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COVER: Green wattle (*Acacia irrorata*) grows in eucalyptus forests in South-eastern Queensland. It is commonly found near watercourses.

See 'Bipinnate-leaved wattles in South-eastern Queensland' in this issue.

Photograph by M. F. Olsen.

Editor, P. R. Lee

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A new idea in rice cultivation

by C. P. Norris, Engineering Services Section.

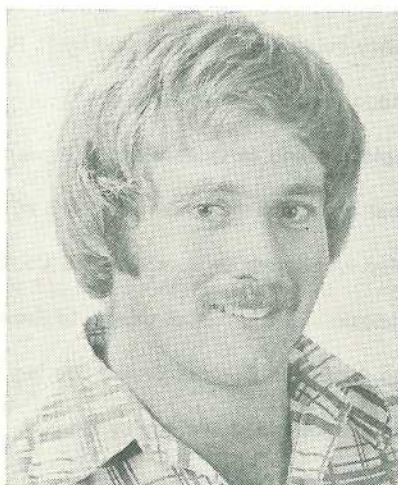
THE constant threat of cyclones and rain means that North Queensland rice growers may only have a few days to prepare their seedbeds for the summer planted rice crop.

This is particularly so if rain has hindered harvesting operations when the farmer is double cropping.

A new machine, designed by the author and constructed on the farm of Mr J. Norris at Brandon, North Queensland, prepares the seedbed and incorporates liquid fertilizers in one pass. The machine could have a wider application within the rice industry.

Existing cultivation practices are aimed at destroying the old crop root system and preparing a new seedbed in minimum time. The effect of soil wetting and drying on clods and tilth cannot be utilized. The total energy requirement to prepare a seedbed must therefore be supplied by tillage operations. To this end, tillage operations are usually intensive and follow in quick succession. Here are some typical cultivation practices. After slashing and burning old crop residues the farmer will:

- Perform primary tillage operations to a depth of 150 to 170 mm with heavy-wheeled offsets or a heavy chisel plough.
- Secondary tillage operations, typically one pass with a rotary cultivator or one or two passes with heavy offsets followed by one pass with a scarifier.
- Application of basal fertilizer (nitrogen) as deep as possible, with field cultivators or conventional combines.
- Land smoothing (optional) to reduce the undulations formed by the tillage equipment. This is necessary to allow better water management.
- Shallow planting with a conventional combine.



Chris Norris is an agricultural engineer based in Toowoomba. He is the son of well-known North Queensland rice farmer Mr J. Norris, on whose farm this new rice cultivator was constructed.

This land preparation system is both labour intensive (because of the number of operations) and machine intensive. A farmer may be forced to perform at least three and possibly five tillage operations to prepare his seedbed and apply basal fertilizer before planting.

A new system of cultivating

It was felt that both the time and money involved in seedbed preparation could be reduced by applying minimum tillage ideas and examining the actual requirements for a seedbed. For effective farm management, the desirable attributes of a system are:

- The ability to perform a significant proportion of the total land preparation in one pass. Only the upper 50 to 75 mm of soil needs to be in seedbed tilth. However, some cultivation below this depth is necessary.
- Be able to incorporate basal fertilizer during the tillage operation to a depth greater

than that possible with current equipment, preferably to full primary tillage depth.

- Not to require any greater energy (fuel) input than current systems.
- Utilize as many components of the existing equipment as possible, or at least use easily available components which are known to operate reliably.

The machine selected is simply a combination of two well-known cultivating implements—namely a sweep plough operating just in front of a rotary hoe.

From the study of soil mechanics, it is known that the wide sweep gives an energy efficient breaking of the soil, and the rotary hoe gives the required particle size (tilth) for a seedbed. Their interaction in the one machine is more efficient than using both separately. Fertilizer injections can be incorporated under the sweeps (see figure 1).

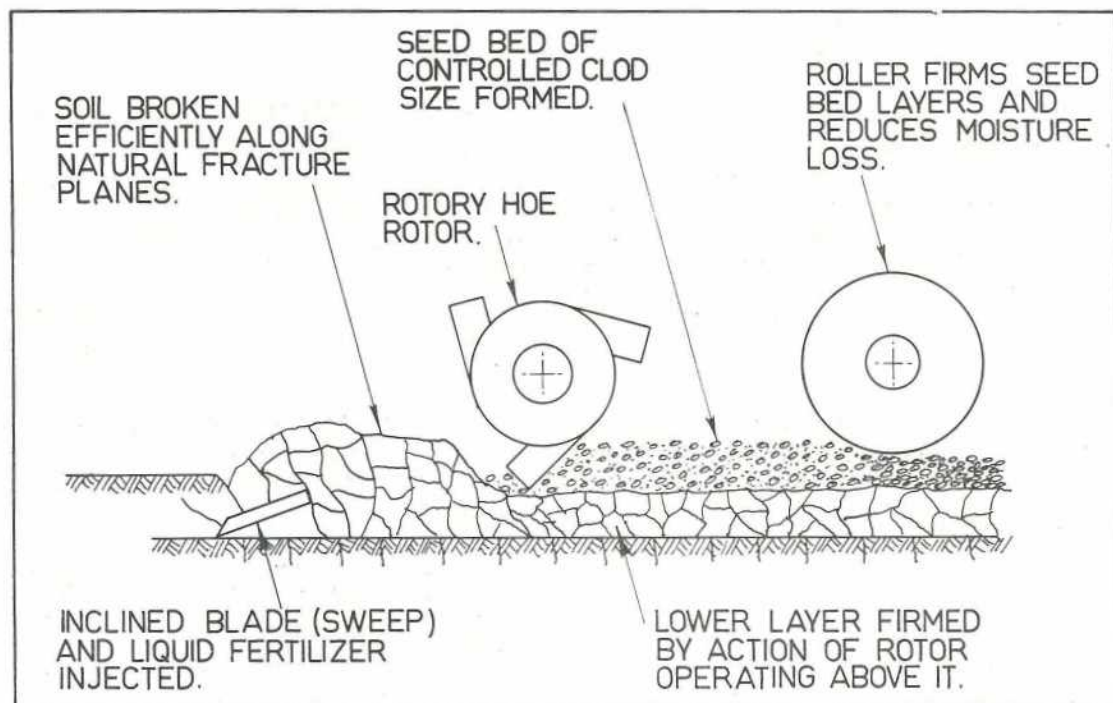


Figure 1.

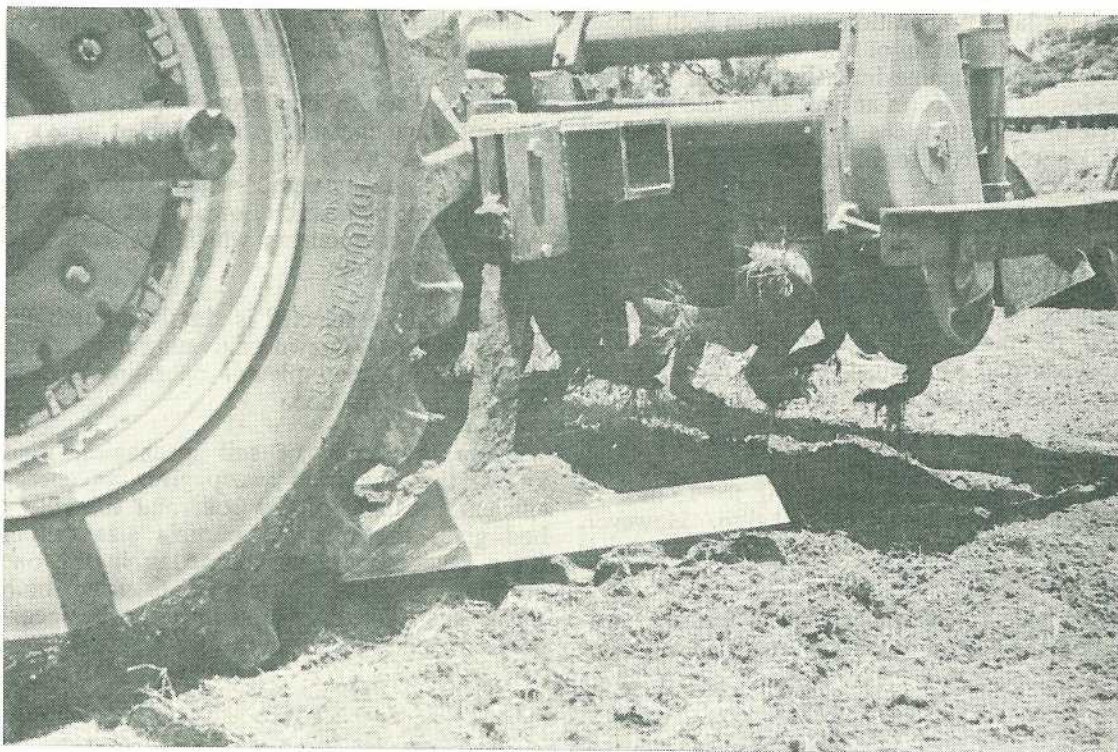


Plate 1. The machine consists of Napier Grasslands 910 mm sweeps which operate at 150 to 170 mm.

Machine description

As seen in plate 1, the machine consists of Napier Grasslands 910 mm sweeps which operate at 150 to 170 mm, breaking the soil and giving a coarse tillage effect over the entire width of the machine to full primary tillage depth. These sweeps are NOT rippers and cannot be used for deep tillage or busting hardpans.

Aqua ammonia can be applied under the blades via a distribution manifold. The rotor then tills the top 60 to 90 mm creating a seedbed and firming the lower tilled layer. The roller operating behind the hoe gives very good depth control over the unit and firms the seedbed.

Machine operation

To date, the machine has only been used in heavy Baratta clay soils, typical of rice

soils in the Burdekin Delta. Some comments on its performance are:

- The machine formed a seedbed of good tilth in one pass in dry, firm soil at an operating speed of about 7 km per hr, behind a tractor of 84 PTO kW.

In moist, firm, paddy conditions, the machine gave a good result in one pass at 4 km per hr.

- Wear on the blades of the rotary hoe is significantly lower than when using the hoe as a separate machine following other tillage machines.
- The energy consumption of the machine, measured in kW per hr per ha is significantly lower than the total energy consumed by the series of tillage machines normally used. The energy consumption also appears to be considerably lower than that required by a rotary hoe in a one-pass operation.

Summary

The combination tillage machine does a neat job of forming a seedbed and applying fertilizer in one pass. Although the energy consumption of the machine is higher than more-conventional tillage machines, the total energy consumption appears to be significantly less than that for the series of operations usually required to form a seedbed. The major advantage of the machine is the improved timeliness it allows. With this machine, a farmer can

double crop with a minimum of operations. For example,

- Slash and burn old crop residues.
- Cultivate and fertilize in one pass.
- Land smooth if required.
- Plant the new crop.

Further 'fine tuning' of the machine will be carried out this year to improve its performance and evaluate it further.

New edition of 'Income Tax for Primary Producers'

The Minister for Primary Industry, Mr Ian Sinclair has announced the release of a new edition of the booklet 'Income Tax for Primary Producers'.

The publication is designed to assist primary producers by explaining the requirements of taxation laws applicable to them and the taxation concessions available.

This tenth edition has been completely revised to provide an up-to-date account.

Of special interest to primary producers will be the inclusion of an extensive section explaining the mechanism of income tax averaging. Other topics covered in the booklet include:

- Allowable deductions.
- Fishing operations.
- Calculation of tax and health insurance levy.
- Provisional tax.
- Partnership transactions.

Guidance is also given on how to compile livestock accounts as well as rates of depreciation.

The publication is prepared by the Australian Taxation Office and published by the Department of Primary Industry.

The booklet is available at a cost of \$2.00 for sale through Australian Government Publishing Service Bookshops, located in all capital cities, except Darwin. Alternatively, it may be ordered by mail at a cost of \$2.45 (including postage) from: Mail Order Sales, Australian Government Publishing Service, P.O. Box 84, Canberra, A.C.T. 2600.

'Rural Industry Directory' released

THE Federal Department of Primary Industry has released the 1978/79 edition of the 'Rural Industry Directory'.

This publication is a valuable aid to communication for people associated with primary industry.

The Directory contains an up-to-date list of Government and private organisations connected with agriculture, forestry, and fishing in Australia, together with their addresses and telephone numbers.

The publication has 859 entries, an index of organisation names and a separate index of office-holders.

It is available at Australian Government Publishing Service bookshops in Canberra and State capital cities at a cost of \$2.30 per copy.

Mail order sales are available through the A.G.P.S. Sales and Distribution Section, P.O. Box 84, Canberra, A.C.T., 2600, at \$2.75 per copy (the bookshop price of \$2.30 plus postage within Australia of 45 cents).

Parallel grass strips . . .



a means of soil conservation?

ONE of the basics of any industry is the sound maintenance of machinery used to manufacture goods. This is especially true for agriculture. It is only common-sense to preserve the basis of your livelihood—the soil.

Cultivated land, particularly in sloping country, is very susceptible to soil erosion. In paddocks not protected against erosion, run-off from storms can remove huge amounts of valuable topsoil. The aim of soil conservation practices is to minimize soil loss.

by G. W. Titmarsh, Soil Conservation Branch.

Photograph above. Grass strips left as a guide for contour cultivation.

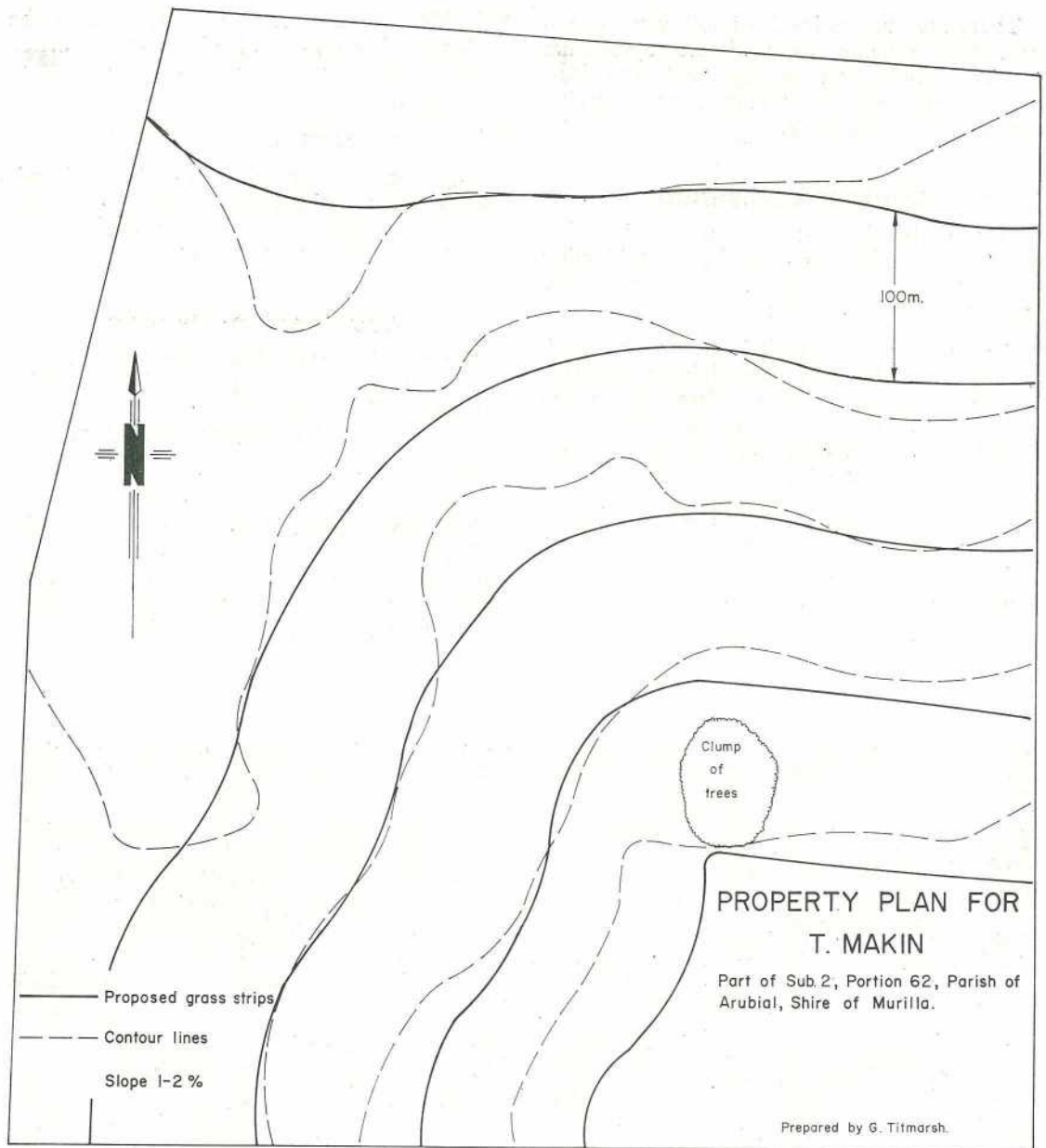


Figure 1. A sketch showing both contour lines and the parallel system implemented in the field. (Slope approx. 1.5%, *belah* soil.)

There are various levels of soil conservation necessary, ranging from simple agronomic measures and land management practices, through mechanical structures, to returning land to its natural state.

Contour cultivation

One of the simplest measures used is that of contour cultivation (that is, all cultivation is carried out on the level). This practice has the following advantages:

- As workings are carried out on the level, each furrow left acts as a miniature pondage bank—this holds up or slows down the flow of run-off water and spreads it more evenly. The result is that more water soaks into the ground with less run-off.
- Less horsepower is needed to pull implements on the level than to drag them up and down slopes.
- There is less wear and tear on linkages, tyres, etc.

- Paddocks are worked in lands across the slope—after rain, cultivation can be carried out at the top sooner than at the bottom of slopes.

- No long corners are left to finish out.

However, contour cultivation alone will not always offer satisfactory protection against erosion, especially on the steeper sloping lands and in areas of higher rainfall.

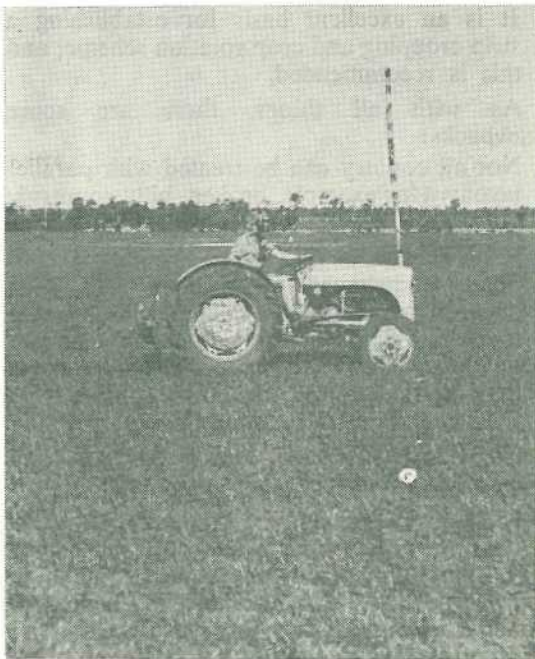
Additional protection

For effective protection of the topsoil, more intensive husbandry practices need to be carried out and soil conservation works constructed in conjunction with contour cultivation.

In the drier areas (for example, the Western Downs) slopes up to 1.5 to 2% and up to 500 to 600 m long, in the case of a soil with a high rate of infiltration, can be safely cultivated using contour cultivation. Other land management practices such as stubble mulching (and that means avoiding the disc



Well established grass strip of Green Panic on 'Denver'.



Above and Below. Surveying and marking contour lines for grass strips or as preparation for a parallel system using a mobile staff.

plough unless absolutely necessary) and growing crops giving maximum ground protection during the summer storm period should also be used in drier areas.

In higher rainfall areas and those with soils of lower infiltration capacity, slopes greater than 1% require more intensive measures such as diversion banks, contour banks and grassed waterways.

Grass strips

In many areas where contour cultivation is widely used, an associated practice is grass stripping. Strips of grass are left or planted on the true contour at certain intervals. These strips hold up any silt being washed, spread water and act as a guide for future cultivations. However, as they are on the true contour, they often leave awkwardly-shaped cultivation bays.

Improved planning and surveying techniques help to overcome the problems.

- Work parallel to the top and/or bottom contour line for each bay and leave the odd-shaped areas as pasture. This can leave considerable areas uncultivated.
- Parallel the bays as much as possible.



Parallel bays

With parallel bays, instead of following the contour exactly, the contour lines are 'smoothed out'. Starting from a contour map or sketch of the paddock, a series of parallel lines are drawn which most closely follow the contour (see figure 1).

