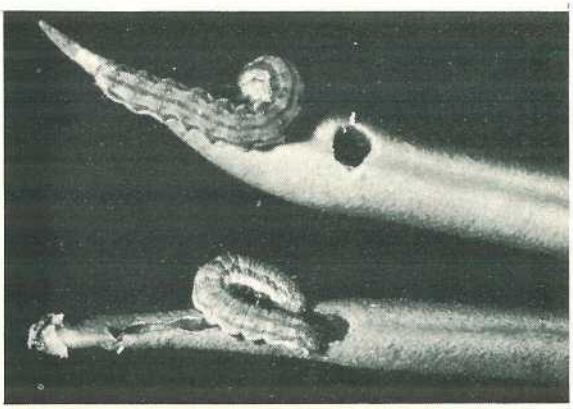
Department of Primary Industries' personnel are also researching other avenues of *Heliothis* control in an effort to reduce our total reliance on crop protection chemicals. Alternatives under investigation include the use of harmless micro-organisms which kill *Heliothis* larvae, release of *Heliothis* egg parasites, and breeding of *Heliothis* tolerant varieties.

Further details on control systems when required, should be sought from Departmental extension officers.

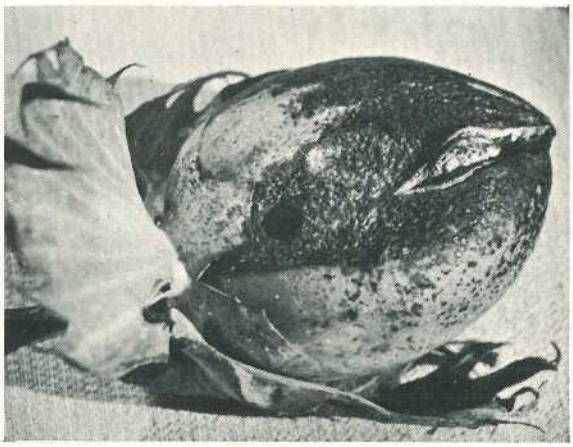
Heliothis . . . a serious threat to crops



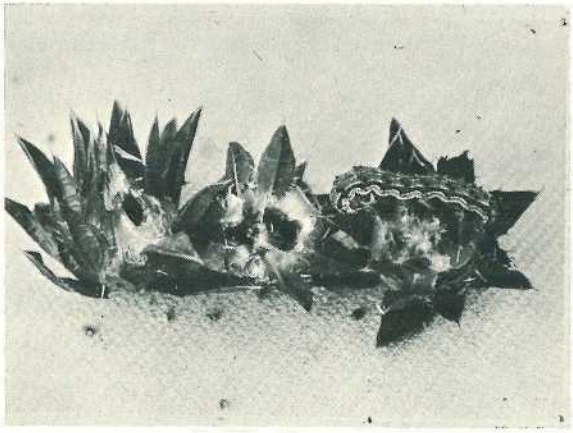
ABOVE. Heliothis armigera *damaging a maize cob.*



Heliothis *damage to French beans.*



The exit hole left by Heliothis *in a cotton boll.*



Heliothis *damaging safflower buds.*

Heliothis

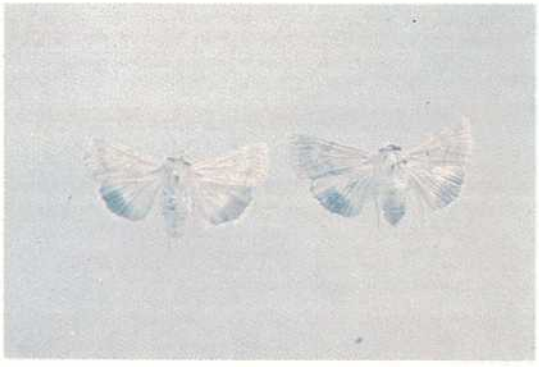


Plate 1. Heliothis punctigera *moths. The female is on the left and the male is on the right.*

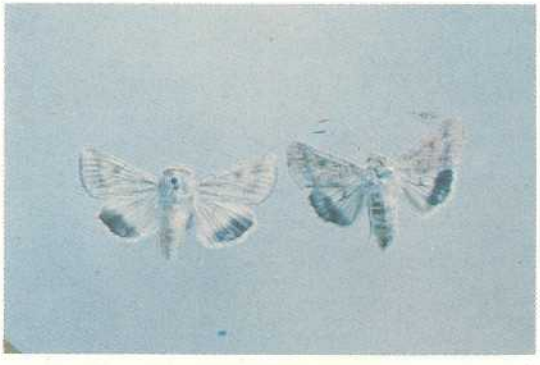


Plate 2. Heliothis armigera *moths. The female is on the left and the male is on the right.*

Plate 3. Heliothis armigera *eggs. The encircling brown band, which appears during egg development, can be partially seen in the upper egg.*

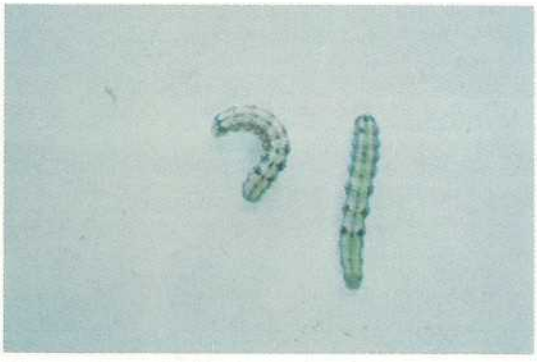


Plate 4. Young Heliothis armigera *larva. The underlying brown colouration with white stripes is partially obscured by the dark body hairs.*

Plate 5. Mature Heliothis armigera *showing part of the wide range of body colouration which occurs in this species.*

life cycle

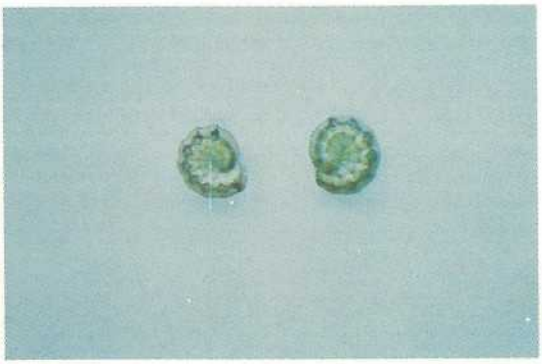
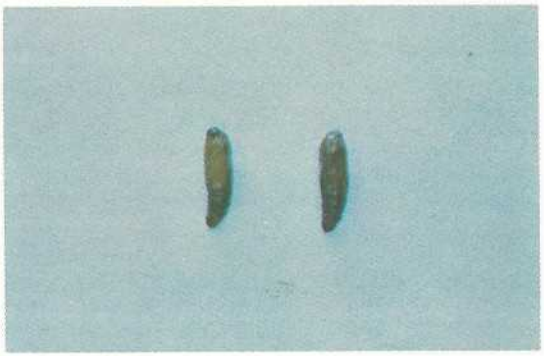


Plate 6. The defensive posture often adopted by Heliothis armigera *larva which has been disturbed.*

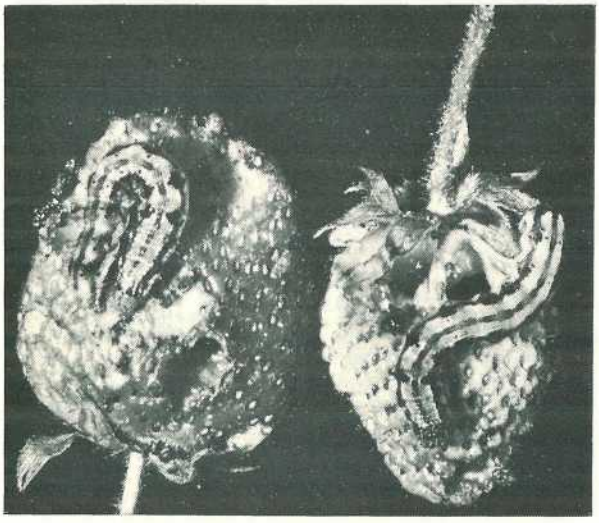
Plate 7. Typical Heliothis *damage to tobacco. Queensland farmers are most familiar with the* Heliothis *larval stage. Damage such as this can be a common sight on a wide range of Queensland crops.*

ABOVE AND BELOW. Plate 8. Heliothis *feeding on safflower heads and Navy beans.*

BELOW. Plate 9. Heliothis armigera *pupae.*



Photographs by R. H. Broadley, Entomology Branch.



RIGHT: Heliothis *damaging a tomato fruit. Note the old entry position.*

ABOVE. Damage to strawberries caused by Heliothis.

BELOW. Heliothis *damaging sunflower heads.*

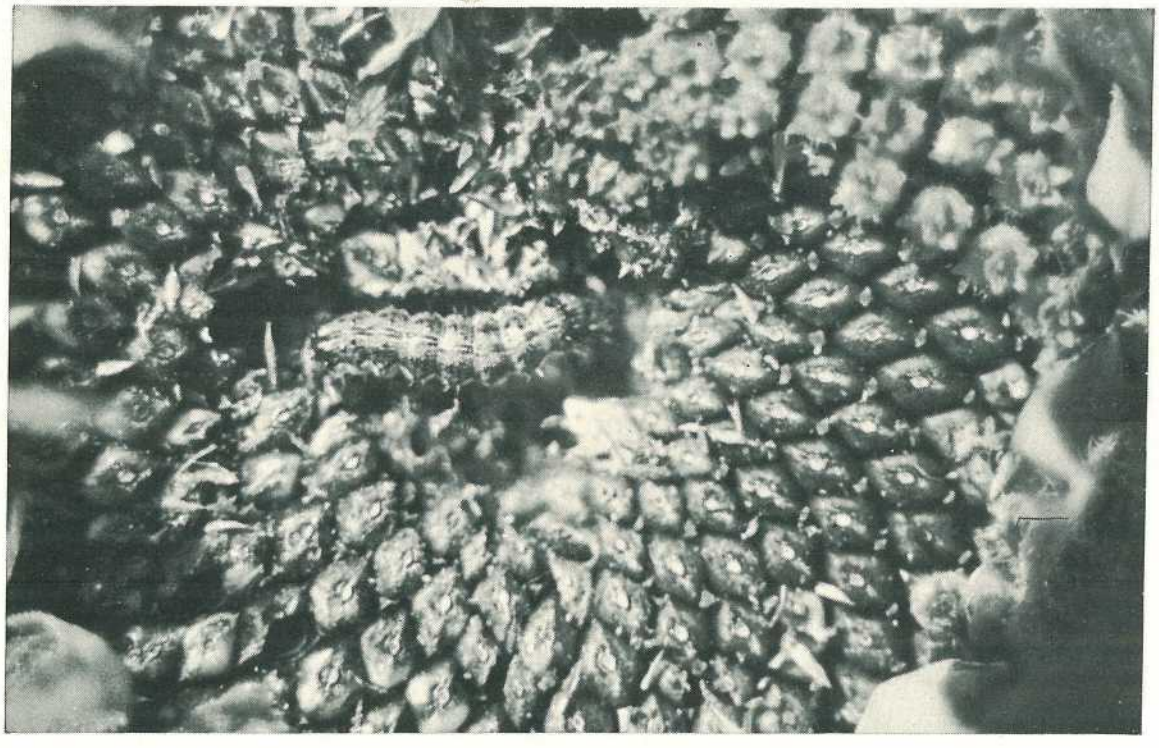


TABLE 1

Crop	Chemical	Dosage Active Constituent	Withholding Period (Days)
Beans	Carbaryl	0·1%	3
	Endosulfan	735 g/ha	7
	Methomyl	340–450 g/ha	1
Capsicums	Endosulfan	0·07% or 735 g/ha	7
Cotton	DDT	550–1 100 g/ha	28
	DDT–camphechlor	720 + 2 000 g/ha–990 + 2 750 g/ha	14
	Endosulfan	735 g/ha	28
	Methomyl	405–540 g/ha	15
Lettuce	Methomyl	450 g/ha or 0·045%	3
Linseed	Endosulfan	735 g/ha	28
Lucerne	Carbaryl	1 100 g/ha	1
Maize	Endosulfan	735 g/ha	21
Navybeans	Endosulfan	735 g/ha	7
	Methomyl	340 g/ha	1
Ornamentals	Carbaryl	0·1%	N.R.*
Peas	Endosulfan	490 g/ha	7
Peanuts	Endosulfan	735 g/ha	28—grazing N.R.—production
Pome fruits	Endosulfan	0·07%	14
Safflower	Endosulfan	735 g/ha	28
Sorghum	Carbaryl	1 100 g/ha	1
	Endosulfan	735 g/ha	7
	Methomyl	340–450 g/ha	42—grain 14—livestock
Soybeans	Endosulfan	735 g/ha	28
	Methomyl	340 g/ha	1
Strawberry	Endosulfan	0·07%	5
Sunflowers	Endosulfan	735 g/ha	28
Tobacco	Endosulfan	0·07% or 735 g/ha	N.R.*
	Methomyl	0·025%	N.R.
	Monocrotophos	0·06%	21
Tomatoes	Acephate	100 g/ha or 0·1%	3
	Endosulfan	0·07% or 735 g/ha	7 (1 day—processing)
	Methomyl	0·034%–0·045%	1
	Methamidophos	0·11%	21
	Monocrotophos	0·07%	7
Sweet corn	Methomyl	340–450 g/ha or 0·034–0·045%	N.R.
Vegetables	Carbaryl	0·1%	3

* N.R.—Withholding period not required.

Peach and nectarine growing

PEACH and nectarine growing in Queensland is confined almost entirely to the Granite Belt. Outside of this, a few small areas have been established around Warwick and Inglewood and, to a much lesser degree, around Brisbane.

Most of the fruit is sold on the fresh fruit market, but a small proportion is processed within the State.

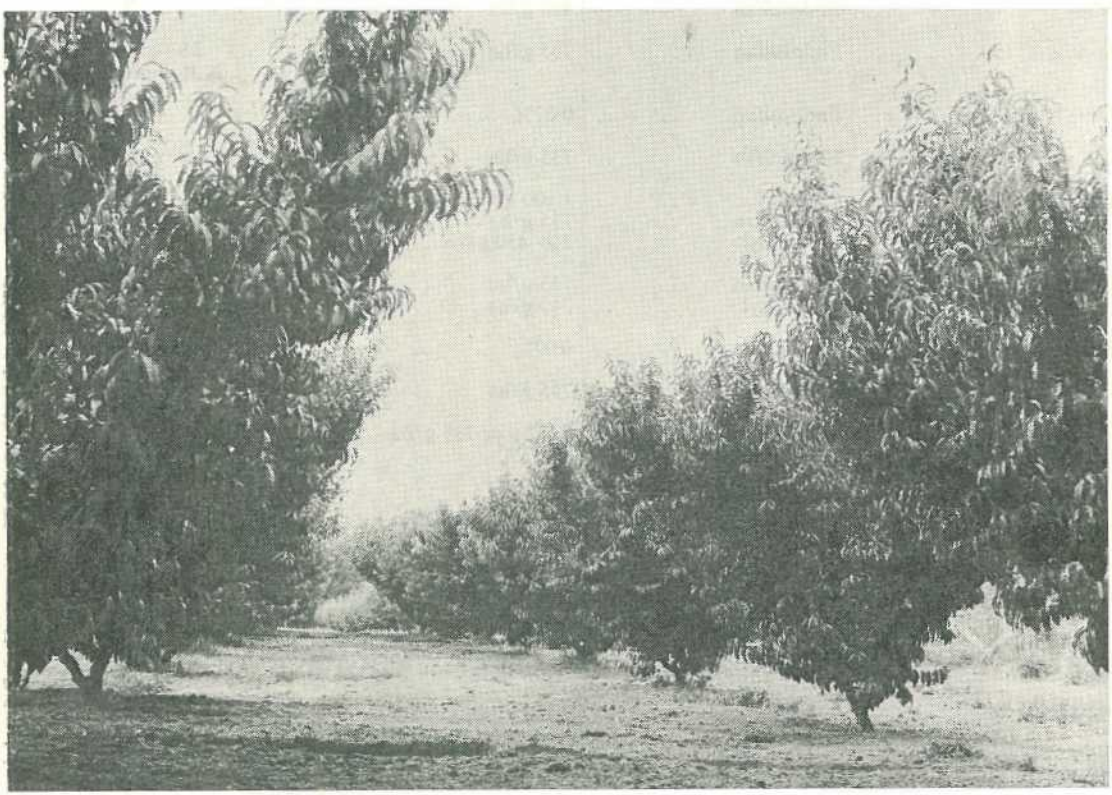
The total area under peaches is approximately 975 ha, consisting of 800 ha of bearing and 175 ha of non-bearing trees. Around 200 ha are planted to nectarines, of which 185 ha are bearing and 15 ha non-bearing. Production varies from year to year but the annual average is about 3 000 tonnes of peaches and 800 tonnes of nectarines.

Climatic requirements

Peach and nectarine, along with other deciduous fruit trees, require a certain amount of chilling during winter for normal development of buds in the following spring. Allied to this are the winter chilling requirements of each variety.

The symptoms of insufficient chilling are:

- Budshed in later winter and early spring.
- Delayed and prolonged flowering.
- Failure of flowers to form properly—leading to poor cropping.
- Delayed and erratic leaf bud development causing poor health.



A peach orchard in the Stanthorpe district.

in Queensland

by M. A. Hannigan, B. C. Dodd and other officers of Horticulture Branch.

Winter chilling requirements are calculated by the total number of hours below 7°C. Peaches generally require more chilling than other stone fruits. The chilling requirements of most varieties fall in the 600 to 1 200 hours' range and are listed in the section under 'Varieties'.

The number of hours for a range of districts is: Stanthorpe 800 to 1 150, Inglewood 600 to 800, Warwick 500 to 650, Gayndah 300 to 450, Herberton 50 to 250, Brisbane 0 to 50.

Although low winter temperatures may cause problems in other peach growing areas in the world, they are not extreme enough to cause tree damage in Queensland. However, spring frosts can cause severe losses of young, developing fruit buds, blossoms and fruitlets. Air temperatures of −4°C to −1°C can cause damage, the most susceptible period being the young fruitlet stage. Varieties with low chilling requirements are unsuited to the Granite Belt as early bud burst leads to greater hazards with spring frosts. Some protection can be obtained through the use of spray irrigation and orchard heating.

Temperatures around 30°C are required for the best development of flavour and colour as the fruit matures. However, fruit quality may be affected where summer temperatures exceed 35°C for long periods. Spray irrigation can provide some degree of cooling of the fruit and foliage.