Some areas in the Western Downs have had parallel grass strip systems implemented for some time. Mr E. Cameron, manager of 'Denver' near Toobeah, laid out a parallel system some 5 years ago. Since then he maintains erosion has been dramatically reduced. Large areas have since been treated similarly in this area.

There are several benefits obtained from these systems:

- Time needed for working the land may be reduced.
 - The economics of contour cultivation using multi-hitch implements are improved.
 - Double plantings are all but eliminated (the width of bays is preferably a multiple of the planting machine's width).
 - Row cropping and any inter-row cultivations are made easier.
- It is an excellent basis for establishing a strip cropping and crop rotation scheme, and this is recommended.

As with all things, there are some drawbacks:

- Not all country can be treated with parallel layouts (for example, broken, hilly country); only gently undulating country of low slopes is suitable.
- Some odd-shaped areas often still exist between parallel areas. This results because there is a limit to the paralleling that can be done. It is advisable not to get more than 1 to 2% off the true contour and then only for short distances.
- These systems take longer to plan and install than just contour grass strips.

Despite these drawbacks, parallel grass strips have proved their value. Although they take more time and are more trouble to install, they are still a relatively cheap and effective soil conservation measure under certain conditions.

Perhaps your land can be treated safely in this manner. As in all cases of soil erosion, the Soil Conservation Branch of the Department of Primary Industries offers a free service for advice and planning needs. Contact your local officer who can discuss with you what is needed on your property.

Appointed Agricultural Bank Assistant General Manager

THE Minister for Primary Industries, Mr V. B. Sullivan, announced that Mr Edward O'Connor has been appointed Secretary and Assistant General Manager of the Agricultural Bank as from 22 June 1979. He succeeds Mr Alan Dellit, who recently was appointed General Manager.

Mr Sullivan said that Mr O'Connor, 55, had served with the Bank since 1940 and had been the Chief Inspector since August, 1978.

Before this, he had lengthy experience in Brisbane and country districts, including 5 years at Ayr at the time when the Clare-Dalbeg-Millaroo Irrigation Area was being established and developed.

Cottontails . . .

a recently declared noxious weed

by H. E. Kleinschmidt, Botany Branch.

COTTONTAILS is the common name applied in Queensland to *Froelichia floridana*, a native of the United States.

It was recently declared noxious under the Stock Routes and Rural Lands Protection Act.

In the United States, this plant is known under the common names of Florida snake cotton and plains snake cotton. Our first record of the plant here was in 1959, from a few kilometres west of Yalleroi in the Mitchell district. It is thought to have been introduced with buffel grass seed. About 1970, it started to spread and has now been recorded from areas around Injune, Mitchell, Roma, Chinchilla and Yandilla.

While the infestation was fairly small, it was decided to declare the plant a noxious weed, in an endeavour to prevent its further spread and possibly to eradicate it.

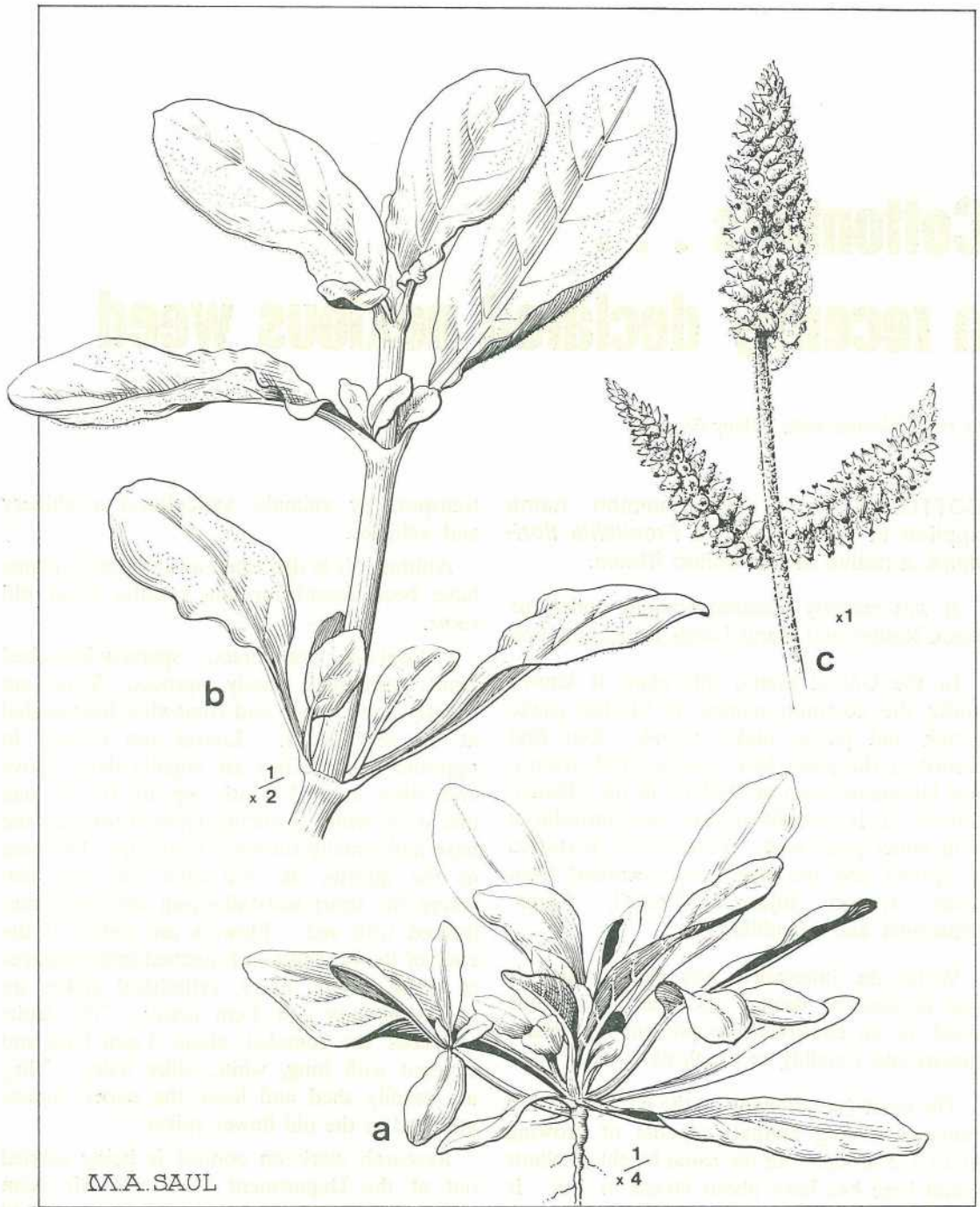
The plant (see drawing on the next page) is a summer-growing annual, capable of growing up to 1.5 m high, but the usual height of plants found here has been about 80 cm to 1 m. It germinates with spring to early summer rain and seeds from mid-summer to autumn. It favours sandy soils and disturbed situations. The hairy seed covering equips it well for

transport by animals, agricultural machinery and vehicles.

Although it is described as an annual, plants have been found forming rosettes from old roots.

Cottontails are erect, sparsely-branched plants with long, woody taproots. Stems are slightly hairy, stout and somewhat four-angled at the leaf joints. Leaves are carried in opposite pairs. They are slightly hairy above and silky hairy beneath, up to 10 cm long and 4 cm wide, gradually tapered towards the base and usually rounded at the tip. The base of the midrib, the leafstalks and the stem where the short leafstalks join are sometimes flushed with red. Flowers are borne at the ends of the branches in branched inflorescences of dense, white, hairy, cylindrical spikes up to 10 cm long and 1 cm across. The fruits or 'seeds' are rounded, about 4 mm long and covered with long, white, silky hairs. They are readily shed and leave the papery bracts attached to the old flower spikes.

Research work on control is being carried out at the Department of Lands' Sir Alan Fletcher Research Station in Brisbane. Early results indicate that the plant is susceptible to 2,4-D amine and also to atrazine and dicamba.



Cottontails (*Froelichia floridana*).

A butchers' picnic



A Meat Quality Symposium was held at the CSIRO Meat Research Laboratory, Cannon Hill in 1978.

The symposium was organized by officers of the Queensland Department of Primary Industries and CSIRO.

The purpose of the symposium was to assess the tenderness of Zebu cross and British breed meat and also the effects of tenderstretch hanging.

Abattoir processors, wholesale and retail butchers as well as some producers attended the symposium.

At the beginning of the symposium everyone received a shishebab with four cubes of meat from the rib eye muscle. Two cubes were Zebu x British meat and two were British breed meat. For each breed, one cube was from the tenderstretched side of the carcass and one from the side hung in the traditional or non-stretch way. We were asked to determine the tenderness of each cube using a tenderness scale from 0 (very tender) to 5 (very tough).

Photograph above. Plate 1. Testing tenderstretch and non-stretch meat from British breed and Zebu cross carcasses are Mr John Sullivan, Sullivan's Meats, Coorparoo, Brisbane, Mr Bill Meynink, Chairman of the Queensland Meat Industry Organization and Marketing Authority and Mr Barry Daley, State Manager of Woolworths' Meat Division. Photograph courtesy of Queensland Country Life.

Taste evaluation

		Day 1 (41 tasters)	Day 2 (31 tasters)	Mean (72)
Zebu X British	Tenderstretch	1.34	1.48	1.40
	Non-stretch	1.90	1.94	1.92
British breed	Tenderstretch	1.34	1.65	1.47
	Non-stretch	1.68	1.77	1.72

SCALE

0 very tender	3 fairly tough
1 tender	4 tough
2 fairly tender	5 very tough

by Jennifer R. Wythes,
Beef Cattle Husbandry Branch.

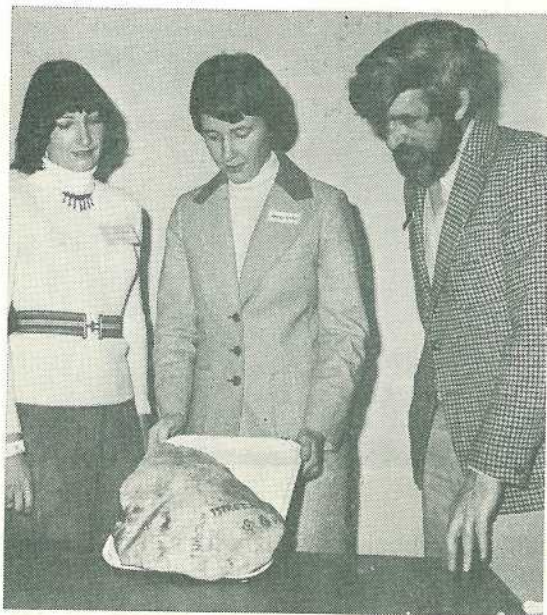


Plate 2. Mrs Anne Ford of the CSIRO, Miss Jennifer Wythes of the Queensland Department of Primary Industries and Dr Robin Shorthose of the CSIRO examine a tenderstretch rump from a Zebu cross carcass. Photograph courtesy of Queensland Country Life.

Statistical analysis of these results showed that tasters were able to distinguish the significant ($P < 0.01$) differences between tenderstretch and non-stretch beef (mean score 1.44 v. 1.82). Tasters could not differentiate between Zebu cross and British beef (mean score 1.66 v. 1.60).

Test carcasses

	Zebu X British	British breed
Carcass wt (kg)	218	171
Fat cover (mm)	1.7	1.2
% Hindquarter	47.2	47.2
Muscle pH	5.62	5.71

Dr Des Walker, CSIRO Officer-in-Charge at the Laboratory, welcomed us to the symposium.

Mr Max Burns, District Beef Cattle Husbandry Adviser, explained the role of Zebu

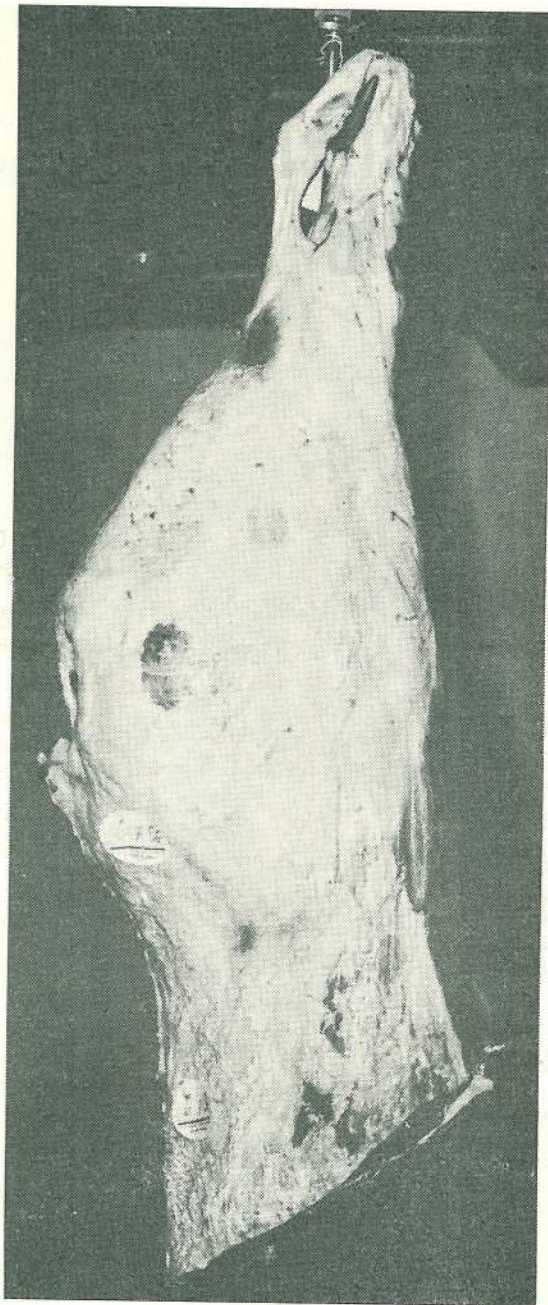


Plate 3. Traditional or non-stretch hindquarter from the same Zebu cross steer as in plate 4. The non-stretch beef was not as tender.

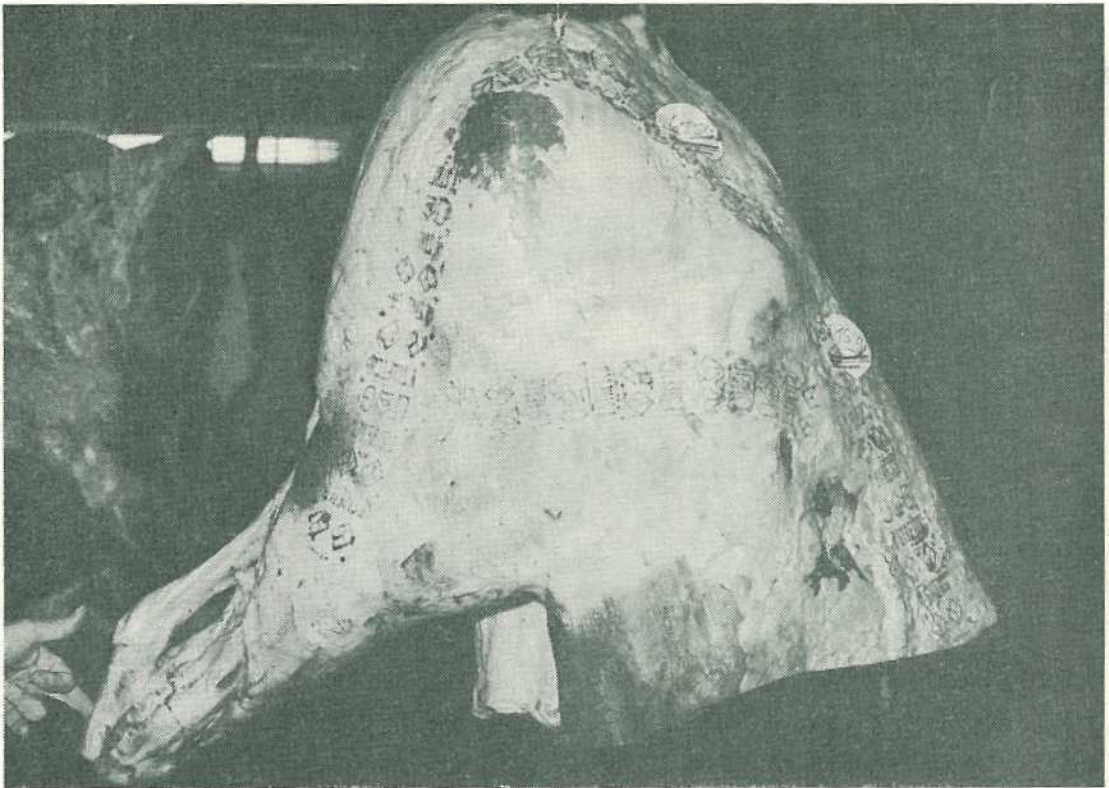


Plate 4. A tenderstretch hindquarter from a Zebu cross steer used for the symposium. The attractive lime-green 'T-STRETCH' brand tells the consumer the beef is tenderstretch and the 'Y' (inside the diamond) shows that it meets the blue ribbon grading standard.

cross cattle in southern Queensland as the need to use environmentally adapted cattle increased.

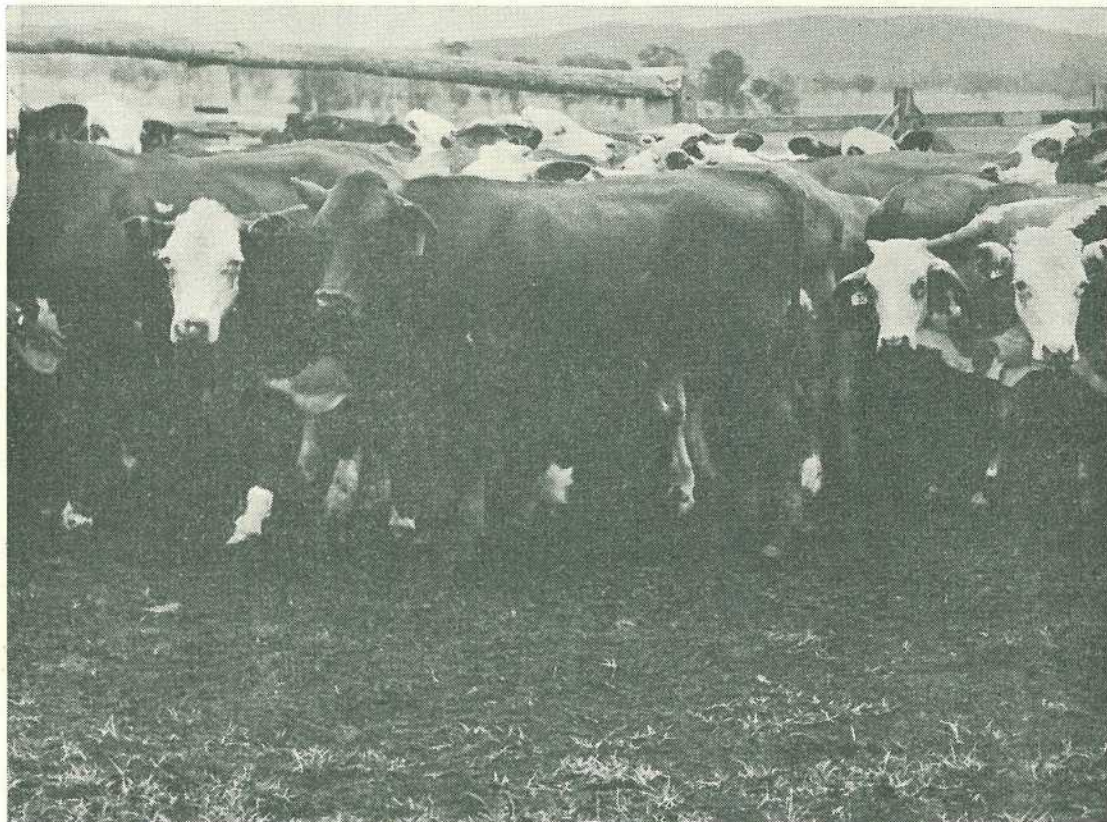
Mr Burns said that cattlemen are fortunate in being able to take advantage of the higher production potential of European cattle and blend it with the tick resistance of Zebus. In this way, they can develop a highly productive animal which requires minimal or no dipping.

Mr Don Wall of Mackay related his experiences with Brahman crossbred and British cattle and their relative carcass merits (the text of his talk is given in the next article).

Dr Robin Shorthose and Mrs Anne Ford explained the research being undertaken at the laboratory on muscle tenderness of different breeds. Dr Shorthose said that a consumer panel of Brisbane residents could distinguish between tenderstretch and non-stretch meat. However, they could not tell if the meat was from Friesian, Brahman and Simmental cross or Hereford steers.

The symposium concluded with a barbeque—some very tasty and tender rump steaks from Zebu cross carcasses that had been tenderstretch.

An industry view on the meat quality of



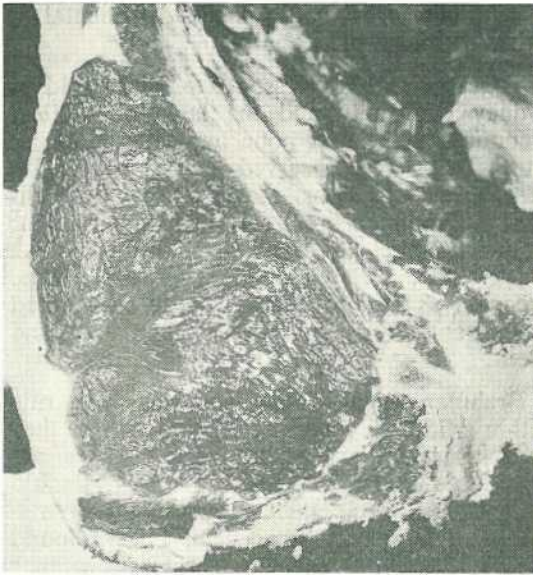
Brahman crossbred and British breeds

by D. Wall.

This paper was presented by Don Wall, a Mackay butcher, at the Meat Quality Symposium held at the CSIRO Meat Research Laboratory at Cannon Hill. The symposium was organized by officers of the Department of Primary Industries with the assistance of CSIRO officers at the Laboratory.

HAVING been in the meat trade for the past 36 years, 26 of which I have owned my own business, I have had ample opportunity to observe both Brahman crossbreds and British breeds.

By personally purchasing my cattle requirements during the past 23 years, I have observed both types in the paddock, during processing, as carcasses in the shop, and as meat in the display cases.

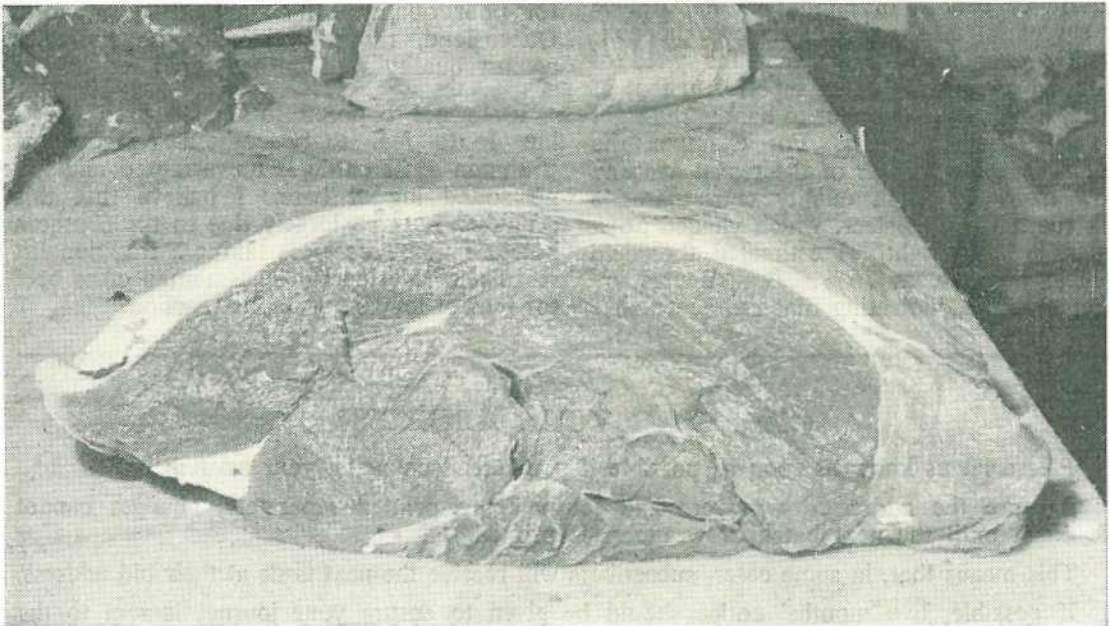


Rib eye muscle of a Zebu cross carcass. Brisbane consumers could not detect differences in meat tenderness between breeds in a CSIRO test.

I understand there is a distinct prejudice against Brahman cross beef in southern markets. Perhaps Brahman crosses have partly found disfavour because of their largely undeserved reputation for being temperamental. However, cattle of any breed reflect the attitude and capability of the cattlemen. A Brahman cross steer properly weaned, well handled and educated will be no more temperamental than a straight British breed.

If a British steer and a Brahman cross steer run free without any supervision or handling in early life, I would not get into a yard with either one. Make no mistake, I have found many Brahman cross cattle were 'fizzy', but the proportion is no greater than in British breeds. I stress that handling is the key to production of better quality meat animals.

Temperament leads to the topic of pre-slaughter handling, in which I have a great interest. Irrespective of breed, our present system is most undesirable. Cattle are often mustered, loaded and trucked on the one day without any settling period. At the meatworks they are handled by complete strangers, who are often inexperienced. The cattle are shouted



Rump from the grand champion carcass at the Mackay Show—a Brangus steer.

at, prodded and hosed—all in a completely foreign environment to any they have previously experienced.

Picture yourself transported to a foreign country where you were unknown, could not speak the language, had no credit and were unable to obtain food, drink and shelter. I venture to say you would be bewildered and frightened. Furthermore if you were struck and prodded each time you did the wrong thing, despite ignorance of your mistake, would you remain calm? This situation applies directly to cattle sent for slaughter.

The tenderness of Brahman cross cattle is often compared with that of British bred cattle. I say emphatically that tenderness is not an exclusive attribute of any one breed of cattle. In my opinion, tenderness is largely dependent on temperament which is in turn wholly dependent on the capabilities of the cattleman.

To those cattlemen who persist in the attitude that Brahman cross cattle are wild, I would quote 'A bad workman always blames his tools'. It should be noted that a test conducted by CSIRO using cattle from Grafton Agricultural Research Station, N.S.W., found 'no breed difference in tenderness was detected by a consumer panel'.

Yield of beef is of paramount importance for successful meat sales. I have found consistently over many years that the yield of Brahman cross cattle is far superior to that of British bred cattle. I prefer to handle the right type of Brahman cross. For example, the grand champion carcass of the recent Mackay Show from 116 high quality entries was a milk tooth Brangus steer, which yielded 56% carcass to liveweight. I estimated the yield of meat to bone, as 76%. Both figures are extremely high, indicating that the acceptance

of Brahman cross cattle is not detrimental to either yield or profitability.

Together with Professor Rex Butterfield of Sydney University and the late John Riley, I conducted the first bone out competition in Australia. We observed on that and on subsequent occasions the evenness of well-finished Brahman cross cattle was far superior to the lumpiness of most well-finished British breed cattle. Trimming the latter to the same evenness as Brahman cross cattle constituted a substantial cost in time, weight loss and profit.

Brahman cross cattle are now the rule within a 250 km radius of Mackay, where they were once the exception. These cattle are more able to combat the cattle tick, buffalo fly and heat problems. Regarding the saleability of Brahman cross beef, I have found a most gratifying and favourable acceptance by customers to the change over from British breed. Domestic beef consumption and demand have never diminished. I consider that customers and experienced butchers could not distinguish between breeds when the meat is displayed on a tray.

Market bias may be justified for poor quality crossbred animals, but the same applies for poor quality British animals. In North Queensland, there is little or no prejudice against quality well-finished crossbreds.

I am not opposed to British bred cattle, but I do feel that southern rejection of Brahman cross cattle is unwarranted and has no sound logical base. I believe that this prejudice may be largely due to the southern butchers and processors taking a traditionalist stand and refusing to use Brahman cross beef for fear of imaginary public reaction.

CHANGING YOUR ADDRESS?

Please let us know as soon as possible if you intend changing your address.

Because the addressed wrappers and journals are printed separately, changes cannot take effect until the next batch of wrappers is printed.

This means that, in some cases, subscribers will receive the next issue at their old address.

If possible, two months' notice should be given to ensure your journal is sent to the correct address.

Bipinnate-leaved wattles in South-eastern Queensland

by Beryl A. Lebler, Botany Branch.

IN the juvenile stage of a wattle's growth, the leaves are always bipinnate (fernlike).

Only a very small proportion of wattles retain these true leaves throughout their life. The number of pairs of pinnae making up the leaf, the number of leaflets or pinnules in each pinna, and the length and the breadth of individual leaflets vary in different species. Some have linear leaflets but in others they are oblong or obovate-oblong and obtuse.

There is also variation in the pubescence of the young growth. In some, the hairs are short, dense and appressed and may be white, golden-brown or rusty. Another wattle also has golden-brown hairs but they are long and spreading and scattered. This gives the new growth a bristly appearance.

One of the most obvious differences between bipinnate-leaved wattles is in the number and position of glands on the leaf rhachis. In some, the glands are conspicuous and orbicular with one placed between the uppermost pair of pinnae and a second near the lowest pair. In others, they are smaller and are found only on the upper end of the rhachis. From one to five glands may be present. There is even one wattle with large glands at the base of every pair of pinnae in addition to one to three smaller glands of different sizes on the rhachis between the pinnae.

All the bipinnate-leaved wattles have their flowers in globular heads. These heads are solitary or clustered in the axils of the leaves,

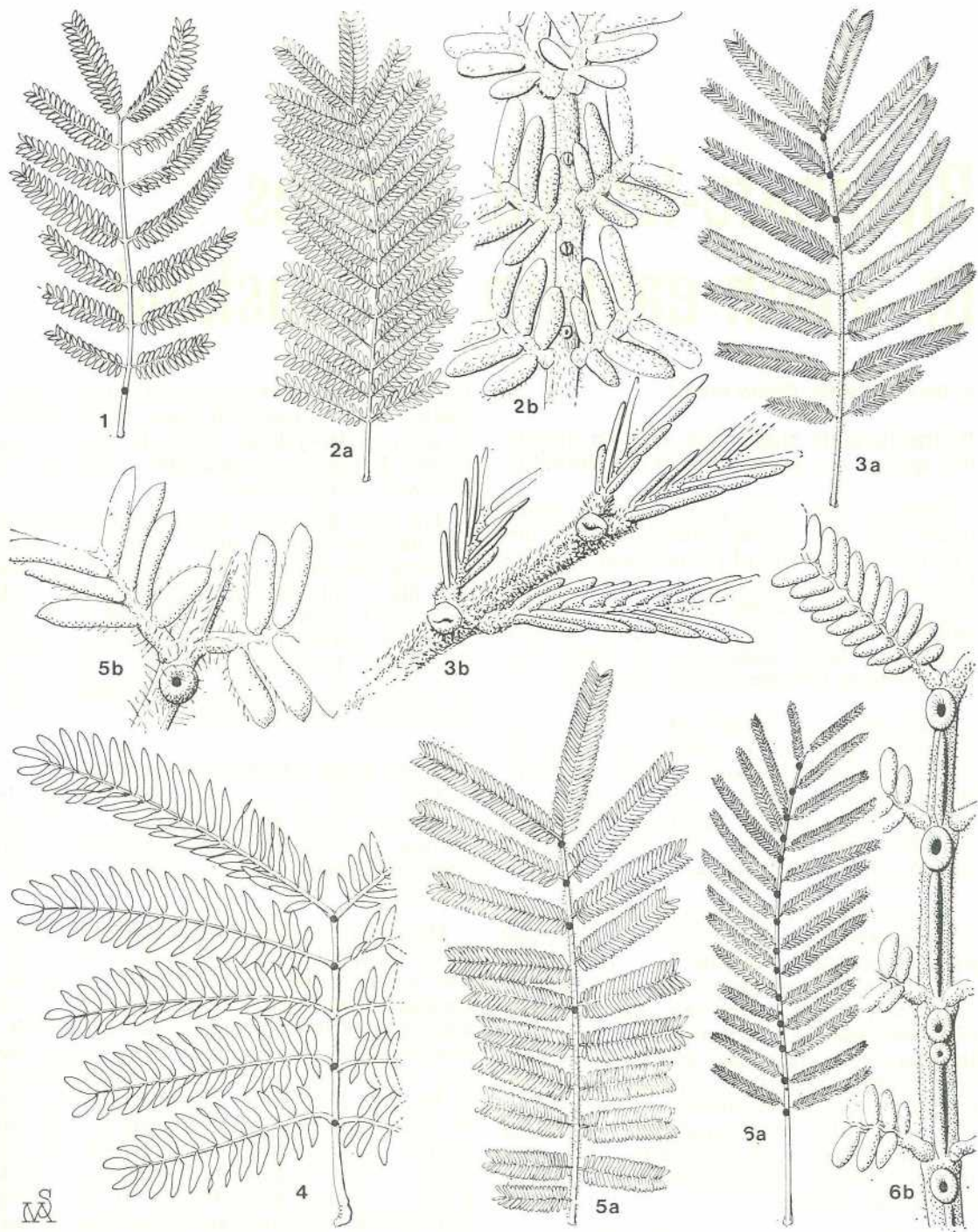
or are arranged in axillary or terminal racemes. Their colour ranges from pale creamy-yellow to deep golden-yellow. There is also a range in their fragrance—from a light, pleasant scent to a very strong perfume.

The fruits are pods which can be 10 cm long and flattened and are more or less contracted between the seeds; or they may be cylindrical and filled with pith that separates the seeds from each other. Six wattles with bipinnate leaves are found in South-eastern Queensland. These are: *Acacia farnesiana*, *A. oshanesii*, *A. irrorata*, *A. glaucocarpa*, *A. leucoclada* subsp. *argentifolia*, and *A. loroloba*.

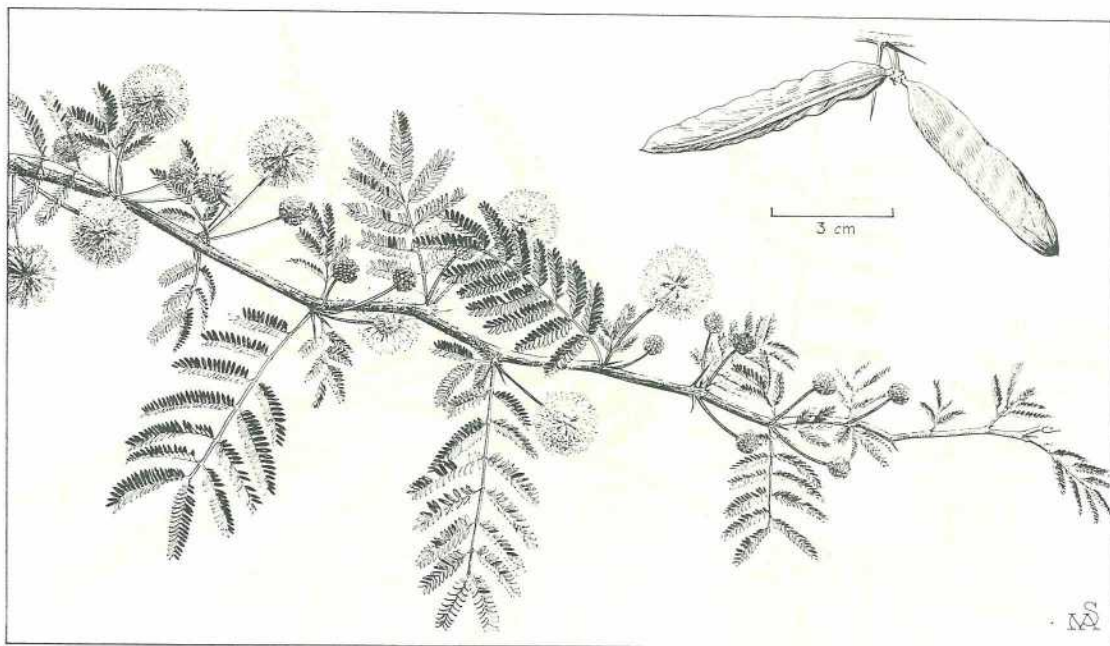
Mimosa bush (*Acacia farnesiana*)

This wattle was described from a plant in cultivation in Rome, in the gardens of Cardinal Farnese. It had been grown from seed sent from the Island of St. Domingo in tropical America.

DESCRIPTION. This is an intricately branched shrub or small tree that grows to 6 m high. The young stems are reddish and often are zig-zag. At each node there is a bipinnate leaf and a pair of stipular spines which are straight, slender and sharply-pointed. The spines are very variable in size and on old branches may be up to 2.5 cm long. The leaf rhachis is up to 9 cm long with as many as 7 pairs of pinnae, each consisting of up to 40 pairs of leaflets. These leaflets are bluish-grey or dark green in colour, linear-oblong, 0.3 cm long and 0.1 cm wide and have obtuse tips. There is a gland about the middle of the rhachis and sometimes another between the upper pair of pinnae.



Variations in gland position and structure—1. *Acacia farnesiana* 2a. *A. leuoclada* subsp. *argentifolia* 2b. enlargement 3a. *A. irrorata* 3b. enlargement 4. *A. glaucocarpa* 5a. *A. oshanesii* 5b. enlargement 6a. *A. loroloba* 6b. enlargement.



Acacia farnesiana

In the axils of the older leaves there are two or three peduncles 2 cm long, each with a globular head, 2.5 cm in diameter, of deep golden-yellow, very fragrant flowers. The pods are almost terete 5 to 7 cm long, 1 to 1.5 cm wide, and may be either straight or curved. When mature they are dark brown in colour, swollen, and filled with a pithy substance separating the seeds.

FLOWERING TIME. This wattle flowers from winter to midspring.

HABITAT. It is common on river flats, along creeks and anywhere there is soakage.

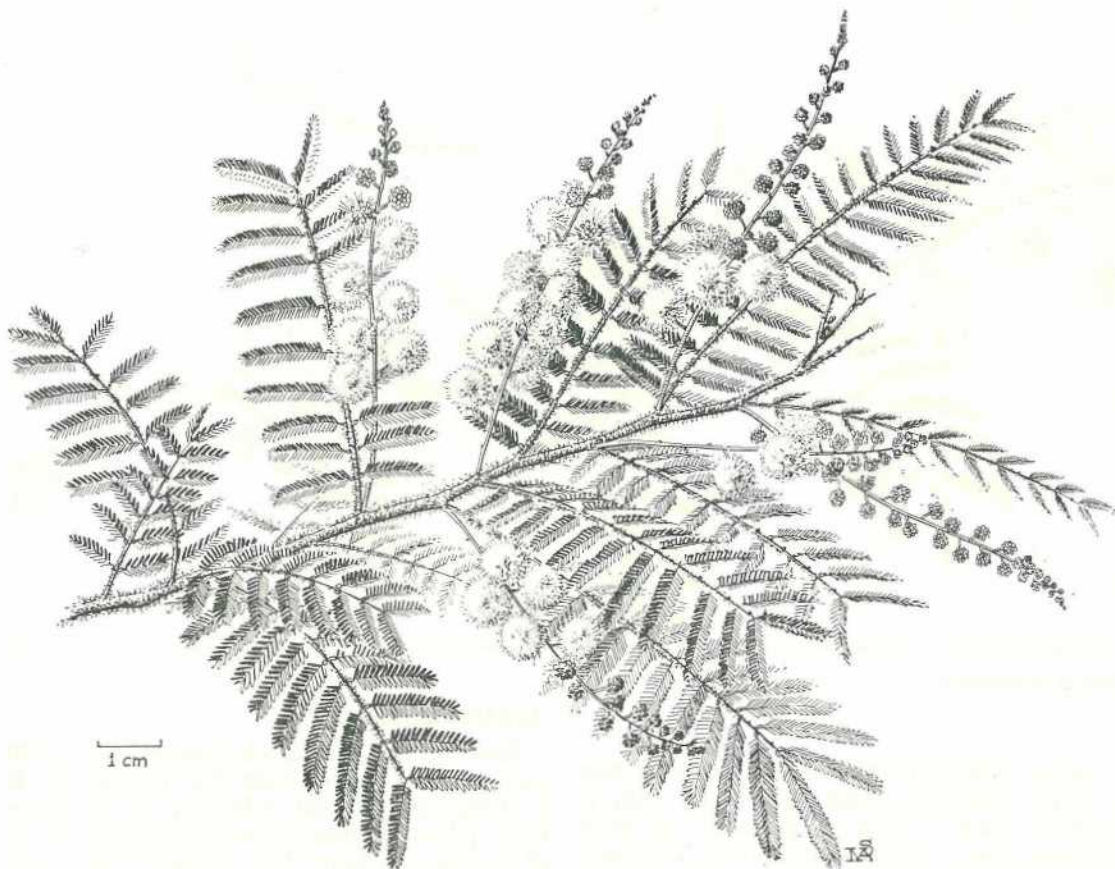
DISTRIBUTION. Mimosa bush is found in all Australian States except Tasmania. In South-east Queensland, it has been recorded from areas around Ipswich to the Great Dividing Range. It is widespread in other parts of Queensland.