Harvesting peaches.

Rainfall should be sufficient throughout the year, and especially during the critical periods, that is, just before blossoming and fruit set, before fruit maturity, and during flower bud initiation from January to March. An evenly distributed annual rainfall of 750 to 850 mm is desirable. However, rainfall is unreliable in most districts and a place exists for irrigation. Prolonged wet conditions near blossom time and when fruit is maturing increase the risk of fungal diseases and fruit splitting. Hail may be a problem in some areas.

Selection and preparation of land

Soils

Peaches can be grown on a wide range of soils provided drainage is good. No single characteristic of good peach land is more important than good drainage.

Most peaches in Queensland are grown on deep loam, sandy loam or even sand. On a deep sand, moisture stress may develop without irrigation. This leads to small, shrivelled, low-quality fruit.

Aspect

In selecting land for peach trees, aspect should be considered, with particular emphasis on freedom from spring frosts. These are a major hazard in some parts of the Granite Belt. A northerly or north-easterly slope, sheltered from westerly winds and with all obstacles and timber cleared at the lowest point, is some safeguard against frost damage in the established orchard. Low-lying flats are extremely vulnerable to frost damage. In the warmer parts of the State, aspect is not so critical.

Clearing

The preparation of land for planting follows a standard practice. Clearing the timber and 'running' the tree roots are done by contractors with bulldozers and other heavy equipment. Deep ripping with a dozer ripper attachment is essential to bring to the surface as many native tree roots as possible so they can be gathered and burnt. Ripping also loosens the subsoil and allows better moisture and root penetration. A skilled dozer operator can push the stands of native timber into rows with a minimum loss of topsoil.

When planning to expand the orchard, it is worthwhile to ring-bark the native trees in the proposed area a few years before clearing. During this interval, the roots decay and this lessens the risk of the *armillariella* fungus infecting the established orchard.

After clearing and ripping, the land should be levelled and ploughed, then cross-ploughed, disc-harrowed and brought to a good tilth. The depth of cultivation is adjusted so that little subsoil is brought to the surface. During soil preparation, roots and other debris should be removed at every opportunity.

Drainage

Poor drainage adversely affects production by:

- Reducing the vigour of trees and making them more liable to other disorders.
- Causing poor drought resistance due to death of deeper roots.
- Shortening the trees' lives.
- Killing trees in very badly drained areas.

Although Granite Belt soils have a sandy topsoil, the subsoil can be badly drained because of shallow, impervious clay layers, compaction layers, and cement and rock bars. Where trees are stunted and yield poorly, bad drainage is often the cause. Testing the land with a soil auger to locate wet spots is recommended. Growth of native timber can be a good guide.

To obtain good drainage, the following points must be considered:

- Careful selection of site before planting.
- Prevention of external water moving on to the orchard.
- Removal of wet spots.

In recent years, PVC perforated pipes have been used for underground drainage. These are available in sizes ranging from 4 cm to 10 cm in diameter in single length coils up to 300 metres long. They are much easier to lay than the agricultural tile pipe.

The drainage system used will depend on the topography of the land and the direction of flow of the water to be removed. The most general system consists of an exit or main drain with lateral drains feeding into it. The lateral drains can be placed at right angles to the main drain allowing the necessary fall, or in a herringbone pattern. The distance at which lateral drains should be placed depends on soil type; the heavier the soil the closer the drains. In most soils in the Granite Belt, drains are placed 12 m apart; in heavier soil they are set about 6 m apart.

The depth at which the drain pipes are placed is governed mainly by the depth at which the clay layer starts. The pipes should be bedded in this hard layer, half in and half out. The usual depth of placement in Granite Belt soils is 60 to 90 cm.

A plan showing the exact position and lay-out of the drainage system is essential, as it is very helpful in locating blockages should they occur.

Soil conservation

On land where the slope exceeds 3%, consideration should be given to contour planting. Orchards are relatively clean-cultivated during most of the summer and are therefore subject to soil erosion. Contour planting, with provision for grassed waterways and banks where necessary, is an effective preventive measure. Waterways should be well established before planting. In the Granite Belt, a suitable mixture for grassing waterways is perennial rye, prairie grass, phalaris and white clover planted the autumn before.

Replant land

More replant areas are now being used. It is preferable to replant after apples or vines. Preparation of the area should begin at least 1 year before planting the trees. Testing the soil for nematodes and pH analysis is essential with replant land. Fumigation and liming may be necessary.

All old roots should be removed and burnt before replanting. The fertility of the soil can be improved by cover cropping. Replant trees grown on banks make better growth than those on flat land because of the increased depth of soil and improved surface drainage.

Varieties

The major difference between peaches and nectarines is that nectarines are smooth-skinned and lack hair (fuzz). Because of this, they are more prone to fungal diseases such as brown rot.

When selecting peach and nectarine varieties to grow, the main requirement is for high popularity with the buying public. The consumer buys mainly on attractive skin colour, shape, size, flesh colour, flavour and firmness. However, varieties must suit the climate, and the major determining factor is the winter chilling requirement. Generally, growers aim at planting the most suitable and popular varieties which mature in sequence.

An important characteristic of different varieties is whether the fruit flesh adheres to the stone. Depending on this, they can be classed as freestone or clingstone with stages in between. Abount 85% of peach varieties grown in the Granite Belt are yellow-fleshed freestones.

Normally, peaches and nectarines are self-pollinating. An exception is the J.H. Hale peach, which has sterile pollen, and requires a cross pollinator.

Seasonal differences in maturity dates can be quite large. Differences of 2 weeks or more in reaching maturity have been recorded over several seasons. This can make a big difference in market returns, particularly for early and pre-Christmas fruit. In other districts, varieties are likely to flower and fruit earlier than on the Granite Belt provided they receive adequate winter chilling. The maturity times for the varieties listed below are for tree-ripened fruit.

Established peach varieties in the Granite Belt

STARKING DELICIOUS. Matures in mid to late December. The fruit is yellow-skinned with a pink blush, semi-freestone, and the pointed fruit apex is subject to bruising.

The tree is vigorous, crops well, but is susceptible to bacterial plum spot. Chilling requirement is 800 hours. It quickly replaced the white-fleshed early varieties on the Granite Belt and now makes up about 7% of the total peach plantings in this district.

JULY ELBERTA. Matures in late December. Fruit resembles Starking Delicious except that the apex is not as pointed. Trees are vigorous and crop well. Chilling requirement is 750 hours.

HALEHAVEN. Matures in early January, and is a popular early mid-season variety, accounting for 10% of the peach plantings on the Granite Belt. Fruit has a yellow skin with a deep-red blush. It is round, firm, yellow-fleshed, and is a freestone with a small stone. Trees grow and crop well. Chilling requirement is 850 hours.

SOUTHLAND. Matures at the same time as Halehaven. Fruit has an attractive, yellow ground colour with some red blush and mottle. It is medium to large, round, yellow-fleshed and freestone. Chilling requirement is 750 hours.

BLACKBURN ELBERTA. This variety matures in mid January, and is the most popular mid-season peach grown on the Granite Belt, making up 28% of the trees planted. The fruit is very attractive with a deep, dark-red blush overlying a yellow ground colour. It is oval-shaped, firm, yellow-fleshed, freestone, and highly flavoured.

The tree is moderately vigorous and upright, and crops well. It is less resistant to late spring frost damage than some other varieties.

DRIPSTONE ELBERTA. Matures mid January. Fruit has a dark-red blush over about half the surface overlying a yellow ground skin colour. It is oval-shaped, large, yellow-fleshed, freestone. The large, colourful fruit usually brings a high price.

The tree is upright, vigorous, and sets a medium-sized crop, but is susceptible to bacterial spot. The chilling requirement is not known.

J.H. HALE. Matures towards the end of January. Fruit has a yellow skin with a deep, mottled blush, is fairly round, large-sized, firm, with deep-yellow flesh. The tree is not as vigorous as Dripstone Elberta, and requires cross-pollinating to set fruit. The recommended pollinating varieties are Halehaven or Blackburn Elberta.

GOLDEN QUEEN. Matures early to mid February, and is practically the only late, yellow-fleshed, clingstone peach variety grown on the Granite Belt. The fruit has a bright yellow skin, and is round, large and firm. Although a canning variety, it is sold mainly on the fresh fruit market in Queensland and makes up about 9% of the peaches grown on the Granite Belt.

White-fleshed varieties were formerly important, but are now losing their significance. These include Mayflower, Highs Early Canada, Wiggins, Beale, and Smith's Seedling. These are listed in order of maturity. The early varieties such as Mayflower and Briggs demand high chilling requirements and, because of this, tend to be poor croppers after mild winters. However, being early maturing, they bring good prices.

Established nectarine varieties

GOLDMINE. Matures mid January. Fruit has highly-coloured, bright-red skin, is round, medium to large, and freestone with a fairly large stone. Flesh colour is light greenish-cream with some red colour near the stone. Fruit is easily bruised when handled roughly and is susceptible to brown rot.

Other nectarine varieties grown in the Granite Belt are Early Rivers and Newboy.

Introduced peach varieties

Early maturing, yellow-fleshed peaches introduced from the United States are at present having a considerable impact on the fresh fruit market. These are:

CARDINAL. The fruit matures about mid December, before Starking Delicious, and has a very attractive, bright red blush. It is round, medium size, firm, yellow-fleshed, semi-freestone, and has good flavour. Trees need thinning to improve fruit size. Chilling requirement is 950 hours.

HILAND. Matures at the same time as Cardinal but is not as brightly coloured. It is medium-sized, firm, yellow-fleshed, clingstone, and of fair eating quality. Trees are vigorous, flower heavily, and set a medium crop. Chilling requirement is 750 to 800 hours.

MAYGOLD. Matures in mid December about 2 days later than Cardinal and Hiland. Colour is an attractive, mottled red but not as bright as Cardinal or Hiland. Fruit is well-shaped, round, medium sized, firm, yellow-fleshed, and clingstone, and has fairly good eating quality. Trees grow vigorously and crop at an early age. Chilling requirement is 650 hours.

CORONET. This variety matures about the same time as Starking Delicious. Fruit has an attractive bright-red blush over most of the surface. It is of desirable round shape, medium size, firm, yellow-fleshed, freestone, and has good flavour, superior to Starking Delicious. Trees are fairly vigorous and set an average crop. Chilling requirement is 750 hours. It is suitable for planting as a second early variety.

Introduced nectarine varieties

Nectared nectarines are a series of varieties numbered 1 to 10. They were bred in the United States to mature in sequence at about weekly intervals. Nectared 1, 5, and 8 are not yet available for testing. They are all red-skinned, yellow-fleshed, medium sized (early) or large (late maturing), firm, semi-freestone or freestone, and of good eating quality. Winter chilling requirements are not definitely known but are within the range of the above mentioned peach varieties.

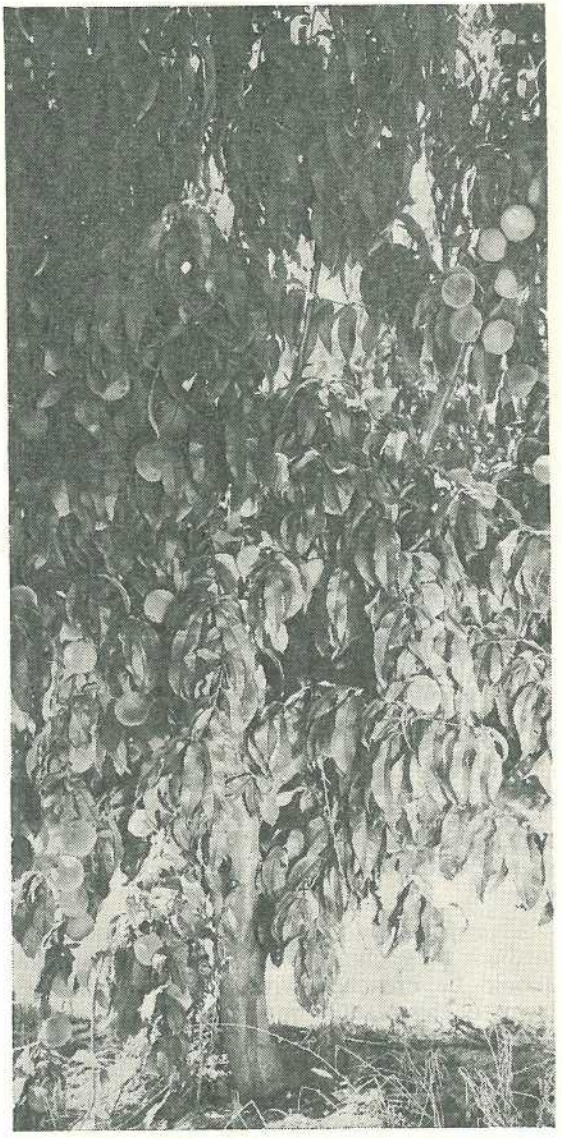
Nectared 2 matures about mid December. Nectared 3 is about 7 to 10 days later followed in a few days by Nectared 4.

Like all nectarines, all the Nectared varieties are highly subject to brown rot, particularly the later maturing ones.

Low chilling, subtropical varieties

China Flat, Bells November, Beauty of Booroodabin, and Watts Early Champion are grown in small areas in the Pinkenba and Nudgee areas near Brisbane. These varieties have low chilling requirements, flower and mature very early, but are small, soft, white-fleshed and of poor quality.

Current research is aimed at introducing and evaluating American varieties that have low chilling requirements. Trees of two yellow-fleshed, early maturing peaches, Flordaqueen and Flordasun with chilling requirements of 500 and 350 hours respectively, have been sent to various centres in Queensland for testing.



A 9-year-old Halehaven peach tree.

Rootstocks

Peach seedling has given the best results as the rootstock for both peaches and nectarines in the Granite Belt. The variety most commonly used is Elberta, because of its low virus status. Occasional plantings are made with Golden Queen.

Following the introduction of the nematode-resistant rootstocks, Nemaguard and Okinawa plantings of Nemaguard have increased, particularly in the Granite Belt. Okinawa is more suited to warmer climates because of its low chilling requirements.

Plum stocks were used in the past because of their better tolerance of poor drainage, but are now less favoured.

Propagation

Seedling production

Fruit required for seed should be disease free, and picked at the firm-ripe stage. Germination will be reduced if the fruit is over-ripe before the stone is removed. Stones should be washed of all traces of flesh and allowed to air dry for several days in a cool, dry place. After drying, they can be stored in ventilated containers in a cool, dry place until ready for use.

A chilling period of about 3 months at 1 to 5°C is necessary before seed can germinate. Seeds should be given this treatment in late May or early June so germination occurs in early spring.

Cracking the stone and extracting the seed is preferable, as a lower germination percentage will result from uncracked stones. Dusting the seed with the fungicide Captan is recommended.

Clean sand or vermiculite can be used as a medium to germinate the seed. The material should be drenched with Captan. Successive layers of this planting medium and seed should be placed so that seeds are not in contact with each other. The container is kept in a cool place for about 2 days to allow the seeds to absorb water before placing in a refrigerator or cold room at about 1 to 5°C. Frequent inspections are necessary to ensure the medium is neither too wet nor dry. Any mouldy seed must be discarded.

When about 5 to 10% of the seeds are showing signs of germinating, the entire batch should be removed from the refrigerator and sown in a well-prepared seedbed.

The temperature of the seedbed must not exceed 23 to 25°C as exposure to higher temperatures for only a few hours will reimpose dormancy and reduce seedling vigour markedly.

The seed can either be planted in a seedbed and grown for one season, or planted directly in the nursery rows and budded the same season. Direct planting in nursery rows gives a rootstock more quickly but, because of misses, the seed should be planted at 15 to 20 cm spacings and thinned if necessary to 20 to 40 cm.

Selecting scion wood

Select scion wood with strong, well-developed buds on the previous season's growth. Scion wood should come from mature trees, free from virus disease, and have a good cropping record and good fruit type. The trees should be selected during the growing season, over a period of several years.

Scion wood for grafting and spring budding is collected in winter before pruning, and then labelled and stored. Short storage may be undertaken by putting the wood in plastic bags in a refrigerator, or by burying it to about two-thirds its depth in a cool, shaded soil. For long storage, the wood should be placed in moist sand in plastic bags and kept in the refrigerator, or buried approximately 100 cm deep in cool, shady soil.

Propagation techniques

Peaches are normally budded. Budding can be done at almost any time of the year provided the sap is flowing and the bark lifts freely. However, the best time to bud is in late summer-early autumn. Some spring budding is undertaken.

The common budding technique is the "T" bud. A "T" is cut on the stock with the vertical and horizontal cuts made longer than necessary to accommodate the bud. The flaps of bark are gently raised to receive the bud.

The bud, with a slice of bark about 30 cm long, is cut from the scion wood with a sharp, thin-bladed knife, using a single stroke. The wood chip below the bud may be removed.

The bud is inserted in the 'T' on the stock and tied firmly with plastic tape. Budding should be done about 150 mm above ground level.

The correct labelling of the rootstock and the scion variety after budding is essential. Faulty identification of young trees can cause embarrassment to both the nurseryman and the orchardist.

With spring budding, the bud should begin to grow as soon as the union is complete. With autumn budding, the union will 'take', but growth from the bud will not occur until the following spring.

The plastic tape must be cut about 6 weeks after budding. By that time, the union will be completed. The tape is cut on the side of the stock opposite to the bud.

With budded trees, the stock is headed back with a straight cut as soon as the bud starts to grow. Sucker growth on the stock must be suppressed from the time of budding.

Queensland nurserymen can supply most tree requirements. However, if trees are to be obtained interstate, the local office of the Department of Primary Industries should first be consulted, because of State quarantine regulations.

Planting

Trees should be ordered a year in advance of the proposed planting time. Virus-free planting material is becoming available and should be obtained wherever possible. Trees should be obtained for planting out 1 year after budding. Never accept poorly grown trees or trees 2 years after budding.

Planting should be made in mid July. Trees should be graded for size and any stunted or damaged trees discarded. Trees should also be inspected for crown gall, *armilleriella* (shoe string fungus) and nematodes. Infected trees should not be planted. While awaiting planting, trees are best 'hilled in' in firm soil and kept moist in a cool spot.

Planting on the square is the most common planting system used for dryland farming on level ground. The distance between rows and trees within the rows varies according to the fertility of soil and vigour of the nursery tree. The most common planting distance is 6 metres on the square.

Holes are dug about 50 cm wide and 40 cm deep. A small mound of top soil is formed in the bottom of the hole. Trim roots to a minimum and spread them evenly around the mound.