GENERAL REMARKS. It is a useful, edible shrub as the pods are relished by sheep. The flowers are the source of an essential oil used in perfumery, and the plant is cultivated for the heavily-perfumed flowers.

Acacia oshanesii

Late in the nineteenth century this plant was collected in the Wide Bay district by Mr J. O'Shanesy and sent to Sydney for identification. It was originally thought to be a variety of *Acacia decurrens*, but was later considered distinct, and was named in honour of the collector. It is interesting to note that the same wattle was collected at a later date near the railway line between Maroochy and Eumundi. When 'The Queensland Flora' was published, F. M. Bailey described this wattle as *Acacia arundelliana* after E. H. Arundell who collected it. Apparently he was not aware it had already been named.

DESCRIPTION. It is a graceful shrub or small tree to 8 m high often with drooping branches. The young growth is covered by long, golden-brown, spreading hairs which give a bristly appearance to the stems. Older stems become glabrous. The leaves are up to 8 cm long and 4 cm broad. They consist of 9 to 16 pairs of pinnae, each with 25 to 40 pairs of linear leaflets, 0.2 to 0.5 cm long and no more than 0.1 cm wide. From one to five small glands with thick, raised rims are present on the rachis between the upper pinnae. The leaflets are markedly discolorous.



Acacia oshanesii

The flowers of this wattle are pale lemon-yellow and are very sweetly perfumed. The heads of flowers are 0.8 cm in diameter and are arranged in simple racemes 13 to 15 cm long. Its pod is flattened, about 13 cm long and 1.3 cm wide.

FLOWERING TIME. This wattle flowers spasmodically throughout the year, but the best flush of flowering occurs in midsummer.

HABITAT. Plants grow commonly in open eucalyptus forest and along creek banks where the drooping branches often hang over the water.

DISTRIBUTION. This species is restricted to the coastal lowlands from Coff's Harbour in northern New South Wales to the Burrum River in southern Queensland.

GENERAL REMARKS. This wattle has been in cultivation for about 70 years. It is grown principally for its perfumed flowers and its attractive foliage.

Green wattle (*Acacia irrorata*)

The latin word *irrorata* means 'dew-sprinkled' but it is sometimes erroneously used to mean freckled, mottled or minutely spotted. The reason it was chosen as the specific epithet for this wattle is obscure.

Green wattle is very similar in appearance to *A. oshanesii* but differs noticeably in having leaflets which are dark green on both surfaces.

On the young growth, the hairs are golden-brown but they are dense, short and appressed. The young shoots and leaves are usually

golden-yellow. A squat globular gland is found on the rachis between the upper pair of pinnae only, or between the upper two or three pairs.

Pale creamy-yellow flowers are in globular heads 0.8 cm in diameter. These flowers are pleasantly perfumed but the fragrance is much fainter than in those of *A. oshanesii*.

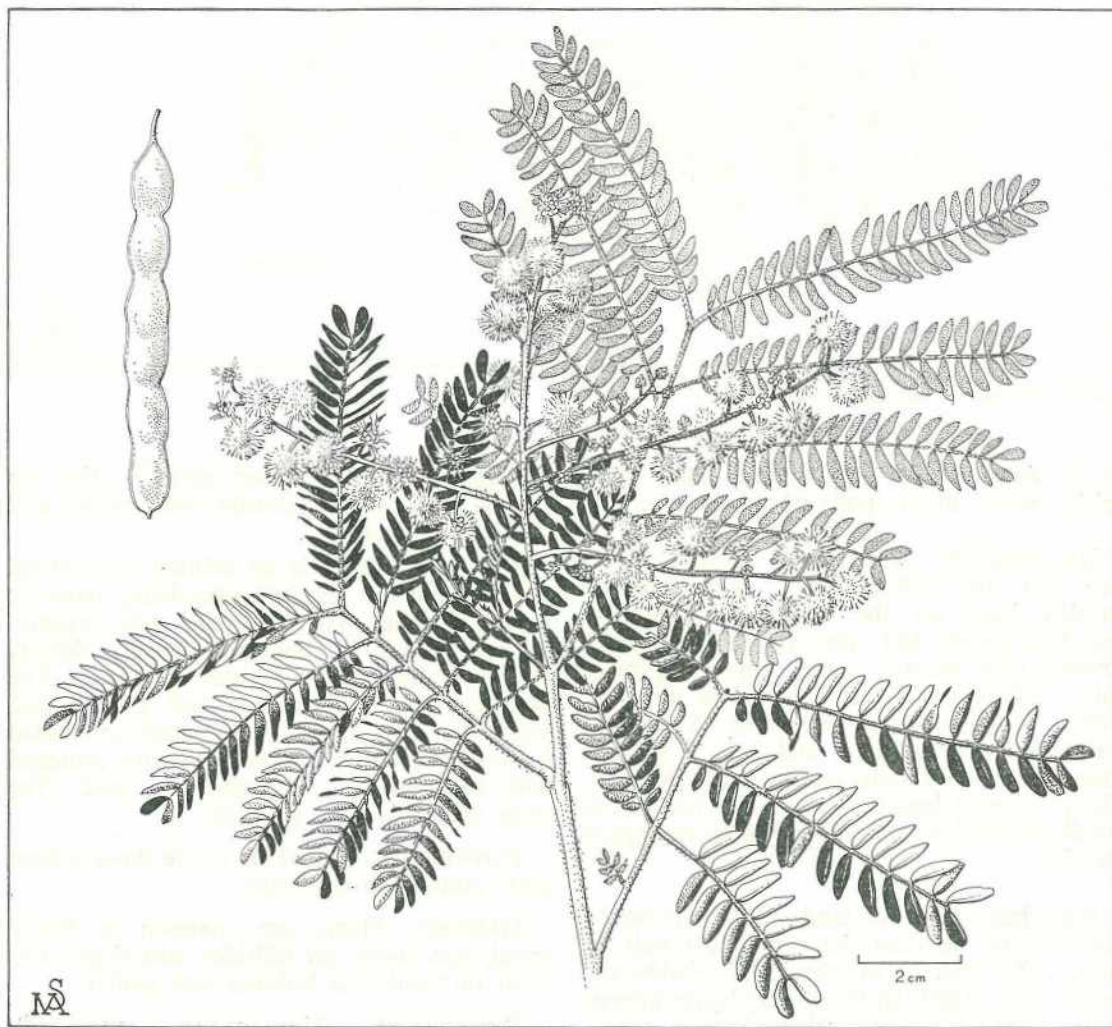
FLOWERING TIME. Plants may be found in flower from midspring to midsummer.

HABITAT. Green wattle grows in eucalyptus forest and is common near watercourses and on creek banks.

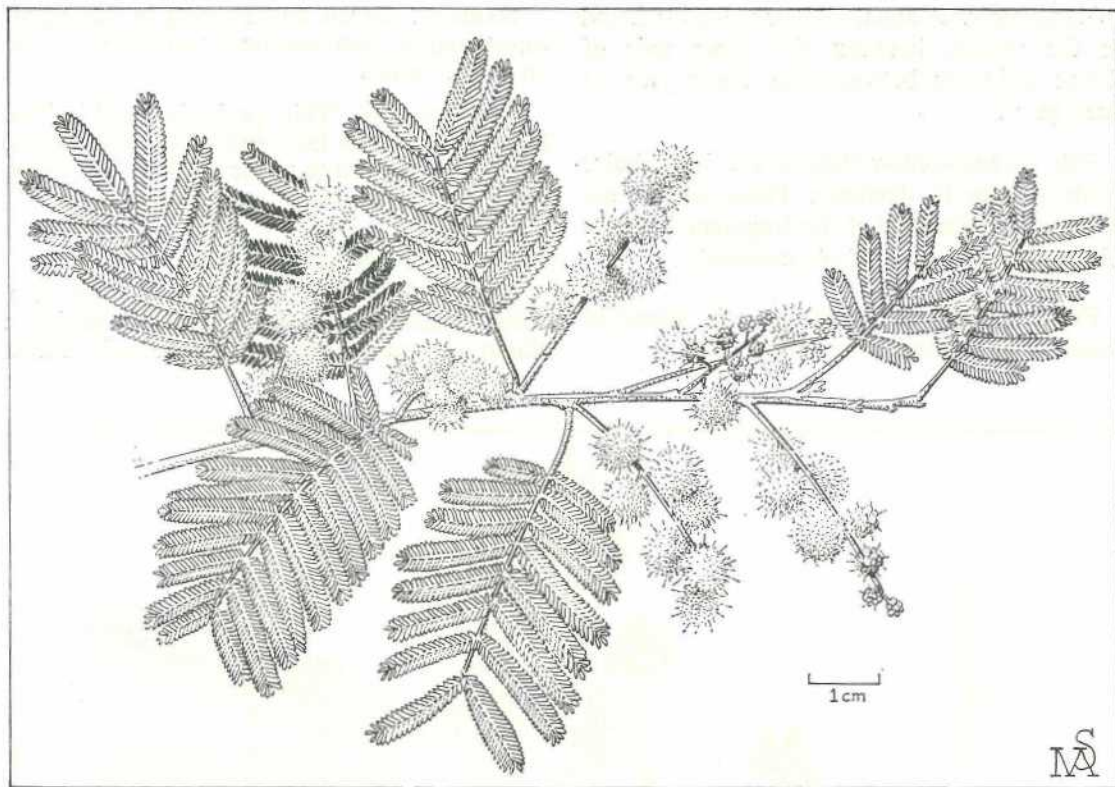
DISTRIBUTION. This species is found in New South Wales to as far south as the south coast and in Queensland to as far north as Kalpowar, north-east of Monto.

Acacia glaucocarpa

The specific epithet is a combination of a Latin adjective *glaucus* which means having a bloom (as on the leaf of a cabbage), and a



Acacia glaucocarpa



Acacia leucoclada subsp. *argentifolia*

Greek noun *karpos* meaning a fruit. The epithet refers to the pods of this wattle.

DESCRIPTION. This is a slender, erect tree up to 7.5 m high, with smooth mottled bark on the trunk. The leaflets are blue-green and the young growth is covered with minute, dense, appressed, rusty hairs. There are 3 to 7 or more pairs of pinnae. Each of these has up to 25 pairs of leaflets up to 1 cm long and 0.2 to 0.3 cm wide, which are oblong and end in a blunt tip. The prominent longitudinal vein is not in the middle of the leaflet but is closer to the upper margin.

Sometimes only two glands are present on the rhachis, one between the uppermost pair of pinnae, the other on the rhachis just below the lowest pair. Although the mature leaves appear to be glabrous, magnification shows a sparse covering of loosely-appressed, white hairs,

particularly on the lower surface. On the rhachis, the hairs are shorter, more dense, and darker in colour.

The inflorescence is an axillary or terminal raceme with the terminal ones being more or less paniculate. The heads are pale creamy-yellow, 0.8 cm in diameter, and the flowers have a fairly strong 'wattle' perfume. The pods are 1 to 13 cm long and 1 cm broad, straight or curved and prominently contracted between the seeds. These seeds are arranged with their longest axis along the pod. The pods are noticeably glaucous.

FLOWERING TIME. This wattle flowers from early autumn to midwinter.

HABITAT. Plants are common in mixed eucalyptus forest on hillsides and ridges and grow on sandstone hillsides and gullies.

DISTRIBUTION. This species is apparently confined to Queensland and is found as far

north as Bogantungan, west of Emerald, and as far west as the Carnarvon Gorge National Park.

Acacia leucoclada subsp. *argentifolia*

Two Greek words *leukos* meaning white and *klados* meaning a branch are combined to form the specific epithet for this wattle. It refers to the appearance of the young branches. The name for the subspecies means 'silvery leaf' and refers to the colour of the young growth at the tips of the branches.

DESCRIPTION. This wattle occurs as a tree up to 18 m in height with a habit of growth resembling that of a young silky oak, the branches spreading from an erect trunk. The bark is dark and corrugated. The twigs have a dense covering of short, white hairs.

Its leaves have 6 to 16 pairs of pinnae, each with up to 36 pairs of linear leaflets, about 0.3 cm long and 0.1 cm wide. These leaflets are blue-green in colour and, with magnification, short, white hairs can be seen on the lower surface and on the margins. The glands on the rachis are not evident to the naked eye but magnification shows small, inconspicuous glands at the base of each pair of pinnae and additional glands between the pairs. Young growing tips are silvery or whitish.

The heads of flowers are 0.7 cm in diameter and are arranged in axillary racemes up to 7 cm long containing up to 25 heads. The flowers are bright sulphur-yellow and all parts are brightly coloured. The styles are longer than the stamens and emerge from the mature buds before the flowers open fully. This gives the heads a spiky appearance. The flowers have a faint, sweet perfume. This wattle produces root suckers. The pod is 3 to 11 cm long and 0.5 to 1.2 cm wide and is often slightly contracted between the seeds which are longitudinal in the pod.

FLOWERING TIME. This wattle flowers from midwinter to early spring.

HABITAT. It is common in dry sclerophyll forest, mainly in cleared country and is also common along creek banks.

DISTRIBUTION. The species is found on the north coast of New South Wales and in Queensland to as far north at Kingaroy. On the Darling Downs, it grows in the Warwick to Stanthorpe area. It is not a common plant in South-eastern Queensland.

Acacia loroloba

Two Greek words, *loron* meaning a strap or thong and *lobos* which can mean a capsule or pod, are combined to form the specific epithet for this wattle which has strap-like pods.

DESCRIPTION. This wattle is a shrub or small tree up to 9 m high with the tips of the branches being pale yellow or golden. The leaves have a sparse covering of minute, appressed grey or tawny hairs, and are up to 12 cm long. They have up to 18 pairs of pinnae with 1 to 30 pairs of linear leaflets 0.2 cm long and less than 0.1 cm wide which are the same colour on both surfaces.

The most obvious characteristic of the leaf is the numerous prominent glands present on the rachis. They vary in size and in number between the pairs of pinnae, and adjoining glands are often touching.

The flowers are pale creamy-yellow and have very little perfume. The heads are borne in axillary racemes or panicles. This wattle's strap-like pods are leathery, up to 14 cm long and 0.9 cm wide. In most cases, the sides are straight. Occasionally, there are a few constrictions between the seeds.

FLOWERING TIME. It flowers from summer to early autumn but in some years trees bloom again from the middle of winter to the beginning of spring.

HABITAT. Plants grow in woodland or dry sclerophyll forest in a variety of soils and on alluvial flats.

DISTRIBUTION. The species is found only in Queensland to as far north as Tingoora (between Kingaroy and Murgon) and as far west on the Darling Downs as Jandowae. In South-eastern Queensland, it has been found only south of Helidon in the area between Ma Ma Creek and Stockyard Creek.

FIELD KEY TO THE BIPINNATE-LEAVED WATTLES IN SOUTH-EASTERN QUEENSLAND

1. Stipular spines present. Peduncles 2 or 3 together in the axils of older leaves
Acacia farnesiana
Stipular spines absent. Heads in axillary racemes, or in terminal or axillary panicles 2
 2. Leaflets oblong, 1 cm long, 0.2 to 0.3 cm wide, blue-green. Young growth rusty. Rhachis with two glands, one between uppermost pair of pinnae, one below lowest pair. Flowers pale creamy-yellow.....*Acacia glaucocarpa*
Leaflets linear..... 3
 3. Leaves blue-green, young growth silvery; glands inconspicuous. Flowers sulphur-yellow
Acacia leuoclada subsp. *argentiifolia*
Leaves dark green, young growth not silvery; glands conspicuous..... 4
 4. Glands on rhachis numerous and differing in size. Leaflets 0.2 cm long, less than 0.1 cm wide, some colour on both surfaces. Flower pale canary-yellow.....*Acacia loroloba*
One to five glands with thick, raised rims on upper part of rhachis..... 5
 5. Leaflets markedly discolorous. Young growth bristly with long, spreading golden-brown hairs. One to five glands present on rhachis. Flowers pale lemon-yellow *Acacia oshanesii*
Leaflets dark green on both surfaces. Young growth with appressed, short, golden-brown hairs. One to three glands present on rhachis. Flower pale creamy-yellow *Acacia irrorata*
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New handbook of plant diseases

THE Minister for Primary Industries, Mr V. B. Sullivan, announced that a new two-volume handbook of plant diseases would be released by his Department in late May.

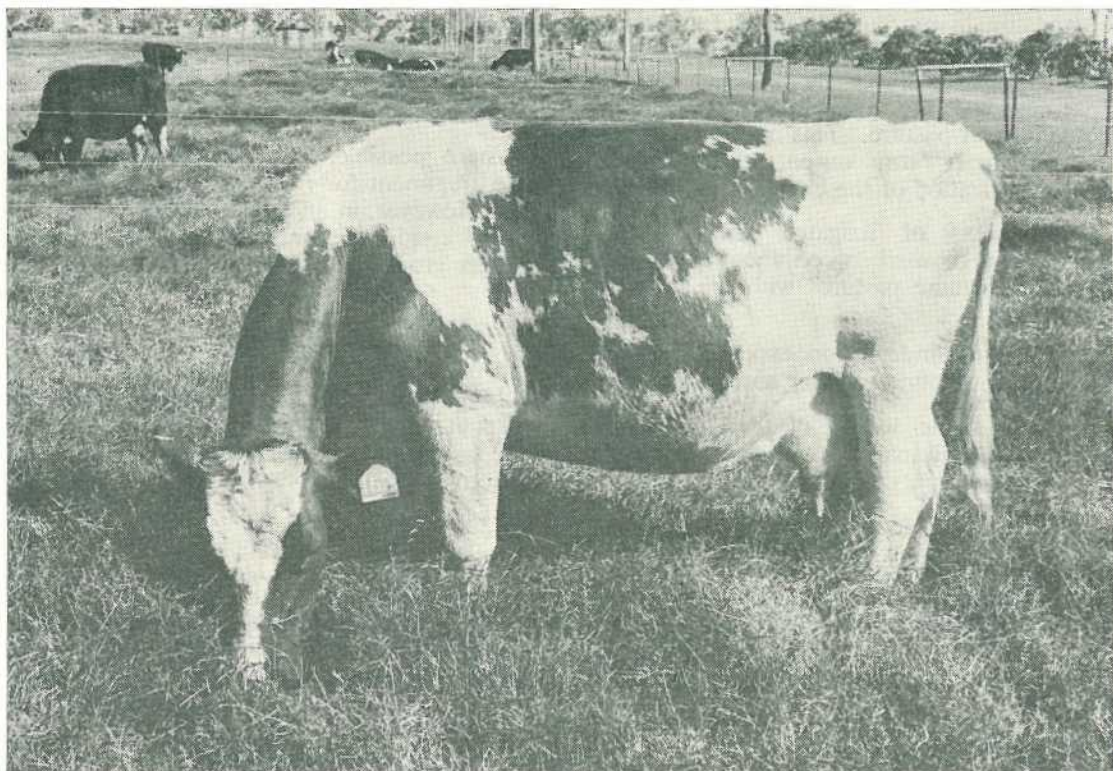
The handbook has been designed for use by farmers, and others, to identify plant diseases as the first essential step in controlling disease and growing healthy crop plants.

The first volume deals with 363 diseases of fruit and vegetables and the second with 199 diseases of field crops, such as potatoes, onions and pumpkins.

The handbook had been compiled by Mr Noel Vock, and other officers of the Plant Pathology Branch, and each volume contained large numbers of colour photographs showing disease symptoms.

The current recommendations for disease control are set out in a section at the back of each volume. Annual revisions of these recommendations will be available from Departmental offices.

Mr Sullivan said the handbook would be available from the Department of Primary Industries, G.P.O. Box 46, Brisbane, at a cost of \$10 per volume. Mail orders from within Queensland should include \$2 extra for postage and handling. Additional postage would be required for orders from inter-State or overseas.



Potential of irrigated tropical pastures for the dairy industry

by D. V. Kerr, Dairy Cattle Husbandry Branch.

PASTURE is the cheapest source of feed for milk production. Farmers should aim to achieve efficient use of this cheap feed.

Irrigated, nitrogen-fertilized tropical grass pastures are capable of exceptionally high levels of pasture production. What place does such a pasture have on Queensland dairy farms?