Top soil is added until the hole is half filled. Each shovelful of soil should be firmed around the roots before adding more. About 5 litres of water are then poured into the hole. The hole is then filled with soil to just below the bud union of the tree. To ensure that the soil is in close contact with all the roots, water well again. Fertilizer should not be placed in the hole at the time of planting as this may damage roots and give the tree a setback.

Trees should be regularly inspected after planting to ensure that they are growing well. Good growth in the first year is of vital importance. A small amount of NPK fertilizer can be lightly chipped in by midsummer.

Close planting

Close planting can increase production per hectare many times above that of standard spacing. However, peaches and nectarines are harmed by shading. Also, rootstocks in the limited range available at present are too vigorous to be ideally suited for close planting. Because of these factors, the present recommended spacing is 3 m between trees planted in rows 4 m apart. This is greater than the recommendations for close planted apples.

Good management is essential for close planted peaches, especially in replant situations. Post-planting practices consist of adequate fertilizing, weed control and irrigation. Because of the much greater moisture competition between trees, close planting is not recommended unless water supplies are adequate.

Rows should run north-south where possible to give maximum exposure to sunlight.

Close planting of peaches is currently under investigation. Other management practices under review are rootstocks, planting distances and training and pruning. At present, the most suitable pruning system appears to be a modified central leader with lateral branches trained along the row.

Soil management

Cultivation

The standard soil management practice during the growing season is cultivation using tines and discs. Cultivation maintains maximum soil moisture by destroying weed growth, and leaves the soil surface more receptive to infiltration by rain. Weed growth, during the growing season can reduce yields and place severe stress on the tree. Cultivation should be shallow, otherwise root damage can result.

The frequency of cultivation should be kept to a minimum. Frequent cultivation speeds up loss of soil organic matter and general fertility, and also tends to destroy soil structure. This results in the soil becoming less permeable to water and more susceptible to erosion. Therefore, an orchard that is slightly weedy is preferred to one kept very clean or very weedy. Later in the season, near harvest time, a light grass cover is desirable.

Trees should be kept free from weeds in their first year, otherwise future growth will be affected. In this situation, the chip hoe is still a useful tool.

Herbicides

Around young trees (up to 3-years-old), the herbicide Dichlobenil will give pre-emergent control of annual grasses and broad-leafed weeds and some perennial weeds. It is most effective when applied to bare soil. Dichlobenil should not be applied within 4 weeks of transplanting into the field.

The contact herbicide Paraquat can also be used around young trees. It should not be sprayed on to green bark and leaves. Paraquat is a more efficient killer of grasses than of broad-leafed weeds but it will kill most annual weed seedlings. Perennial weeds such as couch and paspalum will regenerate.

Terbacil is the recommended herbicide for established trees (3 years and older). When applied to clean ground in early spring, Terbacil gives excellent weed control for 4 to 6 months. It will knock down established weeds if the rate is increased and a wetting agent is added. However, Terbacil does not control sorrel, paspalum and cobbler's pegs.

For control of perennial grasses such as paspalum, couch and kikuyu, 2,2–DPA can be added to Terbacil or used alone as a spot treatment. The grass should be young and growing actively when sprayed if best results are to be achieved.

Green manuring

Cultivation reduces the humus content of the soil which leads to poor moisture holding capacity, soil structure and aeration. One way of overcoming this situation is to incorporate a well-grown winter cover crop into the soil at regular intervals. This green manure will help to restore organic matter levels.

Recent investigations into green manure crops have shown that New Zealand blue lupins and black winter rye will increase root lesion nematode populations. In addition, lupins are subject to some soil-borne fungus diseases, such as base rots, which have been known to cause heavy losses in orchards.

Because of these disadvantages with the traditional green manure crops, oats is now the recommended cover crop.

A rough seedbed is prepared in February and 200 kg per ha of superphosphate and 100 kg per ha of urea are lightly worked into the soil. These fertilizers should not be mixed together but spread separately. About a week later, the seed is broadcast at 30 to 45 kg per ha and covered, using spring tines or discs.

Planting may take place from February to March and the soil should be sufficiently moist to ensure good germination.

Suitable oat varieties for the Granite Belt include Rodney, Saia and Minhafer. Minhafer appears suitable for most peach growing areas of Queensland.

The cover crop is turned in early in August using disc harrows set for a shallow cut. The aim is to incorporate most of the crop with the surface layer of soil leaving some of the green matter on the surface. Discing in at this time will ensure the green crop does not compete with the trees for moisture following budswell which occurs about mid August.

Sod culture

Sod culture is a controlled vegetative soil cover in an orchard. It has not been used to any great extent in Queensland, but there is scope for its increased use.

Under sod, tree roots are not cut by cultivation implements and the whole soil depth can be used by the roots. Soil temperatures are lower in the summer, erosion is reduced and cultural operations can be resumed shortly after rain. Because the sod competes with the tree for moisture, it is not recommended unless supplementary water is available. If the sod is allowed to grow unchecked, not only are moisture requirements greater, but the possibility of tree damage from spring frosts is increased. If the sod is allowed to flower around tree

blossoming time, the ground cover may be preferred by pollinating bees. Frequent mowing keeps the sod down and prevents these problems.

Young trees dislike weed competition in their early establishment stages. For this reason, the sod should be first established as a strip between the rows. As the trees age, this strip can be widened. Never grow sod along the tree line as it is difficult to mow and will cause harvesting and disease problems.

The recommended mixture for sod culture in the Granite Belt is 2 kg of white clover plus 4 kg of perennial rye per hectare, planted in March.

The sod should be fertilized at establishment time with 70 kg of urea plus 160 kg of superphosphate per ha. The superphosphate dressing should be added annually in March. Fertilizing the sod leads indirectly to fertilizing the tree.

Mulching

Mulches suppress weeds, prevent evaporative soil moisture loss and modify soil temperatures, particularly in the hot summer months. The surface soil becomes fully exploited by the roots, and benefits to plant growth and cropping result. Mulches that can be used include sawdust, plastic and straw.

Sawdust must be applied 50 to 75 mm deep to suppress weeds, but even at this depth invasion of couch grass can occur. The material slowly becomes incorporated into the soil and unless nitrogen is added, it may cause nitrogen deficiencies. Sawdust has been used on the Granite Belt, but supplies are limited.

Black plastic sheets 1 metre square can be laid around the young trees at planting time. The remaining soil area is cultivated. Weeds growing around the margin of the plastic should be controlled by knockdown herbicides.

Straw mulches have been used but are very expensive.

Nutrition

Peaches and nectarines may be grown on a wide range of soil types but good depth and drainage are essential. The coarse granitic soils where most of the crop is grown are low in organic matter and fertility. Good productivity on these soils depends to a large extent on the success of green manuring and fertilizing programmes.

Fertilizers

Each winter, it is desirable to check the pH of the soil. If it is too acid, lime should be applied. Lime not only corrects acidity but makes some nutrients more available to the plant. It also supplies calcium, an essential element in tree growth. Lime should be applied following the turning in of the cover crop and 3 to 4 weeks before adding fertilizer to the soil.

In addition to the fertilizer applied for the green manure crop, a complete NPK mixture should be applied each year. The actual composition of the fertilizer depends on the stage of tree development.

For young trees up to 4 years old, a 16:6:6 NPK mixture is suitable. Up to 250 g per year of tree age may be applied annually and should be split into July and October applications. This mixture contains a high percentage of nitrogen, which is essential to produce good growth in the early years.

For bearing trees, a 12:7:13 NPK mixture is suitable. Up to 2 kg per tree may be applied in July followed by 1 kg per tree in late October.

Organic manures may be used at half a bag per tree every 3 years.

All the above rates should be regarded as the normal application for coarse granitic soils of low natural fertility. In areas of high soil fertility, lesser amounts would normally be required for good production.

The management of the nitrogen component of fertilizers is the most important aspect of tree fertilizing. Even when following the recommended fertilizer applications, nitrogen deficiency can occur through leaching rain or heavy production. This is apparent by the yellowing and stunting of leaves, and the slowing down in shoot growth. Nitrogen deficiency can be rectified by applications of urea, up to 500 g per tree.

However, excessive nitrogen is as detrimental to fruit quality as nitrogen deficiency is to tree growth. Too much nitrogen leads to excessive leaf development, and large, soft fruit which is of poor quality and colour, late maturing and is more susceptible to fungal diseases.

A balance of nitrogen is therefore required. Shoot growth should be good, but not too vigorous. Leaves should be light green, not dark green.

Close-planted orchards of young trees should be fertilized as for wide-spaced trees up to 4 years of age. From then on, the amount of fertilizer per tree should be stabilized at the 4-year-old level, but fertilizer mixture should be changed to that for bearing trees, namely a 12:7:13 mixture.

Fertilizers may be broadcast by hand or through a distributor. A distributor is serviceable in a bearing orchard in which the roots have a substantial spread. Hand application is more suitable for young trees. The fertilizers should be lightly incorporated in the soil or watered in.

Nitrogen and potassium fertilizers may also be supplied through an irrigation system at intervals during the growing season. These fertilizers should be applied at the start of an irrigation so that the pipes will be well flushed by the water which follows. Phosphorus is best applied by adding superphosphate to the soil.

Trace elements

Trace element deficiencies in peach and nectarine trees are not common but in soils of low fertility, such as those of the Granite Belt, problems resulting from low levels of boron or zinc occasionally occur.

Boron deficiency symptoms include failure of buds to break in the spring, death of wood and hard, brown spots in the flesh of the fruit.

Control is effected by routine applications of Borax to the soil, applied every third year in late winter. About 50 g for small trees and 100 g for mature trees should be spread evenly around the root zone.

Alternatively, one foliage spray of soluble polyborate at 275 g per 100 litres applied in late October each year may be used. In cases of severe deficiency, two sprays may be applied but excess use of boron compounds must be avoided because they can kill the tree.

Zinc deficiency may produce a crinkling and yellowing of leaves at the ends of twigs and shoots. In severe cases, rosettes of small leaves may form and the leaves may be very small and rigid with no leaf stalks.

Control is best achieved by annual spray application of zinc sulphate at 2·5 kg per 100 litres. This spray must be applied when buds are fully dormant or bud damage can result. Normally it is unwise to spray later than the end of July. Spraying should not be carried out less than 3 weeks after pruning as movement of the zinc solution into the cut surfaces can kill buds lower down the shoot. However, it is safe to prune 1 to 2 days after spraying.

Irrigation

Peach and nectarine trees react greatly to changes in soil moisture. Tree health, crop yield and fruit quality can be affected. As large soil moisture stresses occur in most growing seasons, irrigation facilities are usually necessary on all orchards.

The ideal is for a controlled watering schedule, but where supplies are limited, irrigation has to be confined to periods of greatest need.

Total watering

Irrigating the soil in excess of its water holding capacity is wasteful and may lead to drainage problems. The average depth of the root zone for peach orchards in the Granite Belt is about 90 cm and available moisture content for these sandy soils for this depth is between 75 and 90 mm. So each irrigation should not exceed this amount over the area being watered. This surmises that there has been no recent rainfall and moisture content has not dropped to wilting point where tree stress is obvious. Irrigation should take place before this stage has been reached, so 40 to 45 mm of water would be adequate for most purposes where the water is applied by spray irrigation.

Heavier soils and those with deeper root zones would require greater but less frequent irrigations. With trickle irrigation, where a much smaller part of the root area is being wetted, amounts should be less and more frequent, up to 3 or 4 times a week.

In the Granite Belt, a hectare of well-watered trees will use about 6 million litres of water a year. Water requirements from spray irrigation in a normal season would be about 3 million litres per hectare. In a dry season, depending on severity of drought conditions, between 3 and 6 million litres of water would be required.

These amounts naturally vary for other areas. Trees in hotter, drier districts would have a larger evaporative loss and greater irrigation requirements.

Supplementary watering

At certain stages during the season, water requirements are critical. If water supplies are limiting, as they are in many cases, then irrigation is best used in the following periods:

- From 4 weeks before flowering up to 3 weeks after flowering. It is essential for the trees to have adequate water during blossoming and at the rapid cell division stage of the young fruitlets. Just after this period, stone hardening begins and lasts for 3 weeks. Fruit growth ceases in this period, so water requirements then are very low.
- From 2 to 4 weeks before harvest. If moisture deficiences are acute in this period, fruit will not develop properly. Big improvements in fruit size and quality can take place under good moisture conditions. However, overwatering can lead to fruit splitting.
- Fruit bud initiation. This occurs from January to March depending upon variety. Adequate moisture is required to allow the normal development of fruit buds which is essential for good blossoming and fruit set in the following season.

When consideration is being given to buying an irrigation plant, it is important to ensure that the orchard will be well drained. The quality of the water to be used should also be checked. The Department of Primary Industries provides a water analysis service, and also advises on the suitability of the sample for irrigating.

The most suitable irrigation system to meet requirements should be selected and designed by an irrigation expert who is also prepared to guarantee its installation and maintenance.

Trickle irrigation is gaining favour, and growers who have already installed this system are pleased with the results. A trickle system is less expensive than some others, and is less wasteful of water. If possible, this system should be installed at planting time, so that the water needs of the young trees can be met.

Pruning

Some of the main purposes for pruning are:

- To train the tree during its early non-bearing years, to a desired shape, and in later years to retain this shape.
- To maintain a balance between leaf and fruiting wood growth.
- To remove old fruiting wood which has few or no fruit buds and thereby stimulate dormant buds or new replacement fruiting wood.
- To allow entry of light, sun, and sprays to all parts of the tree.
- To improve access to fruit at harvesting and to all parts of the tree when pruning and thinning.
- To thin out excess fruiting wood and thereby reduce hand thinning.
- To allow free movement of implements between rows.

For wide-spaced trees, the open vase or inverted hollow cone formation is still the most suitable and is a convenient form to handle.

The old system of hard pruning from the time the tree is planted through its entire life has shown to have a marked stunting effect on growth. A more liberal or lighter method is now being practised by most orchardists, and the trees are allowed to carry a crop at an earlier age.

Young trees

The 1-year whip (stem), generally with laterals growing from it, is cut off above a bud or lateral at about 40 cm to 50 cm above ground level. The top three buds or laterals should be evenly spaced around the main stem. The laterals, which are usually thin and spindly are removed near the base, but not too close to the stem to injure the dormant buds.

The shoots from these three buds are allowed to grow during the following year as they will become the three main arms of the tree. During the growing season, any other shoots from the stem should be pinched back when small and succulent, so they do not compete with the main limbs.

In the following winter, these small arms are cut back to an outside bud with another well-spaced bud below and on the side of the arm. The amount these shoots are cut back depends on their vigour, but it should be fairly hard, even as much as one-third of their growth. These three main arms form the crutch of the tree. The ability of the tree to carry heavy crops without cracking or splitting at the crutch depends on the strength of these main arms and the angle where they join the main trunk.

Shoots from the two selected buds on each main arm are allowed to grow. Growth from other shoots is suppressed but not completely removed. Leaves around the main arms and trunk not only supply plant food, but help to prevent sunburn.

The six main leaders are pruned in much the same way as the three in the previous year, but with a reduction in the amount that is cut back. At the following pruning, the tree should have 12 well-spaced leaders in a circle. This is considered enough. Even 10 well-spaced leaders in a circle could be sufficient especially in high rainfall districts and where brown rot disease is a problem.

During the training period, if one or more leaders are making only weak growth, leave them unpruned and higher than other strong pruned leaders. The strongest growing bud of peach and nectarine is the terminal bud.

Bearing trees

Both peaches and nectarines bear fruit on 1-year-old lateral wood and short spurs. These fruiting laterals and spurs are fruitful for only 1 year, and therefore have to be replaced each year by new growth. If left unpruned, the laterals make growth from the end of the previous year's growth. After a few years the fruit will be borne farther away from the leaders on whippy laterals and be more subject to wind and limb damage.

If there are excess fruiting laterals, a large number should be removed at the base to be replaced by new ones. The longest 1-year laterals should be cut back to half length leaving sufficient fruit buds. New growth should shoot from leaf buds at the basal end to replace the previous year's bearing wood which can be removed at the following pruning. Strong and crossing wood growing from the outside of leaders is cut out to allow light, sun and spray to penetrate. Do not over-thin growth from the inside of leaders facing the sun, otherwise the bark on the leaders will be sunburnt.

All strong, heavy growth near the tops of leaders is removed so that they will not rob the leaders of sap. More importantly, if they are not cut out, they will shade lower parts of the tree which will ultimately become bare of fruiting wood. Should leaders be growing too high, they can be cut back to an outside lateral which can be left unpruned for a year.

Re-working

The demand for a certain variety of fruit changes and it may therefore become necessary to re-work trees to a more profitable variety.

The strap graft is the most suitable method for grafting medium sized limbs. Leaders forming the framework of the tree are used provided that they are not larger than 50 mm in diameter.

The tree is ready for grafting when the bark lifts cleanly and the sap is moving freely. The scion should be still at the fully dormant stage. If the buds are swollen or starting to break, do not use them for grafting.

The main leaders are sawn off at about 1 metre from the ground. The scion is held firmly in the left hand with the top end facing the left shoulder. Insert the blade of a razor sharp grafting knife under the bark. Draw the blade towards you cutting a thin piece of the underlying wood and bark for about 100 mm in length depending on the thickness of the leader. Cutting under a bud and leaving it on the strap helps draw sap along the strap and therefore makes a better union.

Leaving the blade in position where it finished cutting, place the left thumb nail firmly against the other surface directly opposite the edge of the knife blade. Bend the strap at right angles to the cut surface. The thin piece of wood under the bark will crack or break and the splinters should be trimmed. Be careful not to tear the strap beyond where the cut finishes. If it does, do not use the scion; cut another one.

The blade is then inserted into the bark on the other side directly opposite where the cut strap finished. With a drawing action away from the body, a straight cut through the bark and wood is made leaving a peg of wood, shaped liked a chisel blade, about 60 mm long.

The leader to be grafted (stock) is prepared by selecting two straight, smooth, opposite sides. Two vertical cuts about 20 mm apart are made just through the bark on each of these sides. If the tree is in the right condition for grafting, the strip of bark between the knife cuts lifts easily. One of the cut strips of bark should preferably be on the inside of the limb.

The peg of the scion is then placed under the strip of bark on the inside of the limb. Draw the strap over the sawn surface of the leader and place it under the other cut strip of bark. The scion is now in position, held firmly by the fingers and thumb. Place one end of a 30 cm length of twine under a finger holding the scion in position and bind tightly around the leader from top to bottom of the peg and strap, finishing with a half hitch.

Grafting mixture is then applied to cover the twine and all cut surfaces. Make sure to thoroughly seal around the peg. Examine the grafts after a few days to see if any cracking of the mastic has occurred and if so apply more mastic. The mastic prevents the entry of air or moisture to the cut surfaces. Callousing over the cuts will not occur if air or moisture enters the cut surfaces.