Dryland grass-legume pastures are the most common source of pasture feed for milk production on Queensland dairy farms. This is

not surprising since such pastures have lower input requirements than grass-nitrogen pastures. As a result, production per litre is cheaper from legume pastures. However, efficient utilization of dryland grass legume pasture and consequently high production per unit area is difficult to achieve because:

- Tropical legumes will not stand heavy stocking. Year-round stocking rates above 1.6 cows per hectare will result in loss of legumes from the pasture.
- Dry matter production from dryland pastures is markedly seasonal. Herd size is generally limited to the number of animals these pastures can maintain during the leanest part of the year (that is, late winter and spring). During summer, gross under-utilization of pasture is common.

To maintain profitability, total farm output must be increased each year. Irrigated, fertilized tropical pastures have better carrying capacities and are able to reduce seasonal fluctuations in pasture. This allows farmers to increase total farm output through more efficient utilization of the cheapest feed source.

Small areas of irrigated grass nitrogen pastures can be used in conjunction with dryland grass legume pastures with the following advantages:

- Reduced dependence on expensive concentrate feeding during winter and spring.
- A more stable supply of feed throughout the year. This can be especially important to farmers supplying market milk.
- Increased total farm output.

Trials in tropical North Queensland have been designed to look at the production potential of irrigated grass nitrogen pastures. A 3 year grazing trial at Ayr Research Station which is in a frost free area is discussed below.

Pasture management

In the trial, cows grazed pangola grass fertilized with 672 kg of nitrogen per hectare per year. Nitrogen was applied as 168 kg urea per hectare every 6 weeks. In addition, an annual application of 500 kg per ha superphosphate and 125 kg per ha muriate of potash was applied in August. Irrigation was applied every 2 to 3 weeks as necessary.

Animal management

Friesian cows grazed the pasture in a two paddock rotational system, each paddock being

grazed for 3 weeks and rested for 3 weeks. Two stocking rates were used, a low rate of 5.9 cows per ha and a high rate of 7.9 cows per ha.

Where possible, animals remained on the same treatment for the 3 year duration of the trial. However, in an attempt to simulate commercial conditions, one-quarter of the animals in each group were replaced by heifers each year.

A supplement of 3.6 kg of molasses per head per day was fed to half the cows at each stocking rate. Urea and mono-ammonium phosphate (M.A.P.) were added at the rate of 2 kg and 1 kg per 100 kg of molasses respectively.

Milk production

High levels of production per unit area were achieved (see table 1). Supplemented cows produced in excess of 21 500 litres of milk per ha per year. For unsupplemented cows production was lower, but always above 14 000 litres of milk per ha per year.

With molasses supplementation, cows produced 0.7 litres of milk for each kilogram of molasses fed. At 6 cents per litre for milk (manufacturing price) molasses can be fed profitably up to a landed cost of \$40.00 per tonne. At 9 cents per litre for milk, molasses is still profitable at \$60.00 per tonne.

Cows at the lower stocking rate produced more milk per lactation but generally less milk per hectare than the higher stocked animals (see table 1). These results have indicated

TABLE 1
PRODUCTION OF MILK AND FAT PER HECTARE AND PER COW OVER 2 YEARS

Treatment	Production per Hectare		Production per Cow	
	Milk* (litres)	Butterfat (kg)	Milk* (litres)	Butterfat (kg)
Low stocking rate plus molasses	22 067	731	3 740	124
Low stocking rate no molasses	15 808	580	2 679	98
High stocking rate plus molasses	25 163	828	3 185	105
High stocking rate no molasses	19 851	661	2 513	84

*Production based on 300 day lactations.

that under commercial conditions such pasture would be best stocked at between 6.0 to 6.5 cows per ha.

Milk composition

Trial cows produced milk which was above standard for butterfat but below standard for S.N.F. Low S.N.F. values of milk produced from tropical pasture are common. They result from the relatively low energy concentration of tropical pasture species and from the effect hot summer conditions have on reducing milk protein percentages. In the commercial situation, above standard S.N.F. percentages can usually be achieved by:

- Including a percentage of Jerseys or Guernseys in the herd.
- Judicious use of energy supplements such as molasses or grain. Molasses feeding in this trial increased S.N.F. percentages from 8.2% to 8.3% but reduced butterfat percentages from 3.6% to 3.3%.
- Keeping heat stress to a minimum in summer by providing adequate shade.

Conclusion

The dairy industry over recent years has contracted and will continue to contract to areas of reliable, extended rainfall or with irrigation potential. The main reasons for this have been the need to increase total farm output to maintain profitability and, in market milk areas, the importance of maintaining an even supply.

Grass legume pastures will undoubtedly continue to play a major role in the production of milk on Queensland dairy farms. But small areas of grass nitrogen pastures in areas of reliable rainfall or irrigation potential will provide a means of increasing stocking rates, and hence farm output, and evening out feed supply.

In recent years, many Queensland farmers with irrigation potential have substantially improved winter spring production by growing annual ryegrass and clover pastures. The next article in this series will look at such pasture systems in detail, discussing establishment, production potential and economics.

New white-skinned cucumber

A new, white-skinned cucumber variety has been released by the Department of Primary Industries. It has been named Redlands Long White.

The new variety will give Queenslanders a high-quality, long-white cucumber with better disease resistance than other varieties available.

It has performed and yielded well in trials and has market appeal. The testing was done with the co-operation of producer organizations and D.P.I. staff.

The new variety was bred at the D.P.I. Redlands Horticultural Research Station.

Its parents were the popular Crystal Apple and Green Gem varieties.

The fruit possessed the clean, white colour of its 'Crystal' parent, was circular in cross-section and had blunt ends. It was elongate in shape like its Green Gem parent but slightly shorter. It had a similar proportion of flesh to seed as Green Gem.

The spine colour was white and there was no premature fruit yellowing.

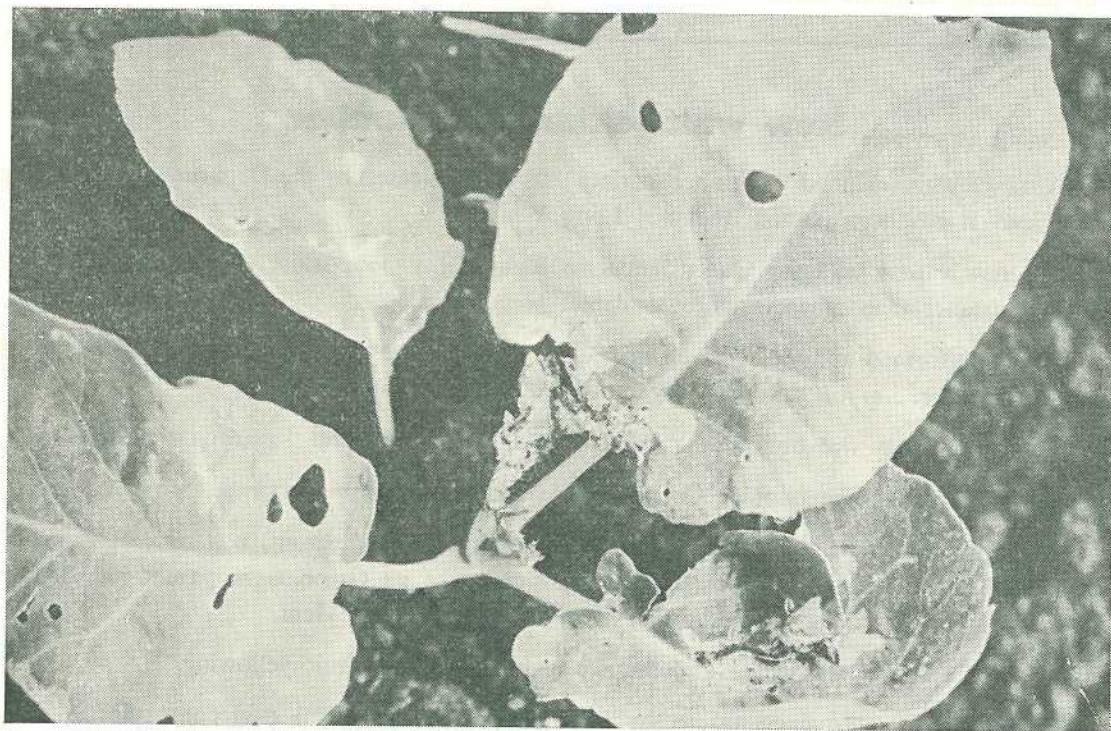
Seed supplies were expected to be available from commercial seed companies in early spring.

Control of cabbage pests

by J. D. Brown and J. R. Hargreaves,
Entomology Branch.

THE control of insect pests is a major factor in the production of quality cabbages and related crops throughout Queensland.

Good control is possible with insecticides provided appropriate chemicals are selected and applied carefully at the right time.



The growing point of a cabbage damaged by a cabbage centre grub.

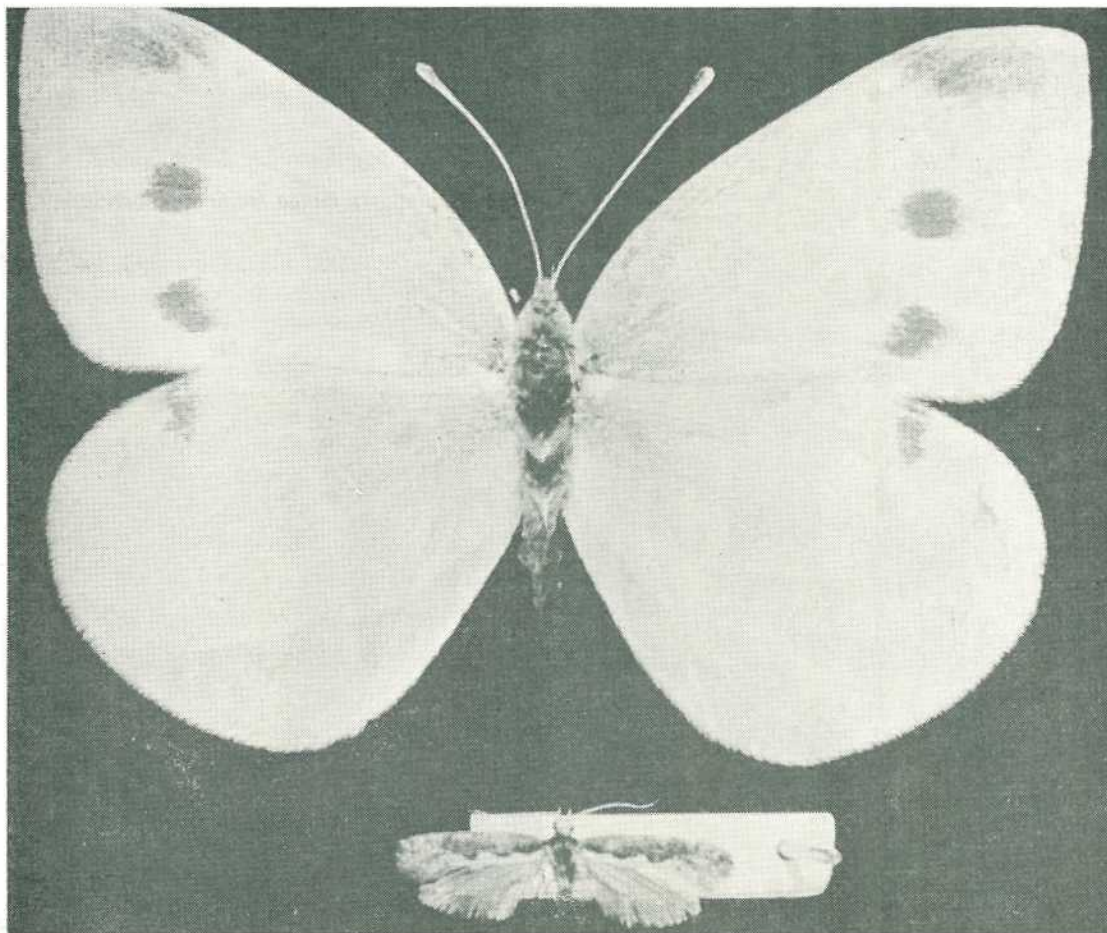
It is vital that the grower be able to recognize the individual pests involved if he is to obtain good control.

Status of pests

The cabbage moth and the cabbage white butterfly are the most important pests encountered although the corn earworm and cabbage centre grub may be almost as damaging to cabbages during summer in southern Queensland. Other species of occasional importance include the cabbage cluster caterpillar, cutworms and aphids. Centre grubs

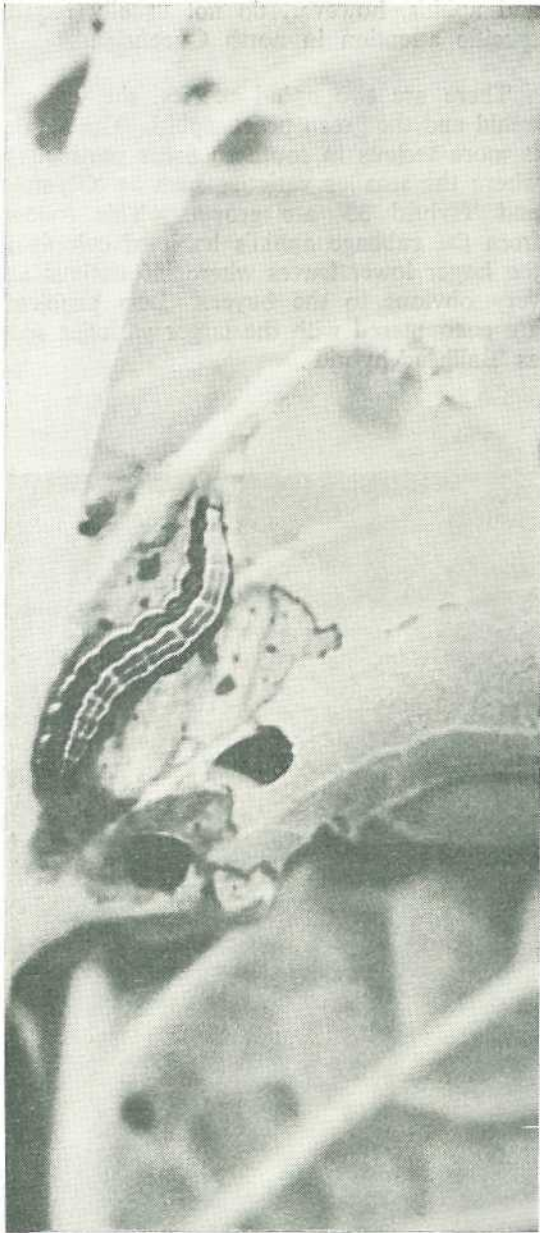
and aphids, however, do not usually require specific attention in north Queensland.

There are two aphid species, the cabbage aphid and the green peach aphid. The former is more serious in southern areas particularly where the smaller varieties such as 'Olympic' and 'Hybrid 33' are grown. This follows from the cabbage aphid's habit of colonizing the larger lower leaves where infestations are very obvious to the buyer. Less problems are encountered with the larger varieties such as 'Ballhead hybrid'.

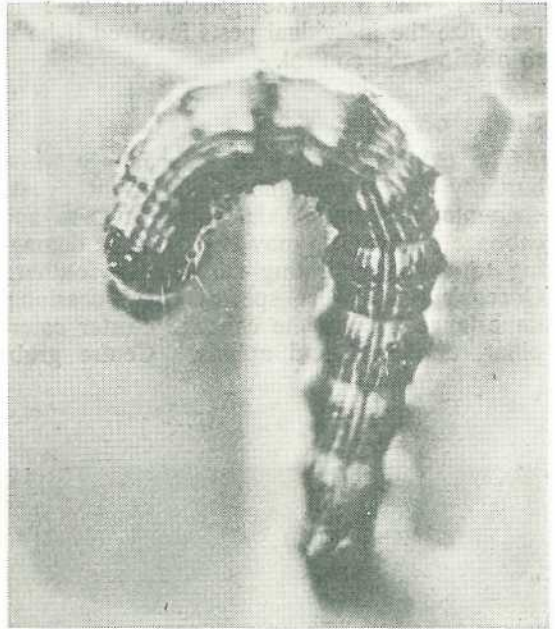


Upper. The cabbage white butterfly adult.

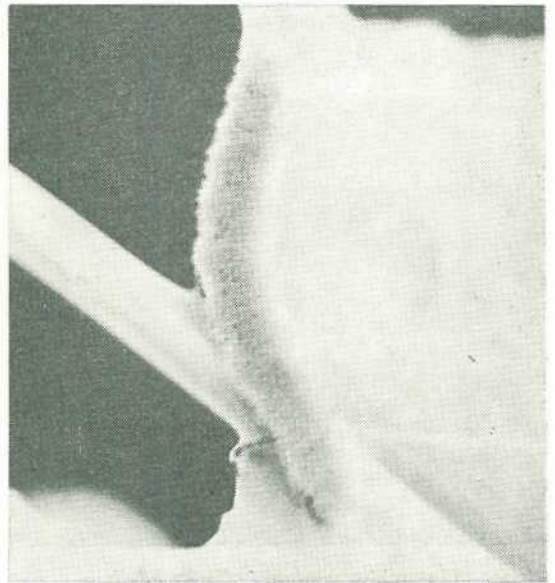
Lower. The adult cabbage moth.



Cabbage cluster caterpillar larvae feeding on a cabbage leaf.



Heliothis armigera larvae feeding on cabbage.



Cabbage white butterfly larvae.

Information on life history, appearance and damage caused by the major pest species is given in table 1.

Controls

Although the insect pests of cabbages are subject to some degree of natural control (from parasites, predators, insect diseases and environmental factors) it is usually necessary to use an insecticide to further suppress the pest population. Just enough insecticide to produce quality vegetables should be used. Too much insecticide may reduce the numbers (and effectiveness) of predacious ladybirds, lace-wing larvae and parasitic wasps.

Early removal or disposal of crop residues left in the field from crucifers (cauliflowers, cabbage, broccoli, khol-rabi, Brussels sprouts, turnips, water cress and rape) will minimize the breeding of pest populations which could invade later-planted crops. Similarly, many of the pests of cabbages breed on weeds such as wild turnip, mustards and cresses.

Weed control in areas adjacent to crops and clean cultivation of fallows prior to planting minimize the intensity of infestations. Rapid preparation of land followed immediately by planting invites insect problems, particularly cutworm, since the moths are attracted to weeds on which they lay their eggs.

Chemicals

In high value crops such as cabbages where pest infestations are regularly encountered, many growers apply insecticides regularly on a weekly basis. Although such a system gives good results, savings can be made by using insecticides according to infestation. Careful inspections will indicate the first signs of damage and less rigorous schedules may be employed as a result. This procedure is recommended particularly during the cooler

periods of the year when pest intensity is less severe than during the heat of summer.

Until recently, the insecticides diazinon and methomyl were recommended for the control of the pest complex attacking cabbages. Over recent seasons, however, diazinon has become quite ineffective for cabbage moth control and as methomyl is not considered satisfactory against this pest, the mixture is no longer recommended.

Trials carried out in both southern and northern Queensland have indicated that a number of products are effective and may be recommended for use. These include acephate, fenvalerate, methamidophos, methomyl and permethrin. Of these, acephate and methamidophos will give good overall control of the pest complex. Fenvalerate and permethrin are somewhat less effective against aphids but will suppress populations to non-economic levels in most situations.

Where specific attention is necessary for aphid control and fenvalerate or permethrin is the insecticide of choice, consideration might be given to the use of acephate, methomyl or methamidophos as alternatives in the particular situations. Methomyl is not recommended if cabbage moth constitutes a problem.

As the cabbage plant is difficult to wet, it is advisable to add a specific wetting agent such as 'Agral', according to label directions in the application of insecticides to cabbages.

Trade names and rates of application

The insecticides mentioned in the text are presently sold under the following trade names: acephate—'Orthene'; methamidophos—'Nitofol' and 'Monitor'; methomyl—'Lannate'; permethrin—'Ambush' and fenvalerate—'Somicidin'. Each should be used strictly in accord with label directions.

TABLE 1
CABBAGE PESTS
LIFE HISTORY, SPECIES RECOGNITION AND IDENTIFICATION OF DAMAGE

Pest	Adult	Egg	Larva and Damage	Pupa
Cabbage moth <i>Plutella xylostella</i> (L.)	The adults are small moths approximately 1 cm in length and a dark grey colour. At rest, the insect's wings are folded over the body and a pale greyish band is visible along the back of the moth. The antennae are held forward in line with the body when the moth is at rest.	The very small, cigar-shaped eggs are cream-coloured and are laid singly or in small groups. They are usually found on the under surface on the leaves along the midribs.	The young larvae are small and colourless. They feed initially by mining and later by chewing on the surface of lower leaves. When fully grown, they measure 1 cm in length and are greenish-coloured with a waxy appearance. Larval body segments are well defined and the body tapers towards each end with the last pair of pseudo (false) legs very noticeable at the rear. Larvae are very active and hang from the plants on silk threads when disturbed. Older larvae eat small holes right through the leaves.	The pupae, found on the plant in open net-structured cocoons, are green in colour but change to brown as the moth develops.
Cabbage white butterfly <i>Pieris rapae</i> (L.)	These slim butterflies have a wing span of 3 to 5 cm. Their wings are mainly white with darker areas near the tip of the forewings.	Eggs of this pest are pale yellow and are laid singly usually on the upper surface of the leaves. They are elliptically shaped and stand on end with longitudinal ribs running down the sides.	Both the young and older larvae are green with a velvet texture. They have stout, parallel-sided bodies and the segments are not obvious. Fully grown larvae are approximately 2 cm long. Both the small and large larvae chew holes through the leaves. These holes are generally larger than those caused by cabbage moth larvae.	Pupae are pale greenish-coloured and are found on the under surface of the leaves. They are attached to the leaf at the tail and on each side by silk threads. Their shape is angular with a few small horns.
Cabbage centre grub <i>Hellula hydralis</i> Guenee	Adult moths have a wing span of approximately 1 cm, the forewings being grey with distinctive buff markings.	The small, oval eggs are laid on the younger parts of the plant. Webbing is associated with the eggs.	Larvae are pale yellow with several brownish stripes along the body, and when fully grown are approximately 1 cm in length. They tunnel in the growing point and developing leaves. In transplants they fold leaf lamina together, and both silk and frass (droppings) are present.	Pupae are found in tunnels in the leaf tissue made by the feeding larvae.

TABLE 1—continued
Cabbage Pests—continued

Life History, Species Recognition and Identification of Damage—continued

Pest	Adult	Egg	Larva and Damage	Pupa
<p>Corn ear worm <i>Heliothis armigera</i> (Hübner)</p>	<p>Adults are stout-bodied moths with a wing span of approximately 3 cm. The fore-wings are reddish to creamy-yellow or brownish in colour. The hind wing is creamy with a large smokey area near the posterior margin.</p>	<p>Eggs are pearly white, bun-shaped with vertical ribs and are about half the size of a pin head. They are laid singly.</p>	<p>Larvae can vary in colour from dark brown to a pale green. When fully grown, they are approximately 3 cm in length and carry longitudinal stripes along their bodies. Larval feeding causes damage similar to that caused by the cluster grub. After early development, larvae tend to feed directly into the heart.</p>	<p>Pupae are brown in colour, and are found in the top 5 cm of soil.</p>
<p>Cabbage cluster caterpillar <i>Crociodolomia binotalis</i> Zeller</p>	<p>Adults are light brown moths with a wing span of approximately 2 cm.</p>	<p>Eggs are laid on the leaves in a cluster. The egg mass has a brown, furry appearance.</p>	<p>Larvae are cream in colour and measure approximately 2 cm in length when fully grown. Young larvae often cluster near the egg mass and chew on the top leaf surfaces. Older larvae destroy the young leaves and the growing point and are usually found in a mass of silk and frass.</p>	<p>Pupae are found in earthen cells in the ground.</p>
<p>Cutworms <i>Agrotis</i> sp.</p>	<p>Moths are stout-bodied with a wing span of 3 to 4 cm, the forewings being predominately brown, broken by conspicuous darker areas. The hind wings are greyish-white with brown margins.</p>	<p>Eggs are small, round and pearly white. They are laid on moist soil under low-growing plants.</p>	<p>Larvae are soft-bodied, approximately 3 cm in length when fully grown and vary in colour from a greyish-green to greyish-brown, often being similar in colour to the soil in which they are found. They feed mainly at night chewing on seedling stems at ground level. During daylight they tend to shelter or burrow into the soil.</p>	<p>Pupae are shiny brown and are found in earthen cells.</p>
<p>Cabbage aphid <i>Brevicoryne brassicae</i> (L.)</p>	<p>Both winged and wingless adults occur. The latter, small greyish-blue insects, are the more prevalent. The pests occur as clusters or colonies of immature and adult insects, most commonly on the upper surfaces of the leaves. Colonies are characterized by the presence of a grey, mealy covering on the older insects.</p>	<p>Eggs are usually not laid. In most generations, aphids multiply by the production of living young (called nymphs).</p>	<p>Aphids do not have a larval stage. Both adults and nymphs feed by puncturing the leaves and extracting plant sap. Nymphs resemble the adults but are initially green, changing gradually to the adult colouration with development.</p>	<p>Aphids do not have a pupal stage.</p>

TABLE 1—continued
Cabbage Pests—continued
Life History, Species Recognition and Identification of Damage—continued

Pest	Adult	Egg	Larva and Damage	Pupa
Green peach aphid <i>Myzus persicae</i> (Sulzer)	These pests have the same form as the cabbage aphid but their colour is greenish-yellow. They occur in clusters on the lower sides of the leaves. Colonies are usually first found on horizontal leaves with infestation of the vertical leaves occurring later.	Eggs are usually not laid. In most generations, aphids multiply by the production of living young (called nymphs).	Aphids do not have a larval stage. Both adults and nymphs feed by puncturing the leaves and extracting plant sap. Nymphs resemble the adults but are initially green, changing gradually to the adult colouration with development.	Aphids do not have a pupal stage.

New wheat variety released

THE Minister for Primary Industries, Mr V. B. Sullivan, has announced the breeding and release for commercial production of a new wheat variety, Banks.

He said the variety has shown valuable adult plant resistance to stem and leaf rusts, combined with high yield potential and excellent hard grain quality.

It should contribute significantly to wheat production in Australia.

The new variety was developed at the Department's Queensland Wheat Research Institute at Toowoomba, on the Darling Downs, by a team led by Dr J. R. Syme.

Banks is a quick-maturing spring wheat which flowers later than Gatcher, but earlier than Cook.

In Departmental trials during 1977 and 1978, Banks yielded exceptionally well, particularly under drier conditions.

In 38 trials, it was significantly better than Gatcher in 24, better than Timgalen in 27 and never was significantly inferior to either.

The mean yield advantage average ranged from 11% to 27%.

Grain quality had been studied in detail over 34 trials in 2 years and Banks had shown consistently it had excellent milling and baking quality and high test weight.

Its quality characteristics certainly should be acceptable in several wheat production areas in Australia.

The new variety was a derivative of species from Mexican introductions.

A.I. training for farmer-inseminators

DURING the last 4 years Artificial Insemination (A.I.) training methods in Queensland have undergone radical changes in response to advances in the A.I. industry.

Do-it-yourself inseminators

There is a world-wide trend especially in the more developed countries towards do-it-yourself (d.i.y.). A.I. and Queensland has been one of the first to make significant moves in this direction. This trend has been prompted chiefly by economic reasons.

D.i.y. A.I. has increased markedly in those areas where rising costs have prevented A.I. co-operatives and commercial inseminators from offering a commercial field service at a price at which cattle breeders can afford, especially in the more scattered dairy areas. In the past, beef cattle breeders wishing to take advantage of the benefits of A.I. have had to rely almost solely on d.i.y. A.I. as there have been very few commercial field services in beef cattle areas.

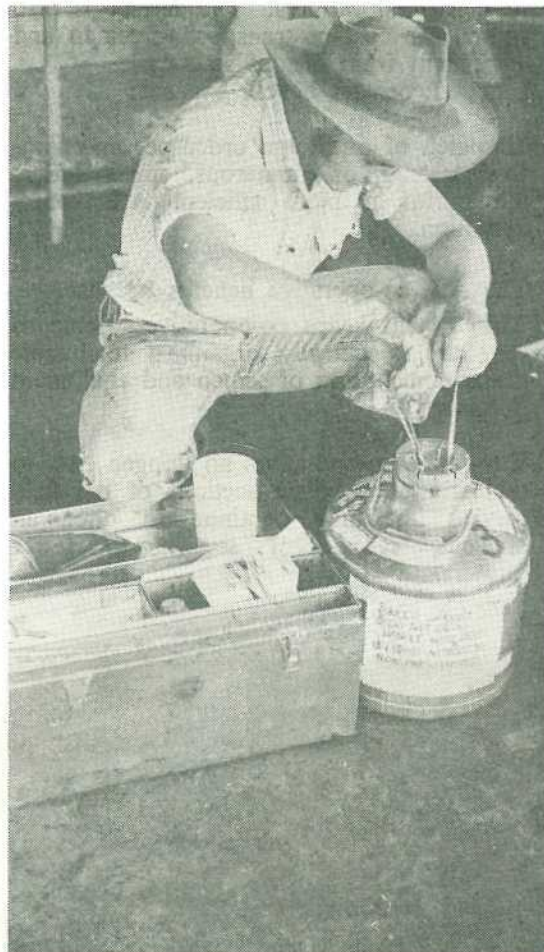
Changing role of A.I. co-operatives

Most A.I. co-operatives have had to limit the extent of their commercial field service and some have turned to merchandizing semen and A.I. equipment on behalf of d.i.y. inseminators in their area in order to cover their withdrawal from the field service.

The Tablelands A.B. Co-operative at Malanda in North Queensland maintains a limited field service and purchases semen and A.I. equipment on behalf of over 100 d.i.y. inseminators.

This arrangement benefits the farmers, the A.I. centres and the A.I. co-operatives.

by D. L. Boothby and W. Hornbuckle,
Dairy Cattle Husbandry Branch.



Correct semen handling techniques are essential for optimum conception rates. A large amount of time on every course is devoted to teaching the correct methods.

The farmers benefit because of:

- **CONVENIENCE OF LOCAL DISTRIBUTION.** The farmer is not faced with the problem of obtaining semen and equipment from a distant source. Urgently needed equipment is usually only a local phone call away. This means that herd improvement through A.I. is more readily available to producers in remote areas.
- **COST SAVINGS.** The A.I. co-operative, with bulk buying, purchases semen and equipment at prices cheaper than those available

to individual farmers. The farmer is also spared the cost of transporting semen and equipment from distant sources.

The A.I. centres benefit because:

- Despatch of one large order per co-operative instead of numerous small orders allows for a more efficient A.I. centre operation.

The A.I. co-operative benefits because:

- This system keeps co-operatives viable as they are specifically organized to handle the administration of semen and equipment purchases.
- The A.I. co-operative no longer has to maintain uneconomic sections of the field service but may continue to offer an efficient, economical service to fewer farmers.

The advantages and disadvantages

A possible disadvantage faced by d.i.y. inseminators is that sometimes they are unable to get sufficient experience to maintain efficiency due to the limited number of cows inseminated each season. However, this is not a serious disadvantage as the standard of training of most d.i.y. inseminators is sufficiently high to overcome lack of experience. The advantages of d.i.y. A.I. far outweigh this minor disadvantage.

Mr Max Ison from the Atherton Tablelands is typical of most d.i.y. inseminators when he admitted that he was worried about lack of experience as he commenced his first insemination programme—'It was a matter of confidence. I had no bulls and just had to get the cows in calf. When the first couple of cows did not repeat, my confidence grew and now I have very little worry about settling my cows', he said.



Individual tuition is given to each person by experienced D.P.I. personnel.



'Walk-through' milking sheds make ideal restraint facilities for A.I. training.

The major advantage of being a d.i.y. inseminator is that inseminations can be timed to achieve maximum conception rates, and are not just timed merely to suit the convenience of an A.I. technician.

Mr Neville Burman of the Atherton Tableland regards this as one of the most desirable features of d.i.y. A.I. He said, 'The cows to be inseminated are held back for 5 minutes only and then they are quickly returned to the grazing herd. I regard correct timing as critical to getting good results and since I have been doing my own inseminations, this is no longer a problem'.

With a first service conception rate of over 80% for his first programme, Mr Burman has more than adequately demonstrated that correct timing of insemination gives good results.



Training with a group of people he knows makes the farmer feel more relaxed.

D.i.y. technicians also have great flexibility in their insemination routine. Mr Joe Avis of Monto taught the experts a new trick with his insemination routine—'My cows were getting upset if they were held back for inseminations, so I tried inseminating them during milking. This proved very successful. I place the cow to be inseminated last in line on the right-hand side of my herringbone milking shed and walk up the ramp behind her. I use disposable gloves and my wife loads the pistolette for me'.

Although performed during milking time, Mr Avis has found that he still has sufficient time to do a thorough job of insemination, and as the cow is not separated from the herd she is more relaxed. He is also making maximum use of the beneficial effects of oxytocin (milk let-down hormone) in reproduction by inseminating during milking.

D.i.y. A.I. can and does work for a large number of Queensland dairy and beef cattle farmers. Many report that since they have been doing the inseminations, they have become more involved with their herds, and have consequently kept better records paying more attention to essentials such as heat detection. The result is improved management.

Training a d.i.y. inseminator

A.I. training courses were once long and arduous—taking about 5 to 6 weeks. Now, modern teaching methods and improved facilities enable the average farmer to learn enough in 5 days' training to become a competent d.i.y. technician.

These 5 day courses for d.i.y. technicians are conducted 'on-farm' or at the Unlicensed Semen Laboratories, Wacol.

In recent years, as many as 200 people have been trained annually as d.i.y. technicians and the majority of these have been farmers trained at the on-farm courses.

Course details

Each day of the training course is divided into two sessions (A.M. and P.M.), each session being of 3 to 4 hours duration.

Day 1. A.M.—Lecture of reproductive anatomy of the cow, including demonstration of reproductive organs obtained from an abattoir.

P.M.—Location of reproductive organs in a live cow.

Day 2. A.M.—Insemination practice and insemination hygiene procedures.

P.M.—Insemination practice and loading procedures for pistolettes.

Day 3. A.M.—Insemination practice.
P.M.—Insemination practice.

Day 4. A.M.—Insemination practice, semen handling and maintenance of liquid nitrogen containers.

P.M.—Insemination practice (complete normal shed routine).

Day 5. A.M.—Insemination practice and assessment of technique.

P.M.—Discussion of the availability of semen and types of A.I. programmes.

On-farm courses

On-farm courses are conducted on the course participants' farms using their own cattle. Courses usually have 8 to 12 participants with each person supplying 15 to 20 suitable cows and facilities for their restraint during practice. Most dairy farms have suitable restraint facilities. 'Walk-through' bails are considered ideal.

On-farm courses are arranged through your local D.P.I. officer. Experienced personnel from the Wacol A.I. Centre conduct the training.

Courses may be provided in any area of Queensland provided that:

- No commercial A.I. service operates in the area.
- 8 to 12 trainees enroll per course.
- Each trainee supplies 15 to 20 suitable cows, that is, not pregnant and easily restrained.

- Trainees supply their own insemination equipment.
- A course fee is paid.
On-farm courses offer many advantages to farmers:
 - The farmer is not absent from the farm for an extended period of time.
 - No extra expenses are involved for accommodation, food, etc.
 - When training with a group of people he knows, the farmer feels more relaxed.
 - Courses can be arranged for a time of the year when the farmer's work load is at a minimum.

One problem which might arise for the farmer is his obligation to provide suitable cows for insemination practice. This generally presents few problems. As correct insemination practice will NOT affect cows, milkers can be used provided that the trainee inseminators follow instructions.

Courses at Wacol

Courses are conducted at Wacol annually, usually during February and May. There are no educational qualifications for attendance. Courses offered are for 1 or 2 weeks.

The 1 week course designed for d.i.y. inseminators attracts a fee of \$125 per trainee.

The 2 week course is designed for persons interested in obtaining a commercial inseminator's licence, and has a total fee of \$254 covering training, examination and registration.

The instructors

In Queensland, all courses are supervised by a veterinarian and the instructors from Wacol are among the most experienced A.I. personnel in Australia. It is the aim on all courses to have one instructor for five to six trainees.

Refresher courses

The A.I. industry is constantly developing new methods and refining techniques, and only those closely associated with the industry can hope to keep pace with all developments. To pass on new information, the Wacol A.I. Centre conducts an A.I. refresher course for all interested persons each August immediately prior to the R.N.A. Exhibition. Where possible, refresher courses are held every 2 years in those areas which have received 'on-farm' training. In other country areas, refresher courses are held according to demand.

Tips on charging cattle dips

CATTLE dips charged above the recommended strengths posed a risk of chemical residue in animals. This practice also created an unnecessary cost for the producer.

If a particular tickicide was proving inefficient at the recommended strength, consideration should be given to using another chemical that had a lower resistance factor.

It is recommended that dips be tested regularly and maintained at the correct strength.

In addition, a sample of 20 adult female ticks should be sent to the local stock inspector or veterinary officer to check for resistance.

When these results were obtained, the inspector would be happy to discuss any dip problems.

He would then be in a position to advise if a change of chemical was necessary, or if the problem was being caused by some other factor.

Phosphorus fertilization of white clover pastures

... soil and plant tests aid prediction

EACH year, many dairy and beef producers in South-east Queensland must decide whether or not to topdress their white clover pastures with phosphorus fertilizer. Now, soil and plant tests can take much of the guess work from this decision.

by G. E. Rayment, Agricultural Chemistry Branch.

This follows 5 years of research by the Department of Primary Industries working in co-operation with a number of primary producers. They generously made available portions of their white clover pastures which



Soil sampling a typical white clover based pasture at Beaudesert.

had not been fertilized for some months so that experiments could be conducted under commercial conditions.

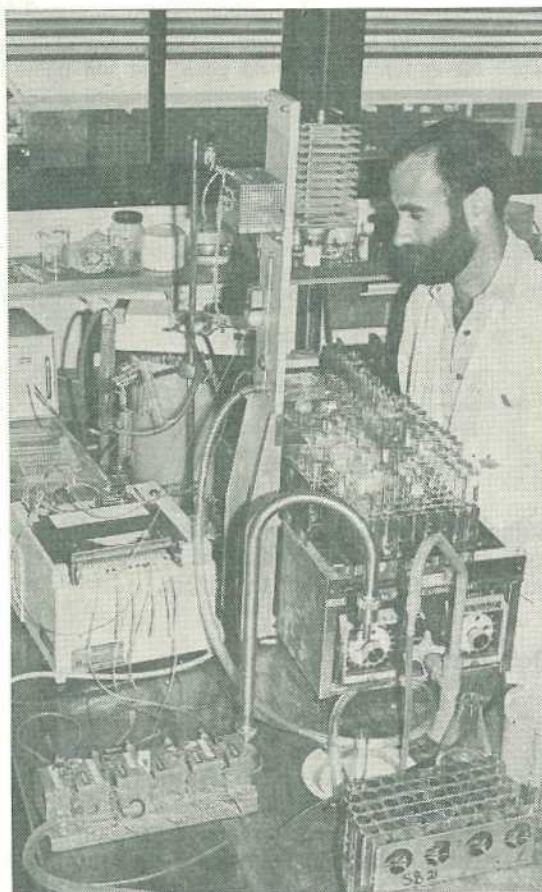
Observations

Phosphorus fertilizer recommendations for white clover pastures have been based on observations that large yield responses could be obtained on most soils following annual applications of this important plant nutrient. However, because of variable past fertilizer applications and pasture management practices, it is increasingly difficult to make a general fertilizer recommendation suitable for all situations. In effect, each property and frequently each paddock could benefit from individual consideration.

As an example, most of the 17 pastures in the study were fertilized annually, but less than half actually required phosphorus for optimum production.

Phosphorus supply

If a soil is deficient in plant available phosphorus or has a marginal supply, failure to apply adequate phosphorus results in reduced yields and lower plant concentration of some nutrients. On the other hand, it is a waste



Measuring phosphorus concentrations in soil extracts.



Soil cores obtained using a tapered tube soil sampler.

of money and resources to topdress with phosphorus at a higher rate than necessary.

Initial assessment

When uncertainty exists as to whether or not a particular white clover pasture will respond to a topdressing with phosphorus fertilizer, soil and plant tests can help clarify the situation.

It is both preferable and convenient to use soil tests for the initial assessment of current phosphorus status. This involves measurement of the phosphorus content of soil to a depth of 10 cm a few weeks prior to the intended application of fertilizer.

TABLE 1

Phosphorus fertility rating and estimated phosphorus fertilizer requirements (kg P per ha) of established white clover for various yield goals and soil phosphorus levels.

Bicarbonate phosphorus (p.p.m. P)	Rating	White clover relative yield goal†					
		40	50	60 (%)	70	80	90
0-10	very low	10	15	20	25	30	40
10-20	low	—‡	5	10	15	20	35
20-30	marginal	—	—	—	5	15	30
> 30	adequate	—	—	—	—	—	—

† Yield (expressed as a percentage of the maximum yield) likely to be achieved with adequate phosphorus when other nutrients are non-limiting.