After the grafts have grown about 100 mm, cut through the mastic and string on opposite sides to where the peg and strap were inserted. Lift the cut ends of the mastic and string to make sure all the strands of string were cut and press back into position. If removed shortly after cutting, sunburn of the bark previously under the mastic occurs.

Other smaller limbs and laterals on the lower part of the worked tree can also be grafted by using the strap graft, the whip tongue or peg, graft or left until the following year if time does not permit.

Thinning

Hand thinning is the only method at present recommended for thinning peaches and nectarines. Ethephon seems to have some promise as a chemical thinner and experimental work is in progress with this material.

At the time of pruning, an assessment of the prospective crop can be made from the quantity and size of fruit buds, and then the amount of fruiting wood removed accordingly. Most varieties of peaches and nectarines are heavy croppers, and therefore thinning is necessary to improve fruit size. Consumers prefer the large dessert fruit.

Some varieties are inclined to shed more than others, and thinning should start after the first early natural shedding occurs. The earlier the thinning is done the better for improving fruit size and in reducing later fruit shed. The amount of fruit removed at thinning could be considerable. Laterals carrying a heavy crop could have as many as half of the fruit removed.

One of the greatest needs of the tree for plant foods occurs when the kernel is being formed. Therefore, thinning before that stage reduces strain on the tree. Thin to leave fruit as evenly spaced as possible on the tree. An ideal spacing is 75 mm for small, fruited varieties and 100 mm for large. Thinning not only improves fruit size, but helps to overcome biennial bearing by improving bud formation for the following year's crop.

Pests

The important pests of peaches are:

QUEENSLAND FRUIT FLY. This is a major pest of all varieties. Adults, which are about 7 mm long, are brown, wasp-like flies and have yellow markings on the thorax and abdomen. The adult females lay eggs in the fruit, the 'sting' appearing as small discoloured spots, often with juice oozing from them. Rot organisms are introduced with the eggs and the internal tissue of fruit is destroyed by the tunnelling of the maggots and the development of the rot organisms.

Rainfall and high humidity when fruit is ripening favour fly activity. Fruit fly lure traps provide the best guide for the timing of chemical control measures.

A fortnightly spray schedule of Fenthion starting 4 weeks before the fruit matures provides satisfactory control in the Granite Belt. More frequent sprayings may be required in warmer areas.

SAN JOSE SCALE. This is a serious pest of all varieties. The adult female is a sedentary, soft-bodied, sap-sucking insect, covered with a hard, dark scale with a central, raised, darker area. The insect is about 1 mm in diameter. Scales are most commonly seen on the bark where they give an ashy appearance. Low scale infestations reduce the vigour of trees but high populations may cause the death of leaders and young trees. Scale-infested trees usually ooze gum.

Superior dormant oil sprays provide good control.

APHIDS. Both the black peach aphid and the green peach aphid are important pests of peaches and nectarines. They are small, soft-bodied, slow-moving, sap-sucking insects, and may be winged or wingless. Winged aphids are up to 3 mm long, The shiny, black, oval-shaped eggs of the green peach aphid may be found on bark around buds in winter. Superior dormant oil sprays will kill these eggs.

The black peach aphid may be present on both the roots and above-ground parts of the tree during winter.

In spring, aphids feed on the developing foliage and fruit and cause discolouration and curling of the new leaves and shedding of the leaves and fruit. The terminals of affected shoots may die back.

A systemic insecticide such as thiometon will control these pests.

LIGHT-BROWN APPLE MOTH (LBAM). This is a pest of all varieties. The adult moths have a wingspan of about 20 mm. The bottom half of the forewings is light brown while the remainder is dark brown. The green caterpillars which grow to about 25 mm long are found in silken shelters between leaves and fruit. They are recognized by their fast, wriggling movements and their habit of parachuting on a strand of silk when disturbed. The caterpillars skeletonize leaves and chew irregular-shaped excavations in the surface of fruits. LBAM has a wide range of host plants including many orchard weeds.

Control measures are applied at the first signs of pest activity. Azinphos-methyl and Carbaryl provide good control.

TWO-SPOTTED MITE. Adults and nymphs are white-yellowish spider-like mites, with two dark spots on the back. Adults are up to 0·5 mm long. Large populations develop quickly during the hot weather and their feeding activities cause mottling and premature-shedding of leaves which reduces the crop in the following year.

Specific miticides such as Cyhexatin provide good control.

RUTHERGLEN BUG. An occasional pest. Adults are active, dark grey, rectangular-shaped bugs, about 4·5 mm long, with two pairs of silvery grey wings. This pest feeds and breeds on weeds and migrates to trees during hot weather when their weed hosts suffer moisture stress. The bugs pierce and suck sap from the fruit causing browning of the fruit. When necessary, Fenthion may be applied for control.

LONG-HORNED GRASSHOPPER. A minor pest of all varieties. This green grasshopper feeds on the skin and surface tissues of young fruit. At harvest, damaged fruit is malformed and catfaced.

Diseases

In Queensland, successful peach and nectarine growing requires a regular programme for disease control. The major diseases are brown rot, scab, shothole, leaf curl, rust, necrotic ring spot virus, bacterial spot, crown gall, *armillariella* root rot, and nematodes.

BROWN ROT. This disease affects blossoms, twigs and ripening fruit. Blossom and twig blight occur when cool, moist weather is experienced during spring. Brown rot of ripening fruit is favoured by warm, moist weather.

The fruit rot develops from small, round spots on the fruit surface which may rapidly enlarge to produce a firm, brown rot on most of the fruit. Masses of grey, brown, talcum powder-like spores develop on the surface of the rot.

Control of the disease is by spraying with a recommended systemic fungicide or Captan or Captafol during blossoming and in the month before harvest.

Post-harvest dipping with a recommended systemic fungicide is also necessary for the control of post-harvest rot.

Hygiene in the orchard to remove and destroy all diseased fruit, twigs and old, diseased fruit stalks is essential for successful chemical control.

TRANSIT ROT. Transit rot is a serious post-harvest disease of peaches. Soft rot develops from infection of cuts and abrasions during marketing. 'Nests' of dark, fuzzy fungal growth quickly develop from affected fruit within a carton leading to severe losses.

Control depends on careful picking, hygiene measures during packing, dipping in Dicloran and careful transport.

SCAB. Scab affects leaves, twigs and fruit. Leaves show pale green to brown spots and fruit green to olive spots becoming black with age.

Scab is controlled by spraying with Thiram, Mancozeb or wettable sulphur 3 weeks after petal fall and repeated twice at intervals of 3 weeks.

LEAF CURL. This disease attacks leaves, flowers, twigs and fruit but usually the only symptoms are on leaves. These become thickened, distorted and have a blistered appearance frequently coloured bright red.

Control of the disease is achieved by a single application of a copper fungicide or lime sulphur at bud swell.

SHOT HOLE. Shot hole affects leaves, twigs and fruits. Small, round, dark spots form on the leaves and quickly enlarge. The affected tissue dies and falls out leaving ragged holes. Fruit spots are small and purplish becoming raised and rough with age.

Control of the disease depends on spraying with a copper fungicide or lime sulphur at leaf fall and again at bud movement.

RUST. Rust affects the leaves mainly, but occasionally twigs and fruit. Rust shows as pale-yellow spots on the upper leaf surfaces. On the under-sides of the leaves these spots are covered with a brown dust of the rust spores.

Rust is controlled by foliar sprays of Dithianon, Mancozeb or Thiram.

Shot hole and rust allied with mite attack can lead to early defoliation.

ARMILLARIELLA ROOT ROT. Root rot caused by the shoestring fungus *Armillariella* causes severe losses especially on newly-cleared land.

The disease attacks the roots and crown of the trees and characteristic black threads of the fungus known as shoestrings are often found on the surface of the roots.

Control depends on removal of all tree roots 2 years before planting, or preplant treatment of the tree site with methyl bromide in conjunction with fumigation treatments in replant land.

NEMATODES. Nematodes are a cause of poor growth of peach and nectarine trees particularly on replant land. The most easily recognised are the root-knot nematodes which produce swellings or galls on the roots. Root lesion, ring, stubby root and dagger nematodes do not produce galls but cause premature death of fine roots.

The peach rootstock Nemaguard which is resistant to the root-knot nematode *Meloidogyne javanica* has performed satisfactorily with a number of peach cultivars in the Granite Belt.

Before planting peaches or nectarines after pome or stone fruit trees, or on land where root-knot nematodes have affected tomatoes or other crops, soil fumigation with DD or EDB15 at 300 litres per ha or Telone at 200 litres per ha is recommended. To reduce costs, fumigation can be restricted to a strip 2 m wide along the middle of the proposed tree rows. Fumigation will aid early establishment of trees on Nemaguard and Elberta peach stocks.

Because of low soil temperatures in the winter at Stanthorpe, fumigation should be carried out before mid April while the soil temperature at a depth of 10 to 15 cm is above 15°C. Disc or tine the area 3 weeks later to hasten the escape of fumigant residues from the soil and delay planting as long as practicable.

VIRUS DISEASES. Prunus necrotic ringspot virus is common in peaches and nectarines but only produces severe symptoms in combination with other viruses and particularly with prune dwarf virus. In this case, young spring growth is delayed and is sparser and slightly curled. Shoot elongation is reduced producing the 'rosette' symptom. Affected trees yield poorly.

The disease is spread by seed transmission in stocks and by propagation from diseased buds. There is also slow spread by pollen from diseased trees.

Planting of blocks of trees from sources known to be free from virus disease is an effective control. Rosette affected trees should be destroyed to prevent spread to new plantings.

CROWN GALL. Crown gall is a serious bacterial disease of nursery trees and some orchards, reducing vigour and sometimes causing tree death. Large galls develop at the crown of the tree and small, nut-sized galls may develop on adjacent roots.

No means of control are yet available, but losses may be reduced by planting disease-free nursery trees.

BACTERIAL SPOT. This disease affects leaves, twigs and fruit and is more serious in certain peach cultivars such as Dripstone Elberta.

Characteristic symptoms include angular leaf spotting developing into a shot hole effect, cankering of twigs with gumming and 'star' cracks on fruit.

Copper fungicide sprays at early bud movement and leaf fall help to reduce the incidence of the disease.

Harvesting

Fruit should be harvested when it begins to ripen. With most yellow-fleshed peaches, this stage is indicated when the unblushed part of the skin develops a yellowish tinge, while white-fleshed peaches develop a cream tinge. Judging the right stage of maturity to harvest full blush varieties is more difficult. Sampling and cutting a few large-sized fruit, and testing for firmness and taste is a guide.

The stage of maturity to harvest depends mainly on distance from market. Peaches and nectarines improve in size, colour and flavour just before reaching the full ripe stage. Harvesting can be done at a more backward stage of maturity for distant markets. This allows for a steady development in maturity en route to market.

Fruit, if picked before the ripening process has started, invariably wither. If they do soften sufficiently to be eaten, the fruit lack the desirable characteristic flavour of the variety.

Fruit mature at different times on the one tree so two or more picks are necessary to harvest them at an even stage. All fruit should be handled gently. This applies at picking, when emptying the fruit into bins and carting it into packing sheds, during grading and packing operations, and when the fruit is being transported to market.

Temperatures often exceed 30°C at harvest. Under these conditions, pick the fruit in the coolest part of the day. Place the fruit in half-filled containers and stack in the shade while awaiting transport to the packing shed. Placing the fruit in a cool store overnight or for a few hours before is advisable. Fruit picked from trees during hot weather and packed shortly afterwards will ripen more quickly and could arrive at the market in an over-ripe condition.

Yield

Some varieties yield higher than others. Production from late-maturing varieties is usually much greater than from early-maturing selections. Trees grown under irrigation give a larger and more regular crop than those under dry farming conditions.

Nectarines are more erratic in cropping than peaches and consequently yields are not as high. However, this is counterbalanced by the greater market demand. Quality nectarines always bring premium prices.

Cool storage

As a general rule, it is not recommended to cool-store peaches and nectarines except for short periods when necessary. They can be held for a few days awaiting transport or opening of markets after holidays. If fruit is left on the trees or in packing sheds, it could become over-ripe. If picked at the right mature stage, fruit can be held up to a maximum of 14 days. The recommended storage temperature is 0°C.

Packing and marketing

As most of the peach and nectarine crop is marketed for dessert, it should be graded, packed and forwarded to market in one of the gazetted metric containers.

The grading machine should be carefully padded with soft matrial to reduce bruising as the flesh and skin are soft. The distances travelled on the grader should be short, and belts and rollers driven at a slower speed.

The metric containers currently gazetted for marketing peaches and nectarines are:

Name of Package	Material Used in Construction	Internal Dimensions (mm)		
		Length	Width	Depth
9 litre stone fruit package	Wood or fibreboard	350	210	125
Quarter package	Wood or fibreboard	350	260	100
Half dump package	Wood or fibreboard	450	215	180
Half peach package	Wood or fibreboard	450	270	145
Half standard package	Wood or fibreboard	450	290	135
Deep half tray pack package	Wood or fibreboard	500	300	145
Standard tray package	Wood or fibreboard	450	290	100 or less
Shallow half tray pack package	Wood or fibreboard	500	300	135
Returnable plastic crate B	length at fill line	470	..	..
	length at bottom	430	..	..
	width at fill line	..	305	..
	width at bottom	..	265	..
	depth from fill line	..	..	275

The Fruit and Vegetable Grading and Packing Regulations stipulate that peaches and nectarines forwarded to market or packed for sale should be of one size, one variety, sound, clean, well-formed, not shrivelled, mature but not over-ripe and free from broken skins and skin blemishes.

The outside of the packed container should be legibly and durably stamped or stencilled with the following:

- Name and address of grower and agent.
- The word peaches or the abbreviated form 'PCH'. The word nectarines or the abbreviated form 'NEC'.
- The name of the variety.
- The size or count of the peaches or nectarines contained therein.

Most peaches and nectarines are sold in Brisbane and other Queensland markets. Only a small proportion of the crop is forwarded interstate.

Workshop on minimum energy weirs and culverts

THE University of New England, Armidale, N.S.W. will be conducting a residential workshop on the concept and practical application of 'minimum energy' to the design and construction of weirs and culverts from 10 to 14 February, 1978. The workshop will be conducted by the developer of this new concept, Dr Gordon McKay, Professor of Civil Engineering at the University of Queensland.

As a more economical and efficient method of construction of weirs and culverts, the workshop should be of interest and benefit to those engaged in agricultural engineering, soil conservation, road construction, water resources, pipe and culvert manufacturing, natural resource consulting and primary industry generally.

For more detailed information please write, phone or telex:

Department of Continuing Education,
University of New England,
Armidale, N.S.W. 2351.
Phone (067) 72 2911, extension 2541 or 2788.
Telex 66050.

Resistance to fungicides

a new problem in control of plant disease

IN the late 1960s, an important breakthrough in plant disease control occurred.

A new fungicide, benomyl, gave spectacular control of a range of plant diseases, many of which had been difficult to control with the fungicides in use up to that time. Problems such as field mould and nestiness in beans caused by the fungus *Sclerotinia sclerotiorum* and brown rot of stone fruit (*Sclerotinia fructicola*) are two good examples important in Queensland.

Most of the other fungicides in use were protectants and controlled diseases by killing disease-producing propagules before they were able to infect the plant. In addition to this function, benomyl possessed systemic properties and thus was able to penetrate some plant tissues and eradicate early infections.

Later, other fungicides with this systemic property such as carbendazim, thiophanate-methyl, and thiabendazole became available on the market. These fungicides, known collectively as benzimidazoles, were widely recommended for diseases such as powdery mildew, black spot of pome fruit, grey mould of grapes, leaf spot of peanuts and post harvest diseases such as green and blue mould of citrus and anthracnose of bananas. There were a number of important diseases, including root rots caused by various *Phytophthora* spp. and stem and leaf rust of winter cereals they would not control. This indicated a degree of specificity.

by G. S. PURSS, Plant Pathology Branch.

The development of resistance

The high degree of disease control with these fungicides was reminiscent of that obtained with resistant cultivars. We all know how this type of resistance has often been overcome by disease organisms. Many astute plant pathologists therefore expressed some doubts as to the long term prospects of such fungicides—the fear was that fungi, a major cause of plant diseases, would 'develop' strains resistant to such fungicides. There had been some limited occurrences previously with other fungicides, a notable one being bunt of wheat which developed resistance to hexachlorbenzene. It has of course been a problem with many insecticides for a long time.

The first indication of resistance to benomyl from overseas was reported in 1970. In Queensland, powdery mildew of cucurbits (*Sphaerotheca fuliginea*) was not controlled by benomyl in a planting at Bowen in 1972 and, in 1974, peanut leaf spot (*Cercosporidium personatum*) was not effectively controlled in some paddocks on the Atherton Tableland.

Since then, the incidence of resistance to the peanut leaf spot organism has been so widespread that benomyl is no longer of any value in north Queensland for control of the disease. Similarly, powdery mildew of cucurbits is no longer controlled by benomyl in most parts of Queensland.

Other resistances to benzimidazoles that have been encountered in the field in Queensland include blue mould of citrus (*Penicillium italicum*) at Mundubbera (1973), leaf spot

of beetroot (*Cercospora beticola*) in the Lockyer Valley (1977) and *Septoria passiflorae* (1975) on passionfruit, the latter only in an experimental planting near Nambour.

The future of benzimidazoles and other systemic fungicides

It is wrong to conclude from this that the benzimidazoles are no longer of any value. On the contrary, they remain as possibly the most valuable single group of fungicides still available and it is important that every effort be made to prolong their useful life by the use of integrated control strategies. Other highly effective 'systemic' fungicides quite unrelated to benzimidazoles are now also becoming available and these will need to be used wisely.

A word of caution—it would be wrong to attribute every failure in control to resistance. Spray applications need to be well timed and thorough.

What can be done about the problem?

Because this is a relatively new problem, research on it is still in its infancy. There are not enough results for definite conclusions to be drawn about the relative value of various suggested strategies. However, it does appear that, in situations where resistance has occurred, there is no alternative to the withdrawal of the fungicide from control programmes on the farm or in the district concerned.

Some strategies that have been considered for situations where resistance has not yet occurred are:

- Every effort should be made to reduce inoculum supply. The selection out of resistant strains is very largely a question of population dynamics. The more spores and other propagules of disease-causing fungi that are around, the more selection pressure is put on any control measure be it resistant cultivar or effective fungicide. Inoculum supply can be reduced by good management practices such as crop rotation, destruction of diseased plant residues, planting resistant cultivars when these are available and by developing a spray control programme which aims at keeping inoculum levels low at all times.