‡ No phosphorus fertilizer required to achieve yield goal.

Sufficient time is therefore available for laboratory analysis, interpretation of results and the purchase of necessary fertilizers.

Soil sampling and analysis

To be representative, each soil sample should comprise a number of subsamples (a minimum of 10 to 15) taken from typical areas of the paddock. As soil phosphorus status commonly varies with increasing depth, it is important that the sampling depth of 0 to 10 cm be maintained. Standard soil sampling equipment (tapered tube, Jarrett auger or spade) can be employed.

Most laboratories require about 500 g of soil. If samples are much larger than this they should be carefully subsampled after thorough mixing.

At the laboratory, soils are extracted overnight with a solution of sodium bicarbonate at a soil to solution ratio of 1:100. Phosphorus removed from the soil by this solution is then measured and reported. Additional soil analyses are often undertaken as a check on other nutrients.

Soil test recommendations

On most soils, the phosphorus fertilizer needed for a given yield of white clover in the pasture can be estimated from the soil bicarbonate extractable phosphorus level. Full details are given in table 1.

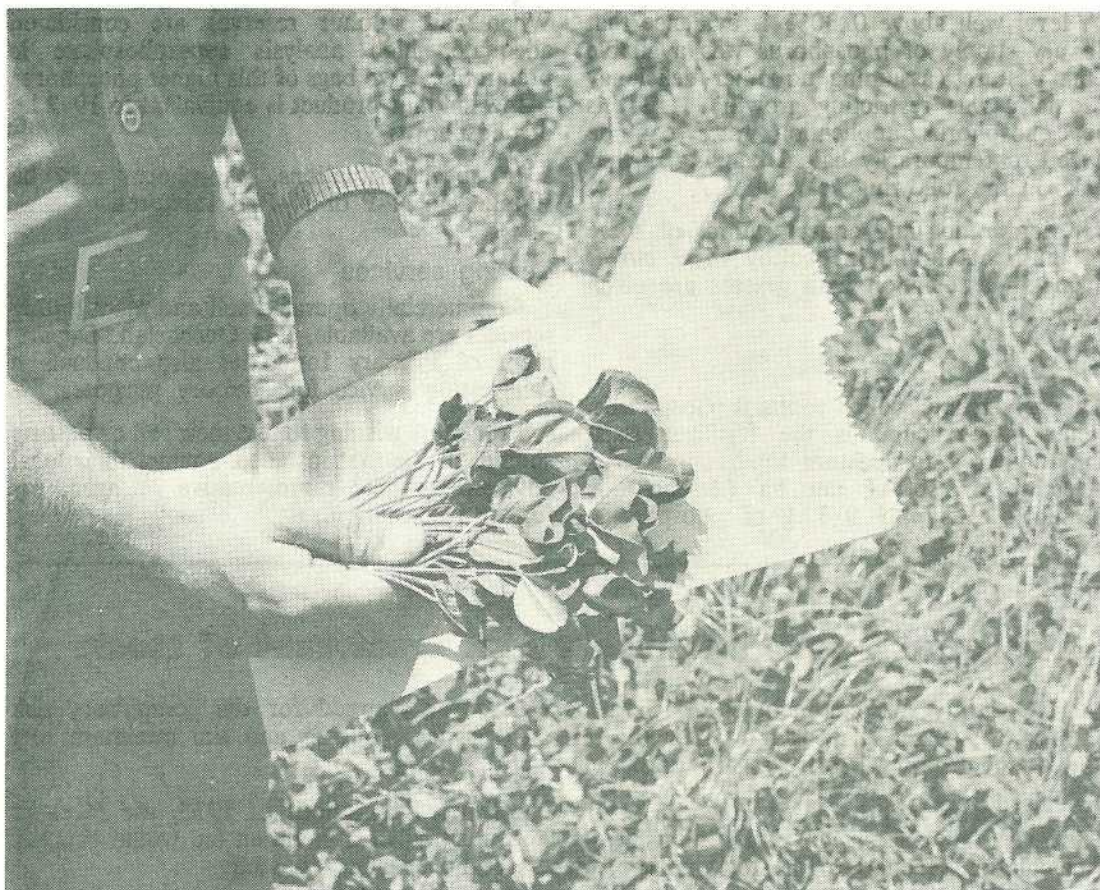
These recommendations were derived from yield responses by white clover at six rates of topdressed phosphorus in conjunction with initial bicarbonate extractable phosphorus levels. Generally, a yield response by white clover can be expected when soil levels are below 28 to 30 p.p.m. P.

Where total dry matter production (white clover plus grasses) is a more important consideration, yield responses to topdressed phosphorus are likely below 22 p.p.m., unlikely above 28 p.p.m. and uncertain between these levels.

Confirmation

From late spring to early summer, plant phosphorus tests can be used to confirm the initial assessment of phosphorus status. They can also be used to determine whether an application of phosphorus earlier in the season was sufficient to overcome phosphorus deficiency.

If continued on an annual basis, trends in plant phosphorus concentrations can be used to develop more precise maintenance fertilizer programmes. This practice is termed 'crop logging'. Alternatively, the fertilizer programme can be monitored by measuring soil phosphorus status on an annual basis. Soil tests have the advantage of being less affected by time of sampling.



Fresh leaves and petioles of white clover being collected for analysis.

TABLE 2

Typical concentrations and nutrient ratios of some plant nutrients found in healthy white clover growing in association with grasses in South-east Queensland.

Element and Unit	Range
N %	3.9-4.6
P %	>0.30
K %	>1.1
Ca %	>1.0
Mg %	>0.3
S %	>0.20
N:P ratio	<15
N:S ratio	18-19

Plant sampling and analysis

A representative sample of about 250 g of fresh leaves and petioles (leaf stalks) of white clover is required from each paddock.

Samples must be taken from effectively nodulated plants which are free from disease, nematode infestations, dust, fertilizer, agricultural chemicals, etc. Grasses growing in association with white clover must not be included in the sample.

Total phosphorus concentration, expressed as a percentage of the oven dry weight, is determined in the laboratory. The same sample can also be used to check levels of other nutrients.

Plant critical concentrations

A phosphorus concentration of less than about 0.30% indicates that the white clover pasture sampled is deficient in phosphorus. Corrective action would normally be taken in the following autumn or winter.

A level well above 0.30% is evidence that a luxury supply of phosphorus was available to the pasture (assuming no other deficiency or toxicity was restricting growth). In this case, phosphorus application rates can be reduced or temporarily halted pending further checks in the following year.

Nutrient ratios and concentrations of some plant nutrients found in healthy white clover growing in association with grasses are given in table 2.

Fertilizers

Superphosphate, which contains phosphorus, sulphur and calcium is the fertilizer most commonly used for pasture topdressing. An application of 100 kg per ha (2 bags) is guaranteed to supply 9.1 kg of phosphorus.

When soil sulphur reserves are considered adequate, high analysis superphosphate is preferable. Two bags of this higher phosphorus—low sulphur product is equivalent to 19.2 kg of phosphorus.

In special situations, phosphorus may be supplied in N-P or N-P-K mixtures.

Testing services

Commercially operated soil and plant testing services are available. The Queensland Department of Primary Industries also conducts a soil testing service for advisory purposes.

Producers wishing to test their soil or pasture should, in the first instance, contact their local advisor, fertilizer representative or agent for further information.

Fee change for compulsory tick treatment of stock

FROM July 1, a common fee of 15c a head is to be charged for the compulsory tick treatment of stock in Queensland within the three categories applying and the minimum rate at Government dips will increase to \$1.50.

Announcing approval for amendments to The Stock Regulations of 1935, the Minister for Primary Industries, Mr V. B. Sullivan, said introduction of a common fee would simplify the calculation of charges for stock, or dip, owners and Departmental staff.

The proposed fee increase had been discussed at a meeting of the Pastoral Advisory Committee and was supported by industry representatives as being quite reasonable in the light of the costs involved in charging dips with efficient acaricides.

Mr Sullivan said the three categories which had operated previously were for Government dips, inter-State or export and private.

The fees for stock treated at private dips charged with medicament supplied by the Department had varied according to location in the State, with northern areas the highest.

In addition, an application from stud stock owners in southern States for an easing of entry conditions into Queensland to enable them to cross the border at night en route to the R.N.A. Showgrounds has been approved.

At present, stock other than lambs for slaughter may enter Queensland only during daylight hours.

Mr Sullivan said that, as stud stock must meet rigorous testing and treatment conditions for entry to the R.N.A. grounds, it was considered their entry at night would impose little risk of introducing disease.

However, a proviso would apply that such stock be introduced through the Wallangarra border crossing place, which was manned 24 hours a day, he added.

Barley guide for 1979

BARLEY is grown in Queensland principally in the Darling Downs, Moreton, Burnett, and parts of the Capricornia and Near South-west regions for grain and sometimes for grazing.

About 232 500 hectares were registered with the Barley Marketing Board in 1978 for an intake of about 500 000 tonnes.

The Barley Marketing Board receives barley into three classifications—malt, manufacturing and feed.

Clipper is the only barley variety that will be accepted for classification as malt or manufacturing. Other varieties such as Corvette, Prior, Maris Baldric, Zephyr, and Lara will only be accepted as feed classification.

Quality

The Barley Marketing Board has set an upper limit of 1.9% nitrogen for grain acceptable as malt quality.

A grain moisture level of 12% is applied to all classifications.

Other grain quality restrictions apply to contamination by foreign matter such as weed seeds. The permissible level of foreign matter

is subject to review but at present includes wild oats 1% by number; Hexham scent 1% by number; *Datura* spp., Mexican poppy—NIL; smut—NIL.

Disease

Barley is normally resistant to stem rust but in hot weather this resistance may break down and some late crops could become infected. Information is not available on the resistance of the barley varieties to current strains of leaf rust.

Planting time

When sown for grain, barley is normally planted from May to July. May-early June planted crops will mature under the cooler temperatures and produce a better malt quality grain. However, frost damage is a danger with grain crops sown very early.

When planted as a grazing or dual purpose crop, barley may be sown from April to August. July or August planted barley will give faster grazing than oats planted at that time. The most useful grazing variety is Corvette.

Planting rates

The planting rate for barley depends on the proposed use of the crop and ranges from 30 to 50 kg per ha for rain-grown conditions but should be increased to 50 to 70 kg per ha when grown under irrigation. The rate should also be adjusted to the district, soil type, available soil mixture, planting time and variety.

Fertilizer

The type and rate of fertilizer is related to soil type, available soil moisture, cropping history and planting time. Under irrigation, higher rates of nitrogen may be applied without affecting the malt quality of the grain. Higher rates of nitrogen may also be used to advantage with feed varieties of barley.

Your local Agricultural Extension Officer should be consulted to determine the best planting rates and fertilizer requirements for your district and/or farm.

Compiled by S. R. Walsh, Agriculture Branch.

BARLEY VARIETAL CHARACTERISTICS, QUEENSLAND 1979

VARIETY	AGRONOMY						DISEASE	GRAIN QUALITY		
	Maturity	Yield Potential % Clipper in D.P.I. Trials	Head Type	Height	Resistance to Lodging	Suitability for Grazing	Resistance to Powdery Mildew	Classification	Test Weight	Grain Colour
Clipper ..	Quick	100	2 Row	Medium	Poor	Fair	Low	Malt, Manufacturing or Feed	High	White
Lara ..	Medium-slow	115	2 Row	Medium	Medium	Fair	Low	Feed only	Medium	White
Corvette ..	Quick	118	2 Row	Short	Medium	Good	Medium	Feed only	Low	Very pale blue
Maris Baldric	Medium	94	2 Row	Medium	Poor	Fair	Not available	Feed only	Medium	White
Prior ..	Quick	93	2 Row	Medium	Very poor	Fair	Low	Feed only	Medium	White
Cape ..	Slow	80	6 Row	Tall	Good	Good	Low-medium	Feed only	Low	White
Skinless ..	Medium	75	6 Row	Tall	Poor	Good	Not available	Feed only	Very high	Brown
Black ..	Slow	70	6 Row	Medium	Medium	Good	Not available	Feed only	Medium	Black

Local mango varieties

THE mango growing industry which depends on the southern fresh fruit markets is well established in the Bowen and Burdekin areas of the Dry Tropics.

Also, the major part of the crop in the Dry Tropics is produced over a short period of 4 to 6 weeks in late November and December, probably because of almost total dependence of the industry on a local variety, Kensington Pride.

Many types of mango are scattered over the state as a result of introductions from as early as the 1960s from India, Ceylon, Indonesia and the Philippines. However, few of these types are well described or have achieved any commercial prominence except the Kensington Pride and Common varieties.

Local varieties are currently being collected by officers of the Department of Primary Industries and evaluated together with recent introductions. Varieties and selections are being assessed for their usefulness in extending the commercial production season. Some local varieties of interest are described:

Kensington Pride (plate 1)

Kensington Pride is believed to be of Indian origin and was first grown at Adelaide Point in the Bowen area between 1864 and 1888. Also known as Bowen Special, this is the main commercial fresh market variety in Queensland.

The fruit is large, averages 0.4 kg in weight, and is ovate to slightly oblong in shape. Flesh is sweet and juicy with a moderate amount of fibre. The fruit is yellow when ripe, commonly with an attractive red blush.

The Kensington variety, while being mainly exploited for the fresh fruit market, has been found in Queensland Department of Primary

Industries' appraisals to be also very suitable for high quality canned and quick-frozen dessert fruit products.

Kensington Pride Selections (plate 2)

Variants of Kensington Pride are known to exist in commercial orchards or in backyard plantings. Major differences in skin colour, fruit shape and fruit size have been observed between trees within the Kensington type. Variants with less obvious differences in flesh and seed characteristics are also known. Some of these Kensington types are being selected and established at the Bowen Horticultural Research Station for detailed assessment of their potential.

Common (plate 3)

This variety occurs widely in coastal Queensland but is of minor commercial significance on the fresh market, and then only in November because it tends to be 2 to 3 weeks earlier than Kensington. The fruit is small, averaging 0.2 kg in weight, and has an oblong or moderately elongated shape. The fruit is normally fully yellow when ripe, rarely blushed, and the flesh is sweet with substantial fibre.

The Common variety continues to be in demand for chipped and sliced fruit for chutney and ripe fruit for flavouring or confectionery.

Banana -1 (plate 4)

Some mango types are termed 'banana' because of their extremely elongated or long oblong shape and yellow skin colour. Several of these types are known in Queensland. The selection termed Banana -1 is one that has not been exploited commercially as yet but was collected in the Burdekin area and is being further evaluated. The fruit of Banana -1 is most attractive, averages 0.3 kg in weight, and the flesh is sweet, mild in flavour, and with low fibre.

Local mango varieties

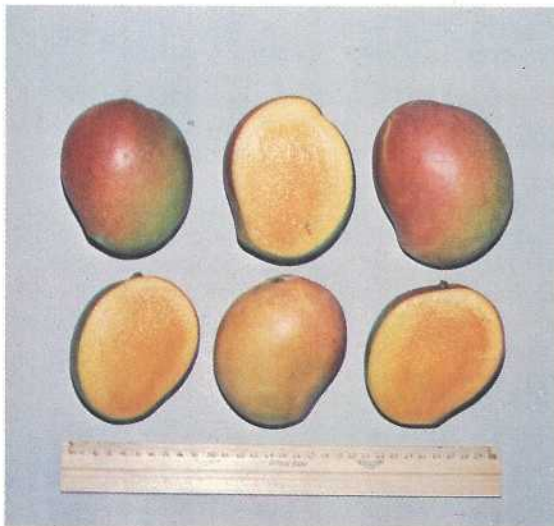


Plate 1. *Kensington Pride*—the major commercial variety in Queensland.

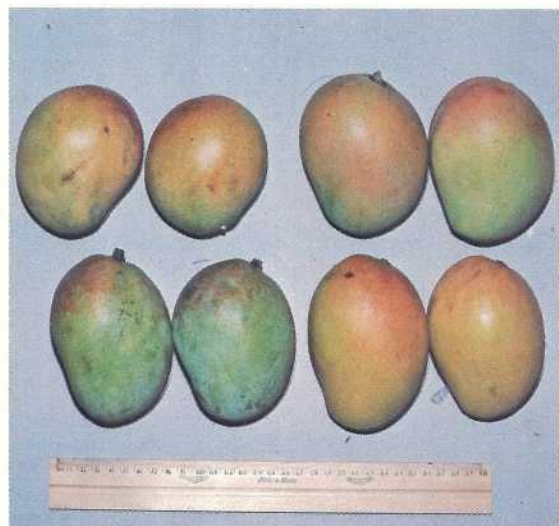


Plate 2. *Kensington Pride Selections*—four variants of the *Kensington* type.



Plate 3. *Common*—a minor commercial variety in Queensland.

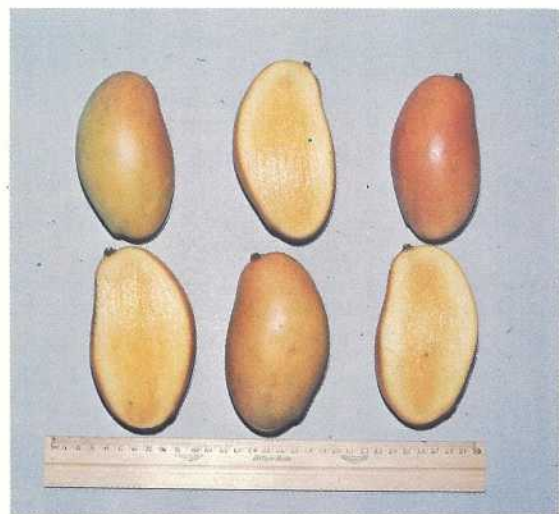


Plate 4. *Banana*—1. This is another local type.

New mango varieties

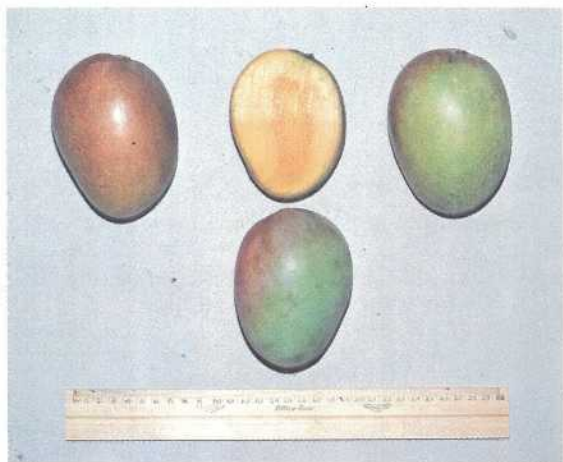


Plate 5. Palmer—the fruit is of good quality and similar in size to that of Kensington Pride.

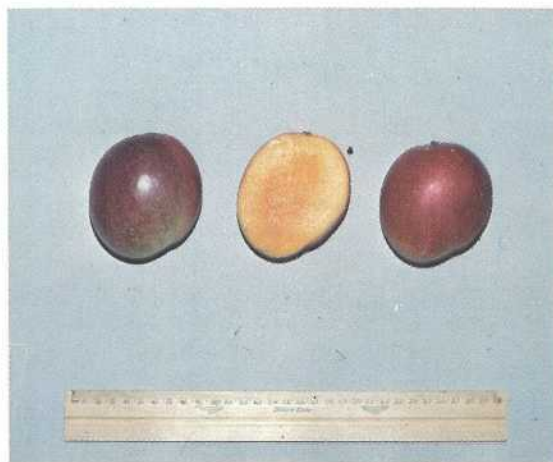


Plate 6. Haden—the firm, plump fruit is of medium size and is most attractively blushed.



Plate 7. Zill—the fruit is small and oval, with a well-defined beak and an extensive dark red blush.



Plate 8. Carrie—of medium size and slightly oblong in shape, this fruit has a completely yellow skin colour when ripe.



RIGHT. Plate 9. Kent—this variety matures its crop 3 to 5 weeks later than Kensington and the fruit is very large and of good quality.

New mango varieties

A MANGO variety introduction and evaluation programme has been carried out by the Queensland Department of Primary Industries since the early 1960s.

This programme aims to extend the commercial cropping season and build up a range of good commercial varieties.

Varieties with good fruit quality and with different cropping seasons have been obtained from several areas including Florida, the West Indies, Hawaii, India and Ceylon. Other introductions from South Africa, Fiji, Florida, Thailand, Philippines and Malaysia are still being made.