  This does not mean using excessive amounts of fungicides for this is wasteful and can cause residue problems. It means using fungicides at their most effective strength because resistance develops faster where sub-lethal doses are used. Destroy old crops as soon as possible after harvest and practice hygiene around packing sheds. These measures have always been important but tend to be neglected where highly effective means of control (such as resistant cultivars or fungicides) are available.

- Where a systemic fungicide is distinctly superior against a difficult disease, avoid using it for diseases in that crop which can be controlled just as effectively by protectant fungicides. A good example of this is in citrus. Of the fungicides currently available, the benzimidazoles are among the most effective as post harvest dips for green and blue mould control.

  Field diseases of citrus such as black spot can be controlled as effectively with copper and dithiocarbamate fungicides so benzimidazoles should not be used in the field. Another example is anthracnose of banana and mango. Again, field sprays with fungicides based on copper compounds or dithiocarbamates are as effective as benzimidazoles and the latter should be reserved for post harvest dips.

- Use systemic fungicides only in situations where non-systemic fungicides are not really effective. Resistance has been reported in other parts of Australia to the organisms causing black spot or scab of apple and pear. As a result, many plant pathologists advocate a protective spray schedule commencing with a green tip copper spray followed by cover sprays with long established fungicides such as captan.

  Benzimidazole fungicides are used only where conditions have allowed infection to occur and an eradicant fungicide is required. We have advocated this on the Granite Belt for some time because it is a more economical schedule. With the prospect of resistance it has added appeal. It may be significant that resistance to the black spot organisms has not yet been detected in Queensland.

- Use mixtures of fungicides, one a normal protectant and one a systemic. There are two quite different reasons given for advocating mixtures.

  The first one, which we would not dispute, is for the control of two diseases one of which is controlled by the protectant and one by the systemic. In such mixtures, full strength of each fungicide is generally recommended unless there is good evidence to suggest otherwise. Two good examples from Queensland are benomyl-dicloran mixture for post harvest treatment of stone fruit to control brown rot and transit rot and benomyl-captan field spray to control grey mould and anthracnose of strawberries.

  The second reason is that the use of a protectant with a systemic, generally with both at a reduced strength, will prolong the effective life of the systemic. There is little scientific evidence at this stage which supports this and consequently we are not recommending it. We will, however, do what we can to investigate its possibilities.

- Use alternating schedules of systemic fungicides with different modes of action. This has some appeal on theoretical grounds and has been advocated to some extent already against powdery mildew in north Queensland. Where resistance to benomyl in powdery mildew has not been recorded, alternating sprays of benomyl and pyrazophos are being recommended. Hopefully, populations of strains resistant to only one of the fungicides will not have the same opportunity to build up. However, cross resistance needs to be checked carefully by plant pathologists in such situations.

- Return to systemic fungicides that have been out of use for a number of years because of resistance. The theory is that the population of the resistant strain would have disappeared. What meagre evidence is already available suggests that this will not work. Strains of the peanut leaf spot organisms resistant to benomyl are still being detected in north Queensland 2 years after use of this fungicide was discontinued.

- Do not allow the marketing and use of a new systemic fungicide while current ones remain highly effective. This is wonderful in theory because the armory is retained but, in a free-enterprise system such as ours, it would be unreasonable to expect the chemical industry to develop fungicides on the off-chance of their use some time in the future.

General comments

A common question asked is—if a grower has resistant strains on his property does this pose a threat to his neighbour? This will obviously vary with the disease organism and its method of dispersal. However, growers can rest assured that in most cases what happens on their own farm will be the most important factor in the development of any resistance problems.

In the final analysis, it falls back on the grower to follow Departmental schedules if strategies are going to work. The pessimist will say that this is an unattainable ideal and fungicides will be like resistant cultivars—we will use them wisely or unwisely until they are no longer effective. It is doubtful if we can afford the luxury of this outlook in an era where new chemicals are becoming increasingly more expensive to market.

Insect and Mite Pests of Tomatoes

by D. SMITH, Entomology Branch.

FOR the successful production of tomatoes, pest control is needed in both the seedbed and the field. Tomato grub, and to a lesser extent potato moth, are active during most months and, as a result, growers usually apply insecticides at regular intervals during the production of the crop. Most of the less important and more sporadic pests are controlled by such routine sprays.

Thorough spray application using up to 3 000 *l*/ha on a fully grown trellis crop is essential and due safety precautions should be observed in the mixing and application of the insecticides recommended.

Tomato grub

Appearance, habits and damage

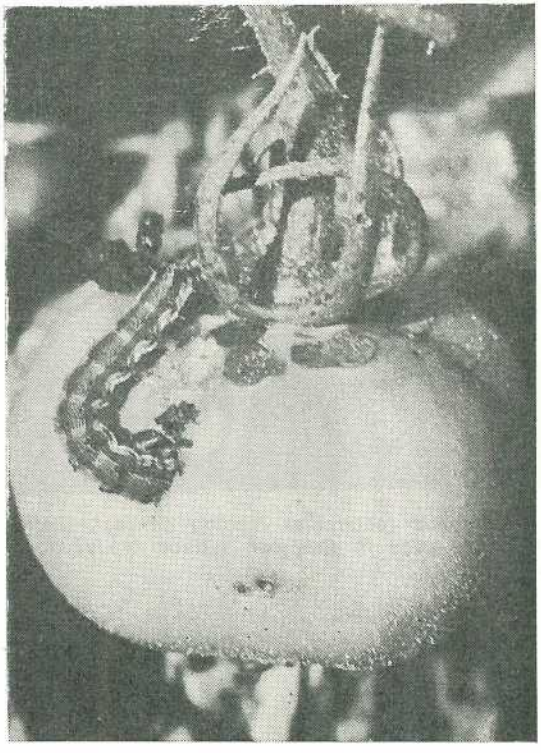
The tomato grub (also known as corn earworm) is the most serious insect pest of tomatoes in Queensland. The native budworm, a closely related species, also infests the crop.

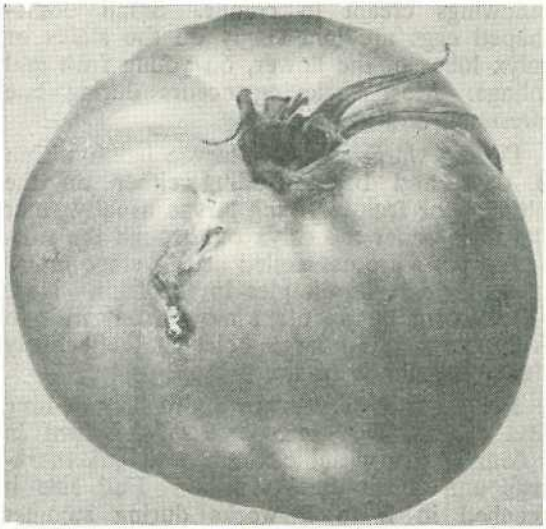
The adult of the tomato grub is a stout-bodied moth with a wingspan of about 35 mm, the forewings being reddish-brown and the hindwings cream in colour. Small dome-shaped eggs are laid singly on the stalks or calyx lobes of the flower, on young fruit and foliage. Most egglaying occurs during late afternoon and at night.

During warm weather, larvae hatch within 3 days and begin feeding either on the blossom or fruit. Young larvae usually enter the fruit under the calyx or through the side. If the pests are controlled at this stage injury often appears as dimples in the fruit. Near fully grown larvae often move from fruit to fruit gouging out large holes and effectively destroying much of the crop.

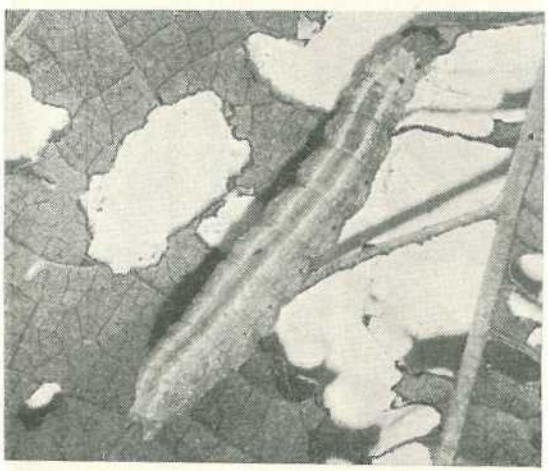
Fully grown larvae are about 35 mm long and are yellow, green or reddish-brown in colour with a variable number of dark markings and longitudinal stripes. Full size is reached in 2 to 3 weeks during summer and in about 6 weeks during winter. Fully grown larvae leave the plant and burrow into the soil to a depth of 80 to 100 mm and pupate.

Tomato grub feeding in tomato fruit. Body markings are typical of a near-mature caterpillar.





Tomato fruit damaged by tunnelling of potato moth caterpillar. Entry through the side of the fruit is less common than entry at the stem end.



Green looper caterpillar feeding on leaf. Large, irregular holes in the leaf surface typify looper attack.

During summer the adult moths emerge a fortnight later but in winter, emergence can be delayed until warmer weather occurs. The total life cycle of the pest in the summer from egg to adult takes about 4 to 5 weeks.

Control measures

The tomato grub is most active from September to April and control measures are usually warranted on a weekly basis during this period. The pest can still be troublesome during the winter but a spray interval of 10 to 14 days will then suffice. Control is given by using endosulfan 0·07%, methamidophos 0·1%, methomyl 0·05%, acephate 0·1% or monocrotophos 0·06 to 0·1%.

Potato moth

Appearance, habits and damage

This pest is also known as the tobacco leaf miner and the stem end grub. This name results from the larva's habit of entering tomatoes at the stem or calyx end.

The adult is a small, brownish-grey moth with a wingspan of 12 mm. It lays eggs at night singly on the undersurfaces of young leaves, on growing points, calyx lobes of the flowers or young fruit. The eggs hatch in about a week during the summer and the larvae mine in the leaves and growing points or more commonly enter the fruit beneath the calyx boring down into the central core, often covering the site of entry with a fine skin. Occasionally, larvae feed in the side of the fruit, again covering the site of entry with a fine skin. The larva is fully grown in about 2 weeks during summer and is then 12 mm long with a dark brown head and a pinkish-grey body. During warm weather, the total life cycle takes about 4 weeks.

Control measures

The potato moth is active during spring-early summer and in the autumn. Control on a weekly basis is given by the materials recommended above for tomato grub except endosulfan. Where endosulfan is used regularly for tomato grub it should be supplemented in alternate sprays with azinphos-ethyl 0·05% to control potato moth.

Brown cutworm

Appearance, habits and damage

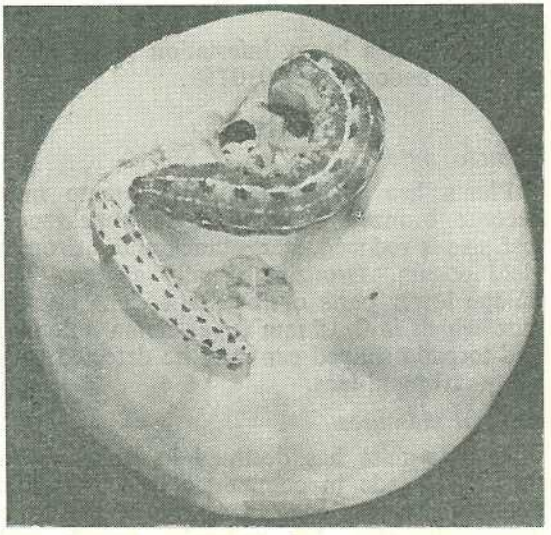
Cutworms are a threat to seedling tomatoes especially in the period just after planting out. The cutworm larvae cut through the stems near ground level and may cause serious stand reduction within 1 or 2 days.

The adult is a stout-bodied dark brown moth with a wingspan of 35 mm. Eggs are deposited at the base of the plant. The larvae hatch in three days in the summer and are fully grown in about a month. Fully grown larvae, greyish-green to brown in colour and 35 mm long, have the habit of curling up when disturbed. They usually rest in the soil during the day and emerge to feed at night. During warm conditions, the total life cycle takes 7 to 8 weeks.

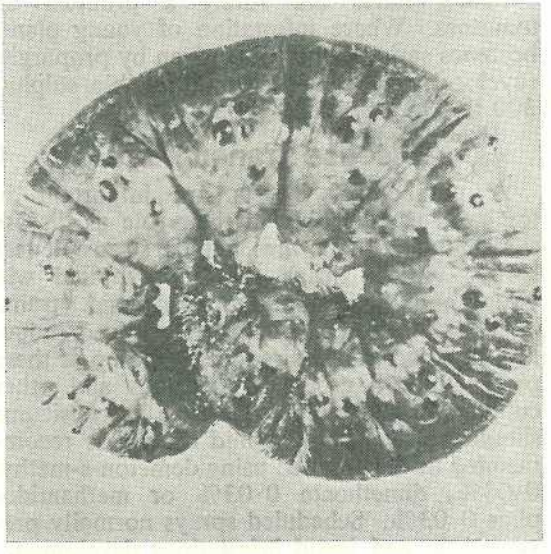
Control measures

Cutworm damage is most common during the warmer months but precautions against infestation are warranted whenever seedlings are planted out. As weeds such as sow thistle, pigweed, and some grasses are alternative hosts for pest breeding, a heavy infestation at planting out may be avoided by sound land preparation.

Scheduled sprays for tomato grub will normally control cutworm. However, seedlings freshly planted out should be sprayed the same day with endosulfan 0·07% or trichlorphon 0·05%.



Cluster caterpillar feeding on tomato fruit. Note the characteristic triangular markings.



Brown cutworm caterpillar in characteristic curled-up pose.

Loopers

The main species occurring on tomatoes in Queensland are the green looper and the tobacco looper. Infestations are sporadic and control measures beyond the routine are usually not necessary.

The adults of both species have copper-brown forewings which are marked with two silvery patches. (The tobacco looper has an additional small 's' shaped patch.) When fully grown the larvae, which move with a characteristic looping motion, are 35 mm long and light green in colour. They feed on the leaves and fruit, gouging out large holes. Larvae become fully grown in 2 to 3 weeks in the summer and pupate in silken cocoons attached to the plant.

Control measures

Control of a heavy infestation of looper is given by endosulphan 0·07%.

Mites

Tomato mite

Plants heavily infested with tomato mite become bronzed or silvered in appearance, leaf size is reduced, stems crack and a drop in yield occurs. Bronzing usually appears first on the lower parts of the plant. The tomato mite which is 0·15 mm long, cream coloured and torpedo shaped can only be detected with an × 10 hand-lens.

Control measures

Tomato mite has declined in incidence in the last decade in commercial plantings due undoubtedly to the incorporation of the dithiocarbonates, for example, maneb and propineb in disease control schedules. Where a significant infestation does occur control may be obtained by the incorporation of a specific miticide such as dispersible sulphur at 300 to 375 g product/100 *l* in the spray programme.

Spider mite

Spider mites are rarely a problem on tomatoes. Where infestation of young plants becomes serious, control is given by propargite (cyclosulfyne) 0·03% or dispersible sulphur 300 to 375 g product/100 *l*.

Disease transmitters

A number of insects are important in tomatoes usually only in their role as disease transmitters. These are: aphids (transmit leaf shrivel virus), thrips (transmit spotted wilt virus) and the common brown jassid (transmits the big bud mycoplasma). Weed reduction in adjacent areas reduces build-up of these pests and old crops of tomatoes and other cultivated susceptible crops such as capsicums should be destroyed. Aphid control is recommended in the seedbed using demeton-s-methyl 0·03%, dimethoate 0·03% or methamidophos 0·03%. Scheduled sprays normally prevent thrip and jassid infestations developing.

Minor pests

Green vegetable bug

This is a shield-shaped bug about 15 mm long which occasionally infests the fruit. A small wasp which parasitizes the eggs of the bug has reduced its importance in coastal Queensland. When insecticide treatment is necessary, endosulfan 0·07% is recommended.

Rutherglen bug and the grey cluster bug

These are small, narrow bugs 6 mm long with two pairs of silvery wings. Plague infestations can develop in the spring on various weed hosts—sowthistle, thickhead or blady grass and move on to nearby cultivated crops including tomatoes. Should specific insecticide treatment be needed, trichlorfon 0·05% spray is recommended.

Fruit fly

Fruit flies, mainly the Queensland Fruit Fly, sometimes attack ripening fruit during periods of warm, humid weather and dimethoate 0·03% is recommended for control as required.

Cluster caterpillar

This moth lays its eggs in clumps giving rise to clusters of young larvae. Fully grown larvae are about 45 mm long and are grey with longitudinal orange stripes and black triangular markings. Larvae feed on the leaves and also on the fruit where they erode the outer layer.

The insects listed as minor pests are rarely of importance as the schedule sprays employed for control of the major pests normally prevent significant populations developing.

Scientific names of the insects and mites referred to are:

Tomato grub ..	*Heliothis armigera* (Hubn.)
Native budworm ..	*Heliothis punctigera* Wall.
Potato moth ..	*Phthorimaea operculella* (Zell.)
Brown cutworm ..	*Agrotis munda* Walk.
Green looper ..	*Plusia chalcites* (Esper)
Tobacco looper ..	*Plusia argentifera* Guen.
Tomato mite ..	*Aculus lycopersici* (Mass.)
Spider mite ..	mainly *Tetranychus urticae* (Koch)
Tomato aphids ..	including *Macrosiphum euphorbiae* (Thomas)
Thrips	including *Frankliniella schultzei* Trybom.
Common brown jassid	*Orosius argentatus* (Evans)
Green vegetable bug	*Nezara viridula* (L.)
Rutherglen bug ..	*Nysius vinitor* Bergr.
Grey cluster bug ..	*Nysius clevelandensis* Evans
Fruit flies	mainly *Dacus tryoni* Frogg.
Cluster caterpillar	*Spodoptera litura* (F.)
A parasitic wasp ..	*Microphanurus basalis*

Grain sorghum planting guide

central and north Queensland 1977-1978 season

Compiled by S. R. WALSH, Agriculture Branch.

GRAIN Sorghum varieties recommended for planting in central and northern Queensland are listed below.

In the guide, the varieties have not been listed in order of preference.

A number of characteristics are considered in assessing the varieties; these include yield, lodging resistance, disease resistance, maturity, height, head characteristics, reaction to insecticides and many other features.

In order to reduce the risk, it is always advisable to sow more than one variety.

The guide for the Capricornia region has been subdivided into major and minor areas.

The varieties recommended for the major areas have been well tested and are proven varieties with a minimum of risk. Other varieties are suggested for sowing in minor areas on a trial basis.

The performance of a variety may vary between districts depending on soil type, time of sowing and other factors. This guide is basic information only, your Shire Agricultural Officer should be consulted.

The guide to grain sorghum characteristics was published in the *Queensland Agricultural Journal* of July–August 1977.

Region and Shires	Planting Time	Varieties	Planting Rate Plants/Hectare
Far Northern— Cook, Mareeba, Atherton, Eacham, Herberton, Mulgrave, Johnstone, Cardwell, Douglas, Etheridge	Dec.–mid Feb.	S: NK 300F MS: E57 MQ: Goldfinger *For trial:* MS: Dorado S: Tropic, Monsoon	75 000–100 000
Northern— Hinchinbrook, Dalrymple, Thuringowa, Ayr, Bowen, Proserpine	Mar.–July	*Irrigated:* MS: E57, Texas 671, E55e, NK275, Golden Acres Tell *For trial:* S: F64a, Tropic, Pacific 303, NK300F, Dorado, Monsoon	250 000
	Dec.–Mar.	*Rain-grown:* MS: E57 MQ: Goldfinger, NK233 *For trial:* S: Pacific 303, Tropic, Monsoon, Dorado	75 000;

Region and Shires	Planting Time	Varieties	Planting Time Plants/Hectare
Capricornia— Livingstone, Fitzroy, Calliope, Nebo, Broadsound	Mid Dec.–mid Feb.	*Rain-grown:* *Major area* E57, F64a	75 000
		Minor area NK233, Goldfinger, Dorado, Leader	
		Irrigated: As for Banana or Duaringa	
Banana, Duaringa	Mid Dec.–mid Feb.	*Rain-grown:* *Major area* Q5161, E57, F64a	75 000
		Minor area Dorado, Leader	
	Mid Dec.–late Jan.	*Irrigated:* *Major Area* E57, F64a, Texas 626	250 000
		Minor area Texas 671, E55e, NK275, Goldfinger, NK233, Goldrush, Leader, Dorado, Y101, Tropic, Big Red	
Emerald, Peak Downs, Belyando, Bauhinia	Mid Dec.–mid Feb.	*Rain-grown:* *Major area* E57, F64a	50 000
		Minor area Dorado, Leader	
	Sept.–Oct.	*Irrigated:* *Major area* E57, F64a	250 000
		Minor area Texas 671, Goldfinger, NK233, Texas, 626, E55e, Goldrush, NK275, Leader, Dorado, Y101, Tropic, Big Red	

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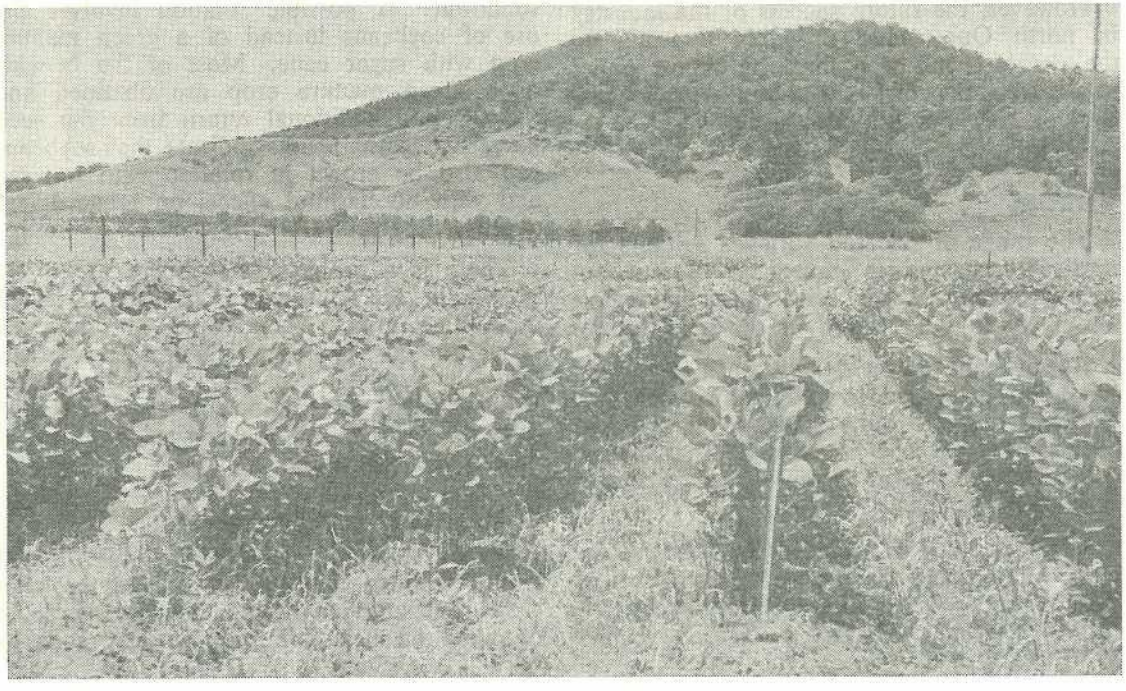
Soybean growing in north Queensland

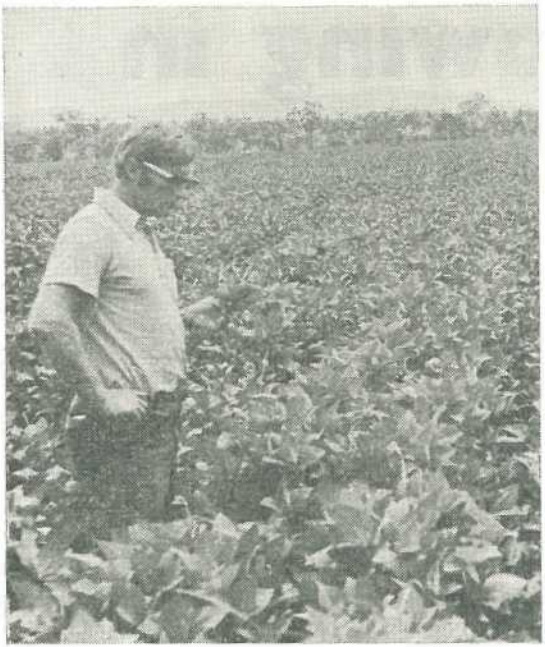
by R. B. BRINSMEAD, F. R. HOBMAN and J. Van der LIST, Agriculture Branch.

SOYBEANS are a very new crop to north Queensland but the limited commercial production to date has been encouraging.

Pilot plantings have been made by farmers in the Mareeba, Lakeland Downs, Ingham, Tully and Mossman districts. Research conducted by officers of the Department of Primary Industries indicates that this crop could also be suitable on several soils of the Lower Burdekin area.

A soybean variety trial at South Johnstone Research Station. Over 500 mm of rain fell on this trial between planting on 17-12-75 and 22-1-76 when this photograph was taken. This rain prevented cultivation for weed control.





Mr. B. A. Middleton, District Adviser in Agriculture, inspects a fine crop of Ross soybeans in the Mareeba district.

However, the future success of the industry in north Queensland probably depends on the development of a local or export outlet as the freighting of beans to southern Queensland or New South Wales is costly.

Varieties

The range of released varieties suitable for north Queensland is limited at present but new varieties especially selected for this region are likely to be released in the near future.

As soybeans are day-length sensitive, variety suitability is related to geographical latitude. Varieties that are quite suited to central and southern Queensland, for example, make insufficient growth before flowering when grown in north Queensland.

Varieties suitable for north Queensland are Ross, Gilbert and Daintree. A description of these varieties is given in *Queensland Agricultural Journal,* Vol. 102, p. 573, November 1976.

The variety, Improved Pelican, is also grown to some extent in north Queensland. It is included in the U.S. maturity group VIII. It is indeterminate and has purple flowers, tawny pubescence and yellow seed. It is susceptible to bacterial pustule (*Xanthomonas phaseoli* var. *sojense*).

All presently released varieties are susceptible to tropical rust so results on the wetter and cooler tablelands have been disappointing. Production on the wet but warm coastal region has not been similarly affected. The breeding and selection of rust resistant lines is currently in progress.

Rotations

Soybean is a valuable crop for rotation purposes. Being a legume, it can obtain most of its nitrogen requirement from the air through fixation by bacteria in the root nodules. Therefore, it does not seriously deplete available soil nitrogen.

Soybean also is generally superior to other crops in leaving the soil in a loose, friable condition.

The crop is best grown in rotation with winter and spring crops such as maize and sunflower. A possible rotation involves the use of soybeans instead of a green manure crop with sugar cane. Most of the benefits of a green manure crop are obtained and there is the additional return from the seed harvest. Recent results indicate that soybeans can also be grown in rotation with tobacco and with no harmful effects on tobacco leaf quality.

There is a problem if soybeans are to be grown in the Burdekin French bean seed quarantine area. They could introduce or provide a host for bacterial diseases, particularly halo blight, affecting French beans. Present seed certification or approved seed schemes restrict the growing of seed beans near soybean crops.

Soils, fertilizers and nodulation

Undoubtedly, fertile, friable, well drained loams produce the highest yielding soybean crops, but surprisingly good results have been obtained on heavy, intractable clay soils in north Queensland.

The crop will not tolerate excess acidity or alkalinity but the former can be counteracted by lime application.

Soybeans have shown good tolerance to wet conditions and have proved superior to most cereals and other legumes grown in the region. The plant is much less tolerant to wet conditions in the early stages of growth than when well developed. Excessively wet situations, however, should be avoided if consistent economic yields are to be obtained. Crops grow better on ridges to improve drainage.

Phosphorus and potassium deficient soils should be fertilized with these elements. Advice on rates of application can be obtained from the local agricultural extension officer.

Experience to date indicates that soybeans nodulate very well under most conditions in north Queensland. This removes the need for nitrogen fertilizer, large applications of which suppress nodulation and nitrogen fixation.

Soybeans grown on land for the first time should be inoculated with the correct strain of nitrogen fixing bacteria. This is generally purchased in peat culture and should be applied according to packers' instructions. Subsequent crops of soybeans should be inoculated until such time as satisfactory natural bacterial infection is assured.

Land preparation

A pre-requisite for soybeans is a clean, medium-fine seedbed. It is difficult to produce worthwhile crops on weedy, ill-prepared land even with the use of herbicides.

Mr. O. Loccisano of the North Queensland Tobacco Growers' Co-operative examines plants in a very good crop of Ross soybeans in the Mareeba district.

Leaf eating caterpillars cause damage to soybean crops but the level of damage depicted here does not warrant protective spraying.

Weeds are best controlled mechanically by thorough land preparation and inter-row cultivation during the early stages of crop growth. Once the crop has completely shaded the ground, most weed species are held in check. Crops having a variable plant stand, however, do not compete well with weeds and conversely the best weed-free crops have a good even plant stand.

Chemical weed control in north Queensland is being investigated and annual grasses can be controlled fairly successfully with trifluralin (sold under the trade name Treflan). Manufacturers' directions for rates and application methods should be followed carefully.

Time of planting

The day length factor and usual wet season patterns mean that the most suitable month for planting soybeans in north Queensland is December. Plantings may continue into January but this is less desirable as the crop may start flowering too early and so reduce yield potential. This may be counteracted by increasing the planting rate.

Winter plantings have shown some promise in the warm coastal areas of the region. Trial work is continuing on these out of season plantings and it is hoped to identify soybean varieties that produce reasonable growth and yield at this time of the year.

Row and plant spacing

Row spacings of the order of 0·75 to 1·0 m are quite satisfactory. Some crops have been grown on a broad acre basis in 18 cm rows. This means that inter-row cultivation is not possible and so narrow row planting should be used only on clean ground and where a good plant stand is assured.

Farmers should aim at a plant stand of 225 000 to 300 000 plants per hectare for a December planting and 300 000 to 500 000 plants per hectare for a January sowing. Seeding rates should be about 25 to 40 seeds per metre to give the usual plant stand of 16 to 25 established plants. Out of season plantings are shorter in plant height and row spacings can be decreased to 40 cm.

Pests and diseases

The main pests recorded on soybeans in north Queensland are green vegetable bug (*Nezara viridula*), lucerne crown borer (*Zygrita diva*), soybean moth (*Stomopteryx simplerella*) and budworms (*Heliothis* spp.). The first mentioned pest is the most serious but its incidence is variable. It can be controlled with endosulphan at 0·75 kg/ha or methomyl at 0·3 kg/ha active ingredient. The other pests mentioned (not lucerne crown borer) can also be kept in check by application of these chemicals. The lucerne crown borer is of unknown economic importance and effective control methods have yet to be worked out.

Several soybean diseases have been noted in north Queensland but the only ones of major importance are rust (*Phakopsora pachyrhiza*) and bacterial pustule (*Xanthomonas phaseoli* var. *sojense*). Rust is a serious disease of the tableland area where the cooler, showery conditions favour the disease. Yield reduction can be severe if the disease attacks the crops before the pods are filled. A mancozeb spray (1·8 kg active ingredient per hectare) at weekly intervals, if conditions are favourable for disease development, will help to stop the disease.

Bacterial pustule is common on susceptible varieties but several varieties resistant to this disease are available.

For more information on soybean diseases see 'Soybean Diseases' *Queensland Agricultural Journal,* Vol. 100, p. 194, June, 1974.

Planting

Seed can be planted with any available grain planter. To help with germination and emergence, it should be planted into moist soil at depths not exceeding 5 cm except on lighter soils where the depth can be increased to 8 cm.

Irrigation

The crop, although grown during the wet season in north Queensland, does benefit by irrigation during dry spells.

The period from flowering until the end of pod filling (when pods have turned yellow) is most critical for soybeans as regards moisture shortage.

Irrigation by spray or furrow should be given if rain is not sufficient during this period.

Need for irrigation is indicated by a flaccid appearance of the leaf stems, at the top of the plant. Looking across the field the undersides of leaves become obvious as the need for irrigation increases. A few thorough soaking irrigations to wet the full root zone are preferred to several light waterings.

Harvesting

Harvesting should begin as soon as the seed has reached sufficiently low moisture content.

Combine harvesters are used to harvest soybeans and manufacturers' instructions as regards drum settings should be followed. High drum speeds should be avoided at all costs if seed damage is to be kept to a minimum.

Harvester losses with soybeans can be high and this generally results from cutting too high, excessive ground speed, incorrect reel adjustment or seed shattering.

Yields

Yields to date have been of the order of 1·75 to 2·5 t/ha.

Seed storage

Seed should be stored in cool, dry conditions and have a moisture content of approximately 10%. The warm, humid conditions in north Queensland cause a rapid decline in seed viability and also encourage the tropical warehouse moth (*Ephestia cautella*). This is an important pest of stored seed, but can be controlled by dusting with BHC powder.

Marketing

In Australia, most soybean is presently used to produce vegetable oil while the residue has importance as a high protein stock food. Only minor quantities are used as whole beans for human consumption.

Before soybean meal may be fed to monogastric animals such as pigs and poultry, it must be treated to destroy a growth inhibiting factor that occurs in the soybeans in their natural state.

To process soybeans, two basic types of plant are available—full oil extraction and heat treatment plants and smaller units that produce a full-fat stock meal only. The former are expensive and require a large annual throughput while the latter are comparatively inexpensive and have a low throughput and labour requirement. Several individuals and companies in north Queensland have expressed interest in installing the smaller unit if a local bean supply is assured.

Another outlet for soybeans exists in the export trade but this would require bulk handling and storage facilities. Ship load size quantities of soybeans must then be assembled at the seaport.

Further information

Agronomic advice is available from the extension service of the Department of Primary Industries and from the field services of contracting companies.

Queensland horticultural exports to Hawaii

IN a recent issue of the Horticulture Digest from the University of Hawaii, an item of interest to Queenslanders was noted in which the following statement was made:

'Pinks Mammoth custard apple is a new high quality fruit of the Annona family, well adapted to growing at low elevations in Hawaii. It was introduced from Queensland, Australia, in 1960.'

The Pinks Mammoth, a hybrid between the cherimoya (*Annona cherimola,* fam. Annonaceae) and the sugar apple (*A. squamosa*) is the most popular variety grown in Queensland where orchards have been established for many years in the Brisbane area and near north coast. The excellent flavour of our custard apples is evidently well appreciated in Hawaii, where it is recognized that 'the soft, melting, slightly aromatic flesh is delicious as a dessert fruit.'

Propagation of the Pinks Mammoth is now well established in Hawaii where grafted plants are available from nurseries in Honolulu, and University of Hawaii branch stations in Kona and Hilo.

It is interesting to note also that another important horticultural export from Queensland to Hawaii is the macadamia nut.

The macadamia nut tree is indigenous to the coastal rain forest of southern Queensland and northern New South Wales. It is one of the few trees of the Australian bush that has edible fruit. In the mid 1800s, macadamia nut trees were discovered by Walter Hill, Director of the Brisbane Botanical Gardens and Ferdinand Mueller, Government Botanist of Victoria. They named the genus after Dr John Macadam, Secretary of the Philosophical Institute of Victoria.

The macadamia nut was taken to Hawaii as early as 1881 and since the 1930s it has become an important commercial crop in Hawaii. However, it was not until the 1950s that selections and evaluations were carried out systematically in Queensland in order to propagate the best types, and it is only in quite recent times that the macadamia nut industry in Queensland has seen a renewed resurgence of commercial interest and expansion by producers and processors.

Sandy Trout Food Preservation Research Laboratory, Hamilton

Soil conservation in the central cane district

by J. D. VEURMAN, Soil Conservation Branch.

IT is well known that cane sugar, directly and indirectly a source of income for many Queenslanders, has been a valuable export commodity for many years.

Less well known perhaps is the fact that the Mackay–Proserpine area, with eight sugar mills, produces 30% of Australia's raw sugar each year.

This central sugar cane district stretches from Carmila in the south to Proserpine in the north, a distance of about 280 km.

Mackay, the main centre of population and port for the area, is centrally situated along this coast.

Area description

• Topography

The major cane growing lands are on a relatively flat area drained by the Pioneer River, Bakers Creek, Sandy Creek and Alligator Creek.

The shape of this area is roughly a right angle triangle with a base of 35 km from Mackay to Sarina and a height of 80 km from Mackay to Netherdale. Steep and rugged mountain ranges form the northern, western and southern boundaries.

Several hills rise up from the flatter surrounding terrain, including Mt. Chelona, Mt. Homebush, Mt. Vince and Mt. Kinchant.

The altitude at which cane is grown is usually not more than 150 m (450 feet) above sea level.

Cane is also grown on a narrow strip of land some 4 to 15 km wide between the sea and the coastal range south of Sarina and north of Mackay to Proserpine. Near Proserpine, along the Proserpine River, the cane strip is some 20 km wide.

• Soils and vegetation

The major soil groups are red and brown earths and duplex soils.

1. The red and brown earths have a structured, loamy, friable surface over a clayey subsoil. They are found in hilly to strongly undulating lands and are usually well-drained.

Typical areas are: Habana, from Pinnacle westwards, Mt. Martin, Kungarri, Mt. Jukes and west of Kuttabul.

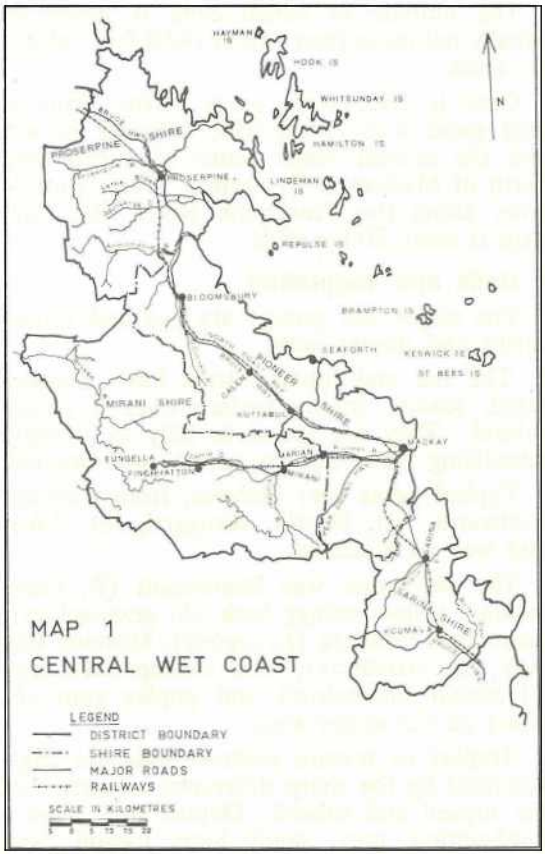
The vegetation was bloodwood (*E. intermedia*), yellow stringy bark (*E. acmenoides*), narrowleaf ironbark (*E. crebra*), Moreton Bay Ash (*E. tessellaris*), with swamp mahogany (*Tristania suaveolens*) and poplar gum (*E. alba*) on the wetter area.

2. Duplex or texture contrast soils are characterized by the sharp difference in texture of the topsoil and subsoil. Duplex soils have a hard-setting, grey, sandy loam topsoil from 15 to 60 cm deep over a clay subsoil. The subsoil is usually a mottled yellow clay but yellow and reddish clays sometimes occur. Water penetration of the clay subsoil is difficult and slow. The duplex soils are the dominant soil type in the area and occupy much of the low hills and undulating country.

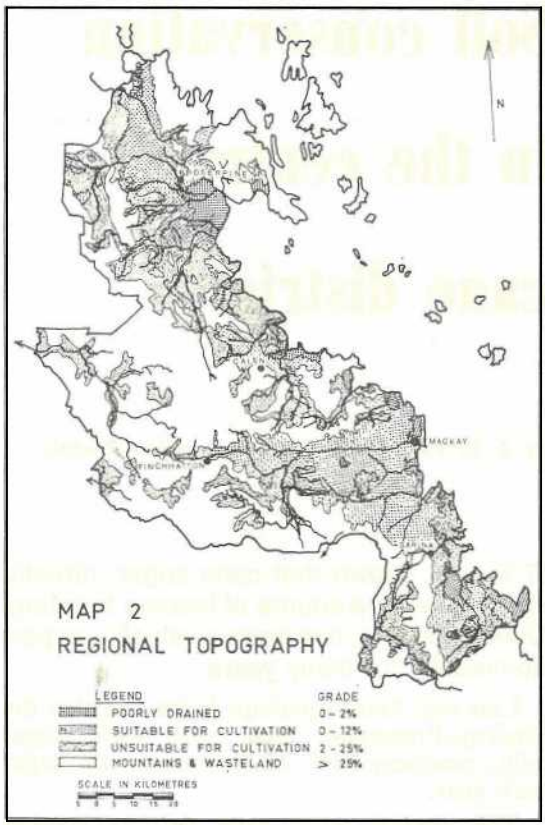
On the lower alluvial plain, the soil varies from sandy loam to clay loam to heavy clays depending on how sedimentation took place.

On the less well-drained duplex soils teatree (*Melaleuca* spp.) and swamp mahogany (*Tristania suaveolens*) are predominant. On better-drained duplex soils, the more common trees are poplar gum (*E. alba*), pink bloodwood (*E. intermedia*) and blue gum (*E. tereticornis*). The timber communities normally change along the river and creek banks with blue gum generally present.

3. 'Glue pot' (black earth) is the local name for a heavy, black clay soil occurring in small patches. It is usually found in low-lying areas.



MAP 1
CENTRAL WET COAST



MAP 2
REGIONAL TOPOGRAPHY

• Climate

The area has a humid, sub-tropical climate with a concentration of rainfall during the warmer part of the year. Approximately 70% of the annual rainfall is received in the 4 months between December and March. The total average rainfall ranges from 1 500 to 1 700 mm with the higher registrations closest to the mountains. An exception is the North Eton area with an average annual rainfall of 1 200 mm and, once in 3 years, less than 1 000 mm. This is regarded as barely sufficient for good cane growing conditions.

Cyclones and rain depressions with heavy, prolonged rainfall periods can be expected from early December to the end of March. Erratic thunderstorms with high intensity rainfall can occur from September to December. Rainfall intensities are among the highest of any along the east coast of Australia.

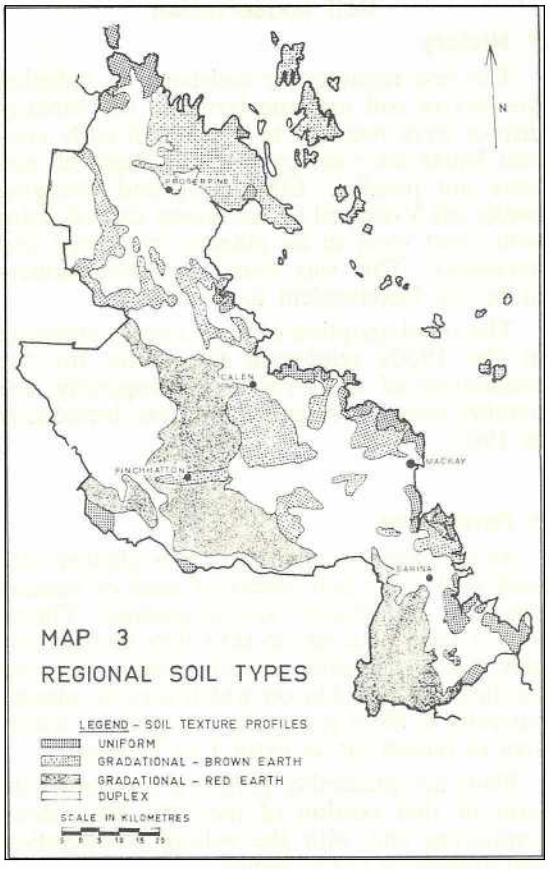
Very high daily rainfalls have been recorded, for example 525 mm in 5 hours and 650 mm in 24 hours in 1957 and 1958. Some 1 500 mm of rain fell from Christmas 1971 till the end of February 1972 in 70 days.

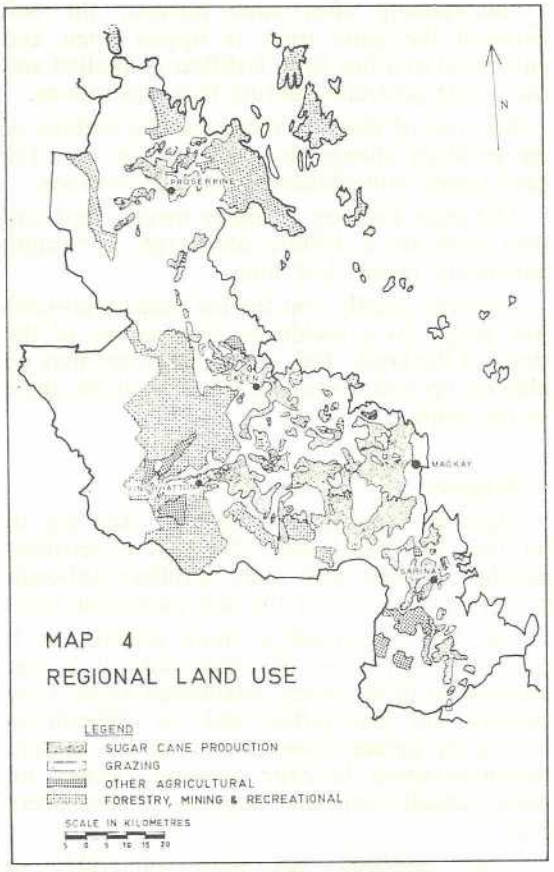
The cane industry

• History

The first cane crop was crushed in 1868 and this crop introduced Mackay's most important industry. Traditionally, cane was grown on the hills and at the foot of the mountains in the better drained areas. It is still grown there, often on very broken country with irregular slopes (Habana area).

After research workers found a method to control wire worms and heavy equipment made it possible to improve drainage, large areas of flat land became available for cane production.





• Cultural practices

The main planting season for sugar cane is from April to July. The crop is grown in rows about 135 cm (4½′) apart. Small sections of cane 37 cm (15″) long (called 'sets' in the industry) are planted horizontally in a furrow some 25 cm (10″) deep and covered with 7·5 cm (3″) soil. The sets form a continuous row. There is a bud or 'eye' at each node on the set, which can produce a new cane plant. There are usually two or more nodes on each set so that several plants arise from each piece of planting material.

As the plant grows, tillers are formed. The base of the plant from where these side shoots sprout is referred to as the 'stool'.

As the plant develops, the planting furrow is further filled with soil in several operations. This cultivation also controls weeds. Fertilizers are used during planting and at a later stage of growth. By the time the plants are too tall to be worked, the paddock is in a flat condition or maybe slightly hilled along the plants.

The first crop after a new planting is called the 'plant crop'. This is machine-harvested about a year after planting and carted to one of the eight mills in the area for processing.

During harvesting, the stalks are cut off at ground level leaving the stool with roots in the ground. New shoots appear almost at once and grow into a second crop, which is called the 'first ratoon'. Usually three ratoons are harvested before the field is completely cleared and prepared for a new planting. This gives a 4 year cycle of growth. However, further ratoons may be harvested depending on the condition of the crop. For obvious reasons, it is cheaper to produce a ratoon crop than a plant cane crop.

Immediately after each harvest, the soil between the cane rows is ripped open and cultivated to a fine tilth, fertilizer is applied and the weeds controlled during these operations.

Because of these cultivations, the surface of the paddock changes to slight rises around the cane stools with shallow hollows in between.

The cane industry is highly mechanized and long rows are a definite advantage, as turning machinery means lost time.

Farmers usually aim for the longest possible row length in a paddock—irrespective of the slope of the land. This means that cane may be planted up and down the slope or at an angle to the slope.

• Erosion

Planting cane in this manner has led to fertilizer and soil losses. The loss of fertilizer can be replaced with more fertilizer although it may have been lost for that particular year.

The loss of topsoil is more serious, as it cannot be replaced. Farming subsoil is not uncommon in the older, established areas. Clay subsoils are less fertile and are difficult to wet-up by lighter showers later in the season. Moisture stress in cane is soon evident on these subsoils and this happens almost every year.

Cane paddocks are most vulnerable to erosion during the spring and early summer thunderstorms. The plant cane is still small, and ratoon cane is being worked after harvesting.

This condition of minimum soil cover, combined with high intensity rainfall, long rows and sloping land can result in serious soil losses.

Later in the season, during January to March, the usual heavy monsoon rain falls on a cane canopy that covers the soil well. However, surface soils become saturated due to the low infiltration rate of the clay subsoil, and water filtering through the cane canopy runs-off the surface between the cane rows.

Depending on the fall or gradient of the rows and the soil type, this surface flow can cause serious inter-row erosion. The need for soil conservation measures, to avoid or at least minimize the loss of agricultural land, is obvious.

Soil conservation

• History

The first requests for assistance in reducing the loss of soil on cane farms in the Mackay district were received in 1954. All early contour banks were surveyed with a fixed fall and were not parallel. Converging and diverging banks left V-shaped or half-moon shaped strips with short rows to be planted, cultivated and harvested. This was found by most farmers to be too inconvenient to work.

The rapid adoption of mechanical harvesting in the 1960s reinforced the desire for the elimination of short rows. Consequently, the parallel contour bank system was introduced in 1967.

• Farm plan

As previously explained, cane is planted only once in 4 years and blocks of cane of various ages may be adjacent to one another. Therefore, a farm plan has to take into account not only the best possible contour layout, but also the farmer's decision on which area to plough out early in the 4 year cycle and perhaps which area to ratoon for an extra 1 or 2 years.

Plans are preferably prepared for the whole farm or that portion of the farm that needs contouring and with the willing co-operation and agreement of the owner.

Inter-row erosion—the loss of fertilizer and soil.

These farm plans are made at a scale of 1:4 000 (approximately 1 inch : 5 chains), the same as the mill maps, and show the proposed layout of cane blocks, access tracks and the proposed water disposal system.

After the owner has agreed to the plan, it can be laid out in stages over a number of years.

On low, sloping country, row direction to ensure good drainage without erosion is all that is needed. On steeper land, above 2% slope, the row direction has to be supported by contour banks to achieve the aim of maximum production without destroying the soil.

• Contour layouts

A contour layout consists of:

1. A top diversion bank; to prevent outside water from entering the paddock. Most farmers already have this sort of bank, although often with too much fall, resulting in bad scouring behind the bank.

2. Contour banks; these are made for three reasons:

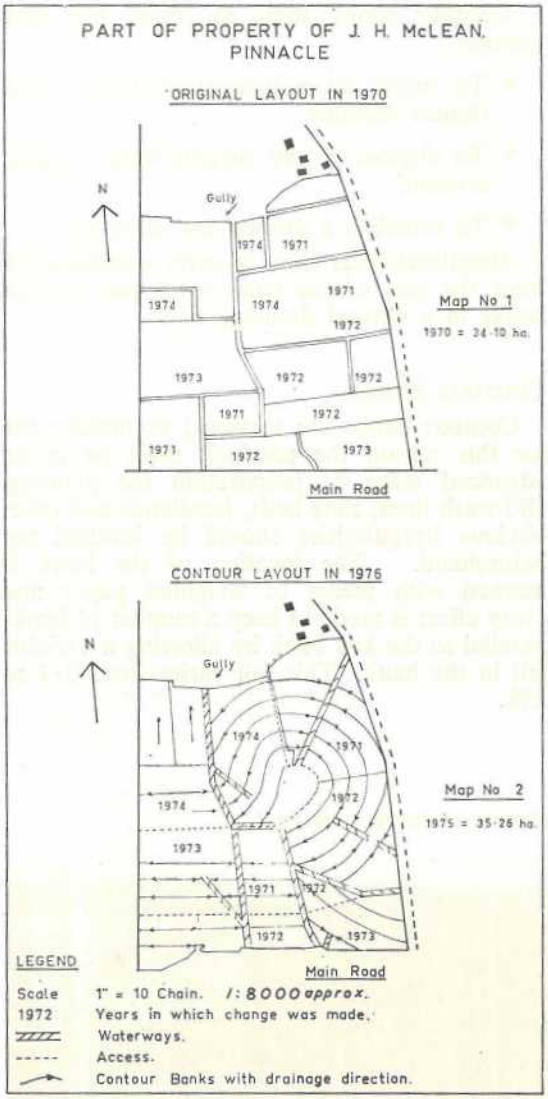
- To break up a long slope into several shorter sections.
- To dispose of any surplus water without erosion.
- To establish a proper row direction.

3. Headland-waterways; to carry surplus water from the end of the cane rows and contour banks to a natural drainage line.

Contour Banks

Contour banks are surveyed accurately and for this reason the paddock must be in an advanced stage of preparation for planting. Old wash lines, cane beds, headlands and other obvious irregularities should be levelled out beforehand. The location of the bank is marked with pieces of weighted paper and every effort is made to keep a number of banks parallel to the key bank by allowing a variable fall in the bank. This fall varies from 0·4 to 2%.

Erosion on fallow cane land.



When the fall becomes too great or too small, a new key bank has to be surveyed. Some of the cane rows between the two non-parallel banks will not run from end to end. The distance between banks depends on the slope of the country and ranges from 44 rows of cane or 60 metres on low, sloping country to 22 rows of cane or 30 metres on steep country.

The bank, a low earth wall 35 to 45 cm (about 1½′) high, is easily constructed with a two or three furrow disc plough. A good bank has a dish-shaped channel above it, not a narrow V cut as left by a plough. The fact that cane rows are slightly hilled up along the stools during the first ratoon cultivation assists in the drainage of surface run-off, as every row acts as a miniature contour bank. If one or more of these cane rows break, the contour bank stops the flow of water down the slope before it reaches damaging proportions.

Waterways

Waterways may be grassed, natural depressions or constructed drains. In cane lands, waterways should be excavated to ensure the free drainage of each cane row into the waterway. They should be constructed as soon as possible after the wet season to allow plenty of time for grassing up.

A scoop or grader makes a good constructing implement. The waterway bottom should be flat and level to ensure an even spread of water over its full width. Flat drains are also easy to cross with implements.

Contour layout for cane.

The grass cover is a MUST to prevent the drains from scouring. Couch, carpet, pangola grass, or any low growing, mat-forming grass is suitable for the purpose.

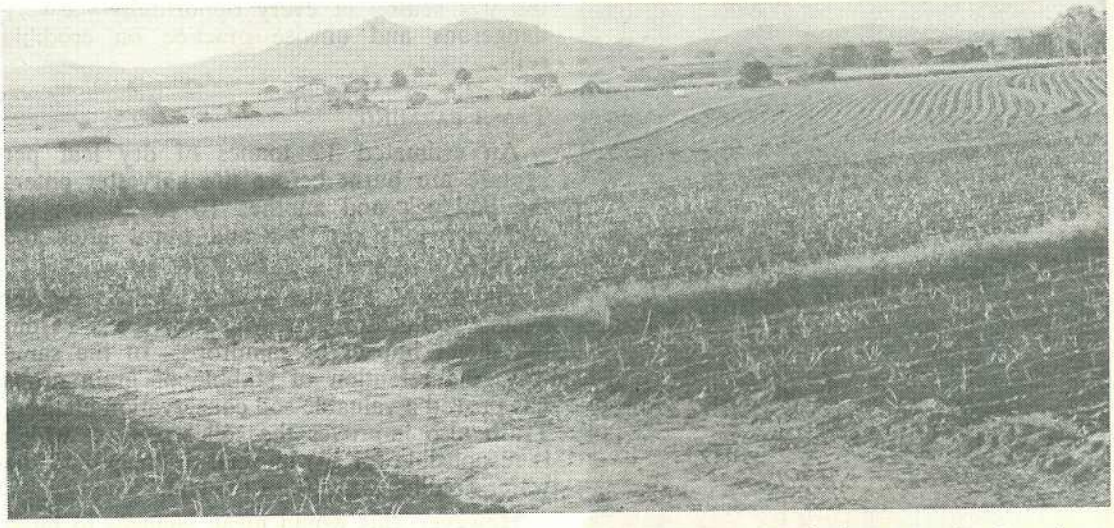
Irrigation to help grass establishment is very useful.

Care must be taken not to damage the grass cover with wheel tracks, if the waterway is used for a headland.

Major cane haulage roads should never be along a drainage line or waterway.

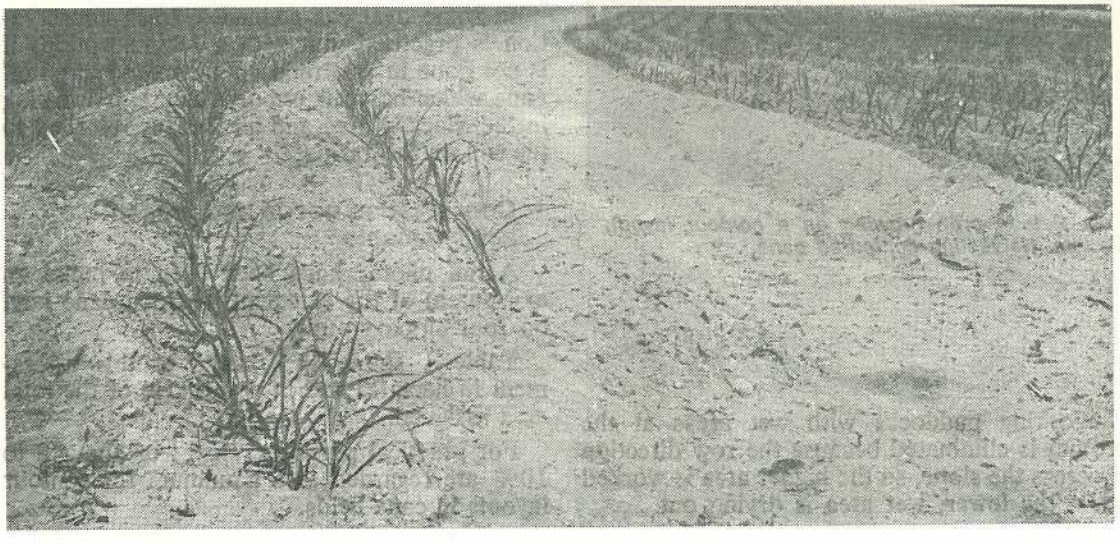
• Additional benefits

In addition to the control of erosion, conservation farming often yields unexpected benefits. Most growers using the contour system claim a better use of fertilizer and better water distribution in the field, both resulting in more even crop maturity, better ratoons and higher yields.



Above. Contoured cane land with waterway (not yet grassed) in foreground.

Below. Contour bank in a newly planted cane paddock.



Top. Ratoon crop growing on a contour layout. Bottom. Harvesting contoured cane.

Working paddocks with wet areas at the bottom is eliminated because the row direction is across the slope, so the higher area is worked while the lower, wet area is drying out.

• Other soil conservation practices

Cover crops

The use of beans as a cover crop during the wet season is recommended as 'bare soil is vulnerable soil'. Raindrops beating on bare soil start the erosion process. The practice of planting beans before the wet season is widespread but not universal.

Some farmers leave their paddock in a rough, 'bumpered' condition during the wet season and let the weeds cover the soil. Some have been seen working their paddock during the wet season at every opportunity—a very dangerous and unwise practice on erodible soils.

Trash farming

An estimated 12 tonnes of dry leaf per hectare are burnt before the harvester enters the paddock and another 10 to 20 tons of greenleaf tops are left and burnt after the harvest.

This trash could be a very effective barrier against soil erosion, by protecting the soil from the direct impact of raindrops. In the same way, the retention of stubble of grain crops has proved a valuable soil conservation method. Trash also improves the soil structure, which is responsible for the internal drainage and the water holding capacity of the soil.

However, this would mean changes to basic farming techniques and perhaps the use of different equipment.

In some overseas countries, trash conservation is practised, but with a few exceptions it is not done in Australia. One 'green harvester' (one which harvests unburnt cane), is working in the Mackay area and all trash is returned to the soil on this farm.

• Conservation needs and present achievements

Aerial photos have been used to make an assessment of the extent of assigned cane land on four slope groups.

Table 1 shows the results of this assessment in hectares and in percentage of the total area assigned.

For practical purposes, slopes of about 8 to 10% are regarded as a maximum for contour layouts in cane fields.

TABLE 1

Percentage Slope	Area in Hectares	Per cent of Total
0 — 2%	63 206	62
2 — 8%	23 784	24
8 — 12%	9 514	9
>12%	4 749	5
	101 253	100

Consideration should be given to the transfer of cane assignments from these steep lands, and the land use changed to pasture or forest. An estimated 9 500 hectares would fall within this category.

The slope group of 0 to 2% may need the determination of row direction more for drainage than for soil conservation reasons.

As drainage is the prerogative of the Bureau of Sugar Experiment Stations, requests of this nature are attended to by their extension staff.

This leaves an estimated 28 500 hectares of assigned caneland on slopes from 2 to 10% which are prone to erosion. This area is spread out over an estimated 1 000 farms.

Through experience, many farmers have found a way to plant their paddocks with the minimum amount of erosion but, even in these cases, improvements can be made by using an engineer's level to check on possible slight alterations.

The first soil conservation officer stationed in Mackay started work in 1967. Since then, the number of farmers applying soil conservation measures and the area treated has steadily increased. At the end of 1975, 125 co-operators had 1 800 hectares of land surveyed for soil protective measures.

Sugar cane is an intensively cultivated row crop grown under high rainfall conditions.

On sloping country, the occurrence of erosion is recognised, although most farmers see it more as a loss of fertilizer to the growing crop, than a loss of soil for future production.

A contour layout of cane blocks may not completely eliminate soil erosion but it has proved itself as a method of reducing soil loss and increasing production per hectare.

Contour farming is relatively new in the cane industry and a large area has still to be protected, but more farmers are becoming involved every year.

To sum-up the situation, one of the staunch co-operators has said:

> 'It requires patience and persistence to make the change, but it certainly justifies the effort. The response is quick and rewarding.'

Q.A.C. poultry course to continue

A SPOKESMAN from the Queensland Agricultural College announced that the course leading to the award of a diploma/degree in applied science (poultry technology) is to be continued to be offered.

This course was to have been replaced by a post graduate diploma in poultry technology commencing in 1978.

However, a decision to delay its implementation at Commonwealth level has made it necessary for the diploma/degree course to be continued.

Anyone interested in undertaking the course should contact the Registrar, Queensland Agricultural College, Lawes as soon as possible.

The Queensland Tertiary Admissions Centre has approved direct applications to the College for this particular course. Enrolments will be accepted until 27 January 1978.

Subject index to volume 103 (1977)

Index to pages and parts

Guide to pages

Party meat snacks

by Mrs. TESS MALLOS, Food Consultant,
Australian Meat Board.

JUDGING by displays in supermarket freezers, there seems to be a constant demand for little party pies, sausage rolls and similar foods. Whether it is a children's birthday party, a teenage gathering, or the 'boys' dropping in for a drink, a stock of meat-filled pastries in the freezer solves the problem.

Save time and money by making a quantity of such foods yourself when you have a baking day. Store them in the freezer, suitably wrapped, and you'll have tasty snacks on hand when the need arises.

These handy snacks will keep for 2 to 3 months in the freezer. To maintain the best flavour, remove air from packages with a freezer or camper's pump, or wrap closely in foil. Use packaged puff pastry or flaky pastry mix for convenience.

Tasty party puffs can be stored for quite a long while in the freezer. This makes them ideal, when baked in quantity, to meet those unexpected demands made by surprise guests.

Party puffs

Here's what you need

1 large onion, finely chopped
2 tablespoons butter
500 g (1 lb) minced beef
2 tablespoons flour
¾ cup beef stock
½ teaspoon mixed dried herbs
2 teaspoons worcestershire sauce
pinch of nutmeg
salt and pepper to taste
2 tablespoons dry breadcrumbs
2 x 284 g (10 oz) packets flaky pastry mix
milk or beaten egg to glaze.

Here's what you do

Gently fry onion in butter until soft, increase heat, add mince and stir over high heat until juices evaporate and meat browns. Add flour, stir and cook for 1 minute. Blend in stock and stir until thickened. Reduce heat, add herbs, sauce, nutmeg and season to taste. Cover and simmer gently for 10 minutes. Stir in breadcrumbs and cool.

Make pastry and roll out thinly. Cut into 12 cm (5 inch) squares. Place a tablespoon of filling in the centre of each square, moisten pastry edges with water and bring up the four corners to form an envelope. Press edges to seal and crimp with the fingers. Brush tops with milk or beaten egg and bake in a hot oven, 200–220°C (400–425°F) for 15 minutes until cooked and golden. Makes 18–20.

NOTE.—If not to be stored in freezer, omit breadcrumbs.

Sausage rolls

Here's what you need

500 g (1 lb) sausage mince
1 small onion, grated
1 tablespoon finely chopped parsley
1 tablespoon tomato sauce
1 x 340 g (12 oz) packet puff pastry
milk or beaten egg to glaze.

Here's what you do

Mix sausage mince with onion, parsley, and tomato sauce. Divide into 4 portions, and shape each portion into a long roll on a lightly floured surface. For easier handling flour hands as well. Rolls should be about 3 cm (1¼ inches) in diameter.

Roll out pastry thinly and cut into four strips, 12 cm (5 inches) wide and as long as rolls of sausage mince. Place a roll of mince towards one end of each pastry strip, moisten top edge with water and roll up, pressing seam to seal well. Cut into long or short lengths depending on requirements and place on baking sheets. Glaze with milk or beaten egg and cut 2–3 slits on top of each roll. Bake in a hot oven, 230°C (450°F) for 15 minutes, lower heat to 190°C (375°F) and cook for further 10–15 minutes. Makes 24–30 according to size.

Beef party pizza

Here's what you need

Crust

1 x 284 g (10 oz) packet flaky pastry mix

Sauce

2 tablespoons olive oil
1 onion, chopped
1 x 450 g (1 lb) tin tomatoes
2 tablespoons tomato paste
1 teaspoon dried oregano
½ teaspoon dried basil
1 teaspoon sugar
salt and pepper

Topping

500 g (1 lb) minced beef, browned in oil
½ cup chopped green capsicum
½ cup sliced mushrooms, cooked in butter
¼ cup sliced stuffed olives
2 tablespoons grated parmesan cheese
1½ cups grated mozzarella cheese

Here's what you do

Make pastry and roll out to fit a greased 30 x 20 cm (12 x 8 inch) slab cake tin, bringing pastry half way up the sides to form a shallow 'shell'. Prick lightly with a fork. Make sauce (see end of method) and spread over pastry. Sprinkle browned beef, capsicum, mushrooms and olives on top. Combine cheeses and scatter on top of filling. Bake in a hot oven, 200–220°C suitably wrapped or packaged. Defrost and reheat in a moderate oven. Cut into squares to serve. Serves 8–10.

To make sauce: Saute onion in oil until soft, add remaining sauce ingredients, cover and simmer for 20 minutes until thick.

NOTE.—Half a roll of frozen bread dough may be used instead of the pastry base.

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Troublesome Queensland weeds

Thornapples

(Datura spp.)

ROBUST, annual herbs growing to about 1 m high; stems erect, repeatedly forked, smooth; leaves mostly borne towards the ends of the branches, dark green, mostly large, with edges shallowly scalloped, emitting an unpleasant smell when crushed; flowers long, tubular, white except in the purple-flowered thornapple *(D. tatula);* fruits globular, covered with prickles of various shapes and sizes; seeds plentiful, dull black.

All species of thornapple occurring in Queensland favour rich soils and are especially common in the Darling Downs, Lockyer, Springsure and Clermont districts. They come up very quickly after spring and summer rains in places where the ground has been disturbed and are very plentiful in places where animals camp. Some species come into cultivated paddocks under weedy summer fallow and persist in the land when it is cropped. All the thornapples are poisonous, but as they are avoided by stock, trouble usually occurs only when fodder containing the weeds is fed to stock. The presence of seeds of thornapples in grains renders the grain unfit for consumption or export.

Thornapples can be controlled by chipping, hand pulling or cultivation. Young plants are susceptible to 2,4-D and, if growing conditions are good, 550 g per ha can give control in some crops. In the open, even 2·2 kg per ha leaves a few survivors. A mixture of picloram and 2,4-D has been used successfully at the rate of 1·4 *l* per ha of commercial product to control seedlings in sorghum and maize.

Harrisia Cactus

(Eriocereus martinii)

PERENNIAL cactus forming large, tangled mats 30 to 60 cm high; stems fleshy, jointed, much-branched, branches rooting where they touch the ground; joints 30 to 45 cm long, 2·5 cm to 4 cm thick, ribbed lengthwise, ribs 6 with low, thick, triangular humps at intervals of 5 to 7·5 cm, humps crowned with rounded, grey cushions of felty hairs from which arise 3 to 5 short spines lying flat and 1 to 3 spreading spines, stiff, very sharp, 2·5 to 3 cm long, grey when old with black tips; flowers white, pink tinged with slender green tube 15 to 20 cm long, opening at night; fruits red, almost spherical, 4 to 5 cm across, with red 'pimples' surmounted by cushions of hairs, each with 3 to 5 short spines and 1 to 3 long, spreading spines as on the stems; seeds small, black, numerous, embedded in crisp, white, juicy pulp.

It has escaped from cultivation in several places in Queensland but is particularly troublesome in the Collinsville district, where it is a major pest of grassland and forest. It is known from 13 other sites including Rockhampton, Mt. Morgan, Gatton, Goondiwindi and Charters Towers. The seeds are widely dispersed by birds.

The plant has thickened storage roots which make it difficult to eradicate. For high volume spraying, use 0·5 kg of hexaflurate to 635 *l* of water, spraying well into the root zone. Boom spraying needs 4·5 kg per ha of hexaflurate.

Bracken

(Pteridium esculentum)

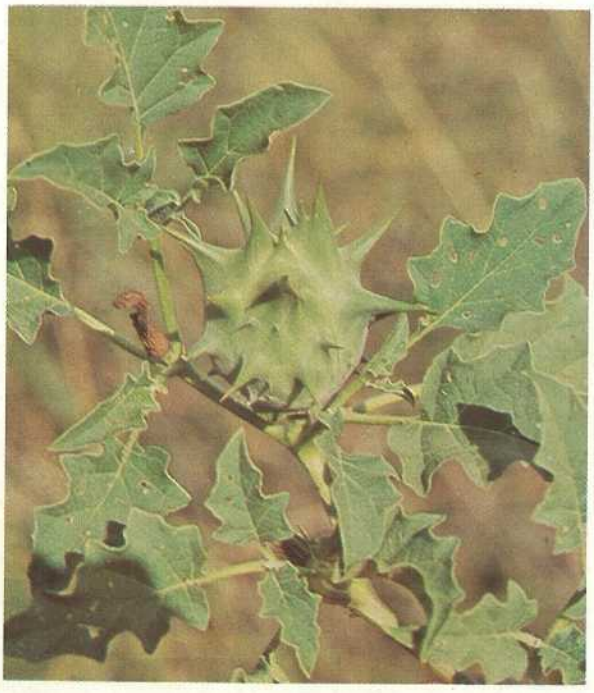
COARSE, robust fern with numerous underground, scaly stems; fronds stiff, rather leathery in texture, very much divided, the edges rolled downwards; usually 60 to 90 cm high, spreading at the top of stout, hard, brown stalks.

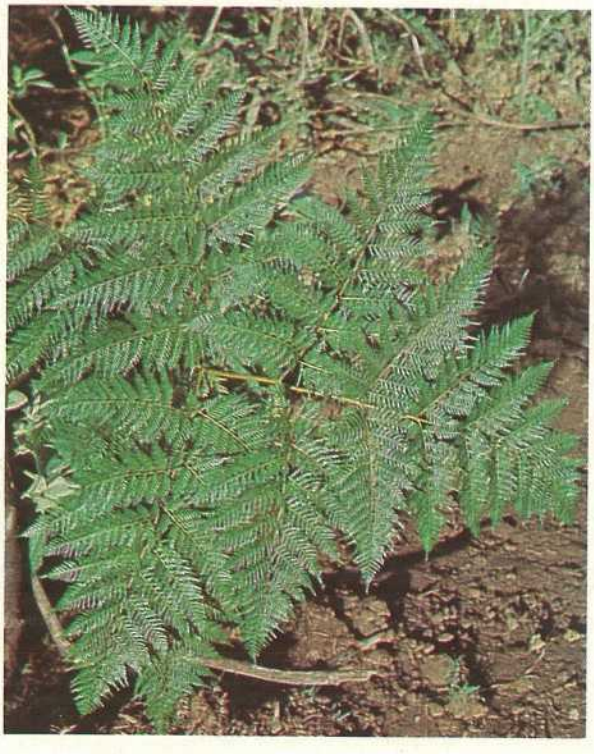
Bracken is a very widespread fern in coastal and sub-coastal Queensland, especially on alluvial flats and in old cultivation areas which have been allowed to revert to pasture. A good deal of run-down paspalum pasture in the south-eastern area and on the northern tablelands is infested with the pest.

The extensive system of underground stems formed by bracken fern renders control very difficult. Chemical treatment has not given satisfactory results. Repeated mowing, cutting or rolling of the fern fronds will in time devitalize the plants. About three treatments each year are sufficient if these are carried out when the fronds have just finished uncurling. Mechanical treatment should be combined with pasture improvement such as the planting of kikuyu grass or Rhodes grass. Bracken fern is poisonous to stock, although pigs may eat the young underground shoots without ill effects.

Compiled by officers of Botany Branch.

Expect trouble from these weeds





Above left: Thornapples (Datura *spp.*)

Left: Bracken (Pteridium esculentum)

Above: Harrisia Cactus (Eriocereus martinii)