More than 50 varieties of good repute have been introduced from overseas and established in the field at the Bowen Horticultural Research Station for evaluation since 1971. Five varieties with fruit of good commercial quality and a total cropping period in excess of 12 weeks were released to the industry in December 1975. Other varieties under test are expected to provide a further extension of cropping.

The fruit of the five new varieties, all of Florida origin, is described as follows:

Palmer (plate 5)

The large fruit averages 0.4 kg and is oblong-ovate in shape. The flesh is free of fibre, sweet, aromatic and very smooth in texture. Skin colour when fully ripe is normally orange-yellow with a light blush on the shoulders.

Haden (plate 6)

The fruit is ovate and plump and averages 0.3 kg. The skin has an extensive and brilliant red blush on a yellow background when ripe, with lenticels being most conspicuous. The flesh is firm and sweet with moderate fibre and with mild turpentine flavour near the shoulders.

Zill (plate 7)

The small, oval fruit has a well-defined beak. It averages 0.2 kg in weight, and has a conspicuous and extensive dark red blush

on a yellow background. The flesh is very sweet, free of fibre and with mild turpentine flavour near the shoulders.

Carrie (plate 8)

This variety has fruit ovate to slightly oblong in shape, with a completely yellow skin colour when ripe, and of similar size to Haden. The flesh is very sweet and free of fibre.

Kent (plate 9)

This very large fruit is ovate to slightly oblong (and plump) in shape, and averages 0.6 kg in weight. The fruit is red-blushed when ripe and the flesh is very sweet, fine textured, and free of fibre.

The cropping season of the new varieties compared to commercial Kensington has been provisionally determined by an examination of their cropping record at the Bowen Horticultural Research Station from 1974 to 1977. Palmer was consistently earlier than Kensington by 1 to 3 weeks. Zill and Haden were rather inconsistent but tended to be earlier than Kensington by 1 to 2 weeks. Carrie tended to be only 1 to 2 weeks later than Kensington. Kent was consistently later than Kensington by 3 to 5 weeks.

Multiplication of the new mango varieties must be by vegetative means as they do not come true-to-type from seed. Grafting and budding are acceptable means of propagation using seedlings of the Common or Kensington varieties, which being vigorous and uniform, are suitable as rootstocks.

Propagation material of the five new varieties and any other promising varieties to be released in the future, may be obtained by application to the Bowen Horticultural Research Station. Also, supplies of grafted trees of the five new varieties should soon be available from Queensland nurseries.

The five new varieties are now established in small trial plantings at 32 sites in Queensland. The potential benefits to industry of a few weeks' extension of cropping season are substantial.

Apple growing in Queensland

IN Queensland, apples are only grown in the Granite Belt district.

Production varies from year to year but the annual average is about two million bushel cases (38 100 tonnes).

The total area of apple trees is approximately 5 260 ha. This consists of 4 900 ha of bearing and 360 hectares of non-bearing apple trees.

Brisbane is the main market for the apple crop but apples are also sold at other markets in Queensland, on the Sydney and Newcastle markets, and on the export market. Approximately half of the crop is sold fresh and the rest is stored either in commercial or privately owned cool stores. A small quantity is processed each year for apple juice, pies and dried crisps.

Major considerations

Climate

The apple is a temperate zone crop. It requires chilling during winter for normal development of buds in the following spring. If chilling is insufficient, leaf and flower buds open erratically over a long period during spring. This leads to poor growth and cropping.

Winter chilling requirements are measured by the total number of hours below 7°C. The chilling requirements of most varieties fall in the range of 1 000 to 1 200 hours. The Granite Belt is the only area in Queensland where these requirements can be adequately satisfied, and even in some years they are not fully satisfied.



Harvesting apples—the apples are picked into bags and then placed into bulk bins.

compiled by S. N. Ledger, Horticulture Branch.

The critical periods for rainfall are just before blossoming and fruit set, before fruit maturity and during flower bud initiation from December to January. Annual rainfall in the Granite Belt is 750 mm but it is unreliable. Irrigation is therefore recommended for apple trees.

Adverse weather conditions occur in some seasons. Frosts occasionally occur around blossom time during late spring. This causes death of fruit buds, blossoms, and fruitlets. North to north-easterly slopes provide warmer conditions. Prolonged wet conditions during spring can increase the risk of an outbreak of diseases. Hail can also be a problem.

Soil

Apples can be grown under a wide range of soil conditions provided drainage is good. In the Granite Belt, apples are grown on sands and sandy loams. A soil depth of 50 cm is desirable. Shallow soils with impervious clay layers or subsurface parent rock should be avoided.

Land preparation

Clearing

The preparation of land for planting follows a standard practice. Native timber is cleared and burnt at least 2 years before planting. Deep ripping is essential to bring tree roots to the surface so they can be removed because they may carry *Armillariella* root rot fungus. Ripping also loosens the subsoil which allows better moisture and root penetration.

The land is then levelled and ploughed, cross-ploughed, disc harrowed, and brought to a good tilth. It is advisable to grow a cover crop of sorghum in summer and oats in winter to build up the soil organic matter.

Drainage

It is essential to consider possible drainage problems. Poor drainage adversely affects production by:

- Reducing the vigor of trees and making them more liable to disorders.



Apple orchard planted on the contour.

- Causing poor drought resistance due to death of deeper roots.
- Shortening the life of trees.
- 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.

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

- Careful selection of site before planting. Growth of native timber can be a good guide.
- Prevention of external water moving on to the orchard.
- Removal of wet spots.

In recent years, perforated PVC pipes have been used for underground drainage. They are available in sizes ranging from 4 cm to 10 cm in diameter and in single length coils up to 300 m long. They are much simpler to lay than 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 common system consists of an exit or main drain with lateral drains feeding into it at right angles 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.

The depth at which the drain pipes are placed is determined 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 layout of the drainage system is essential as it is helpful in locating blockages should they occur.

Soil conservation

On land where the slope exceeds 3%, contour planting is recommended. 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.

Replant land

The basic steps in preparing old orchard land are the same as for new land except more preplanting land preparation is required. The old practice of rotating crops is recommended. If possible, replace stone fruit with apples.

Preparation of the area should begin at least 2 years before planting the trees. Testing the soil for nematodes and pH is essential. Fumigation and liming may be necessary.

For fumigation, DD is injected into the soil at the rate of 440 l per ha. As DD is not effective at low temperatures, it should be injected in April while soil temperatures are still high.

Replanting on banks is recommended because the trees grow better with the increased soil depth and improved surface drainage.

Varieties

The major varieties of apples grown commercially in the Granite Belt are as follows:

Granny Smith	40%
Delicious	36%
Jonathan	13%
Other varieties	11%

Granny Smith is a late-maturing variety with green to green-yellow fruit of excellent quality suitable for both cooking and dessert purposes. It has very good storage life and is suitable for export. Trees are vigorous but liable to overcrop.



Delicious—midseason variety; fruit has a red stripe over a yellow background.

Delicious is a midseason variety, maturing from mid February to mid March. The fruit has a red stripe over a yellow background and has excellent dessert quality. Delicious has good storage life if harvested and stored at the right stage of maturity. Trees are vigorous but liable to biennial bearing.

Delicious and its strains are the most important dessert apples in the Granite Belt. The Delicious variety has produced many mutations or sports with improved colour and a number have been used in commercial plantings in the Granite Belt. The most important of these are:

Lalla was one of the first strains planted. It has a brighter red colour than Delicious but tends to change back to the Delicious colour so careful selection of budwood is important.

Royal Red and **Richared** have full bright to dark red blush.

Hi Early has full bright to dark red colour retaining some of the striped character of Delicious.

Starkrimson has dark red coloured fruit. The fruit tends to be longer and matures 10 to 14 days later than ordinary Delicious. Trees spur readily and lack vigour.

Jonathan is an early to midseason variety maturing from early February. The fruit colour is a rich red passing into red streaks and patches on a greenish-yellow to yellow background. Jonathan has good dessert quality and is only suitable for short term cool storage. Trees are moderately vigorous and susceptible to powdery mildew. Jonathan is the second most popular red variety but its popularity is diminishing.

Red Jonathan. Red sports of Jonathan are similar to Jonathan except they have full red colour development. Because of their better appearance, full red strains are preferred for new plantings.

There are several other varieties grown to meet special requirements. The most common of these is **Gravenstein**. It is an early maturing variety, suitable for dessert and cooking purposes. It matures in mid January. The fruit has a red stripe on a pale yellow background. Strains with red blotches or blush are available.

Poor storage life makes Gravenstein suitable only for the early season fresh market. The trees are vigorous and spreading but susceptible to preharvest drop, gnarl virus, and powdery mildew.

The most important other varieties are as follows:

Twenty Ounce and **Lord Nelson** have green fruit and are only suitable for cooking. They are marketed from late December to early January. The fruit is not suitable for cool storage. Trees are moderately vigorous.

EarliBlaze is a recent early-maturing variety with good shape and appearance suited to the early dessert market. It matures from late January to early February. The fruit is inclined to be soft if left to ripen on the tree.

Winesap has fruit with red stripes and russet spots. It matures in early March and has good storage life but is susceptible to bitter pit. Trees are vigorous.

Legana has fruit with red stripes over a pale red blush on a greenish to golden yellow background. It matures in mid March and has good storage life. Trees are moderately vigorous.

Crofton has red stripes over a bright red blush on a greenish yellow to pale yellow background. Fruit size is generally small. It matures in early April and has a very good storage life. Trees are vigorous.

Dougherty has fruit with a well-developed red blush on a greenish to yellow background. It matures in mid April and has a good storage life. Trees are vigorous.

Poor fruit quality has been a problem with early-maturing varieties grown on the Granite Belt. Because of the marketing advantage obtained from early maturity, there has been a continuing search for better quality varieties for the early season. For this reason, the D.P.I. is conducting an extensive apple breeding programme with the objective of developing good quality, early-maturing varieties.

Pollination

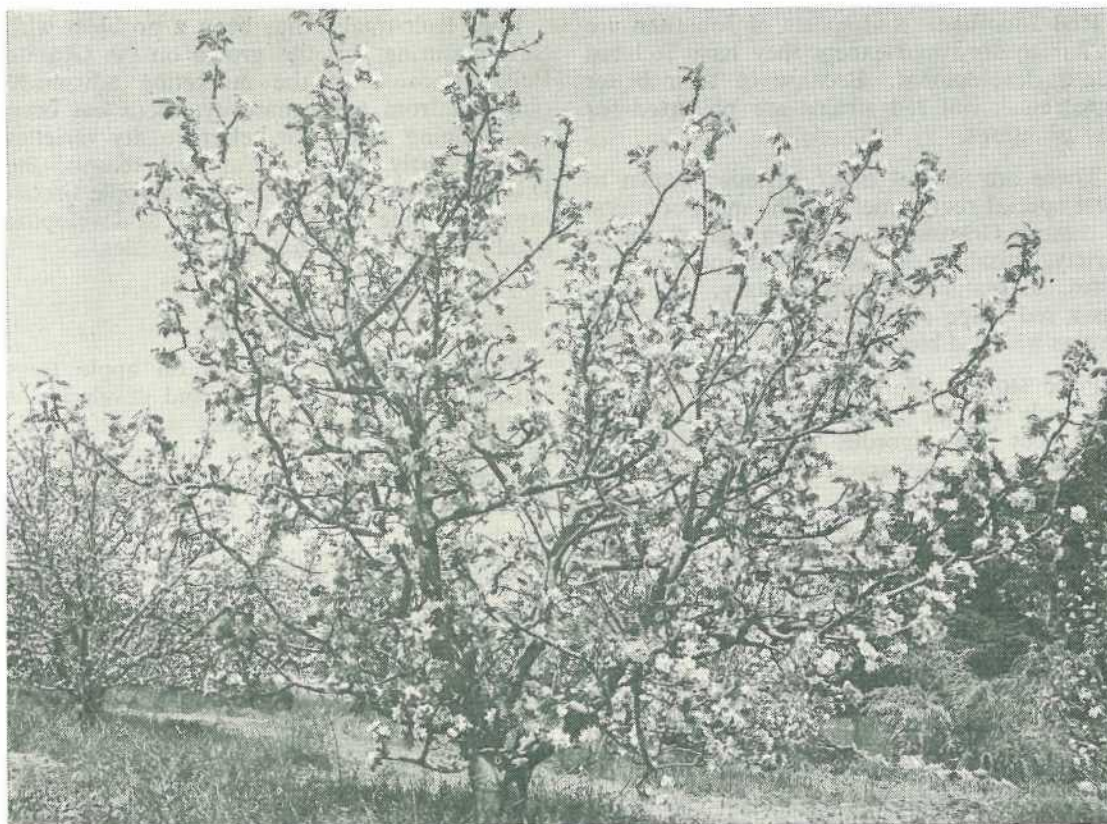
Pollination of the flowers on apple trees is necessary for fruit setting and development of the crop. Apple varieties are self sterile or nearly so and therefore will not pollinate themselves. Cross pollination between varieties is required for fruit set.

The pollination requirement of the varieties must be considered before an orchard is planted. As varieties differ in their time of blossoming and the period from first bloom to petal fall is short, suitable varieties for interplanting must have similar blossoming times.

Transfer of pollen from one flower to another is mostly done by bees. Bees forage over short distances even when conditions are favourable. Wet, cold, windy, or cloudy weather slows down their activity. Therefore, the varieties interplanted for cross pollination should be close together.

To improve the chances of obtaining a full set of fruit under all conditions, it is recommended that at least two bee hives be provided for each hectare of trees, spaced evenly throughout the orchard. Do not use lethal sprays during blossoming when the bees are active as severe damage can be done to the bee population.

In wide-spaced orchards, it is essential that trees be no more than two trees away from a pollinator variety. Ideally, trees should be beside a pollinator but in practical terms, if varieties are of equal importance the best layout is two rows of one variety followed by two rows of the other variety. Should a third variety be required, two rows of first choice, one row of third choice and two rows of second choice is the best layout.



Apple tree in full bloom. Cross pollination between varieties is required for fruit set.

Other layouts can provide adequate pollination. When a minimum number of the pollinator variety is required, every third tree in every third row should be a pollinator. One tree in nine is a pollinator surrounded by eight trees of the favoured variety.



In close planting where hedgerows are present, alternate rows of varieties are essential because bees prefer to work along hedgerows.

In large, established blocks where there are insufficient pollinators, the required number of trees can be converted to a pollinator variety by top working or frame working. This procedure is preferred to grafting pollinators on to single limbs of trees.

The three main varieties, Granny Smith, Delicious and Jonathan, if grown close together will normally cross pollinate each other. Occasionally, due to seasonal factors, the blossoming times of Granny Smith and Delicious do not coincide. Granny Smiths commence blossoming first, followed closely by Jonathans and Delicious shortly afterwards. Therefore the best layout for these varieties is two rows of Granny Smith, one or two rows of Jonathan, and then two rows of Delicious.

Pollen of the Gravenstein variety is non-viable and therefore incapable of pollinating flowers of any other variety. Other varieties with similar blossoming times will pollinate Gravenstein. A three variety combination is necessary and the recommended combination is Granny Smith, Gravenstein, and Jonathan.

Rootstocks

A large number of rootstocks over a wide vigour range are available for apples. The choice of rootstock depends mainly upon the vigour required for specific growing conditions. Trial work on rootstocks has been conducted at the Granite Belt Horticultural Research Station. Rootstocks used in the Granite Belt are:

Merton 778—a vigorous stock suitable for wide spacing. Recommended for Granny Smith on all soil types and for Delicious on the more fertile soils. It is woolly aphid resistant, easily propagated and readily available from local nurseries.

Merton 779—similar to Merton 778 but performs better in poor or replant soil conditions. Woolly aphid resistant. Limited supplies available.

Malling Merton 109—a vigorous rootstock recommended for Jonathan. Some supplies available.

Malling Merton 106 (MM 106)—a semi-dwarf stock recommended for close planting. Supplies available.

Northern Spy—similar vigour to MM 106 and has performed well in close planting trials. Under good growing conditions, it will produce trees large enough for wide spacing. Resistant to woolly aphid.

Seedling—produces very vigorous trees which are very slow in coming into bearing. Susceptible to woolly aphid. Not recommended.

Whenever possible, trees made from virus tested stocks should be obtained. Limited amounts of virus tested Merton 778 and MM 106 are available at present and supplies will increase. Virus tested budwood worked on to non-virus tested rootstocks will become virus infected and vice versa.

Propagation

To obtain uniform orchard trees, uniform nursery trees are essential. This means the budding or grafting of the same scion variety on to uniform rootstocks.

Clonal rootstocks are preferred because of their uniformity and performance. Clonal stocks are those which are produced vegetatively from the same original plant. For example, all the rootstocks from Merton 778 stoolbeds belong to the same clone and have identical characteristics such as vigour, fruitfulness, drought resistance, pest and disease resistance.

With seedling rootstocks, some variability will occur. Because these stocks are grown from seed, each stock is a different individual and will have varying expressions of vigour, fruitfulness, and drought resistance.

Stoolbed management

The soil used for stoolbeds should be fumigated with methyl bromide. Virgin soil is preferred.

The soil should be moistened and well worked before fumigation. The bed is then covered by a sheet of polythene film which is supported about 15 cm above the soil surface to allow an 'air space' above the soil. To prevent the spilling of liquid methyl bromide on to the soil, a tray or wide-mouth bottle is placed under the plastic to receive the tube from the methyl bromide applicator.

The polythene film is sealed around the perimeter of the bed with soil which is either firmed or watered down. The methyl bromide gas is then released and allowed to remain for 24 hours.

Because methyl bromide gas is much heavier than air it is advisable to 'flap' the plastic sheeting to distribute the gas. After 24 hours of fumigation the ends of the sheet are lifted and the gas allowed to escape before the sheeting is removed.

Methyl bromide fumigation should be done in April when soil temperatures are warm as methyl bromide will not vaporize sufficiently below 15°C. When using methyl bromide, care should be taken as it is toxic to humans.



Young apple trees in a nursery showing one season's growth after budding.

After fumigation, work the soil several times to allow the gas to escape. The bed should not be used for at least 1 week after treatment.

Stoolbeds are established by planting rooted shoots of the desired rootstock in rows at least 1 m apart with plants 15 to 45 cm apart in the row. It is important to commence with healthy material. If nematode infestation is suspected, the roots can be dipped in a mercuric chloride solution. An alternative is to graft the rootstock on to seedlings grown in fumigated ground and then layer the rootstock wood to commence the stool. The seedling portion is dug out once the rootstock portion has become established.

The stoolbed plant is headed 5 to 8 cm above the ground and hilled up with soil as the shoots start to grow in the spring. Hilling up is continued throughout the growing season and the shoots are covered up to one-third to one-half their height.

In the following winter, the soil is removed and the rooted shoots are cut off. These are graded for size and planted in nursery rows 20 to 45 cm apart.

The process is repeated annually with an annual increase in stock numbers.

Where an increased number of stocks is required from stoolbeds, layering can be practised. Here the 1-year-old shoots are pegged to the ground and the resultant side shoots are hilled up.

When transplanting, any off-type shoots are discarded. Grading for size gives uniformity of growth and simplifies budding and grafting operations.

The nursery should be irrigated when necessary so that growth is continuous throughout the season. Weed growth should be kept under control.

Propagation techniques

Apples can be budded or grafted.

Timing

Budding and grafting 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 to early autumn while grafting is done in the spring after growth commences.

Selection of scion wood

Select scion wood with strong, well-developed buds on the current season's growth. Scion wood should be taken from mature trees free of virus disease with a good cropping record over several years and good fruit type.

Scion wood for grafting and spring budding is collected in winter before pruning then labelled and stored. Short storage may be undertaken in plastic bags in a refrigerator or by burying the wood in cool, shaded soil to about two-thirds its depth. Scion wood stored this way will keep for 1 to 2 weeks.

For long storage it is advisable to pack the scions in layers of moist sand or sawdust in boxes and store them in a cool store. If a cool store is not available the scions may be buried in a cool, moist area until needed. The site should be well-drained and shaded from the sun. Spread the scion wood thinly in the bottom of the trench and then cover with hessian and 12 to 16 cm of soil.



Apple trees planted 6 m apart on the square (wide spacing).

Scion wood for autumn budding can be collected as required during the budding season. A few days' supply can be taken and the cut end kept in water.

On no account should scion wood be allowed to become partially dry or to shrivel.

Budding

The common budding technique is the T bud.

A T is cut on the stock with the vertical and horizontal cuts 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 3 cm long is cut from the scion wood with a single stroke using a sharp thin-bladed knife.

The bud is inserted in the T on the stock and tied firmly with plastic tape. Budding should be done about 15 cm above ground level.

Grafting

The whip tongue is the normal grafting technique used.

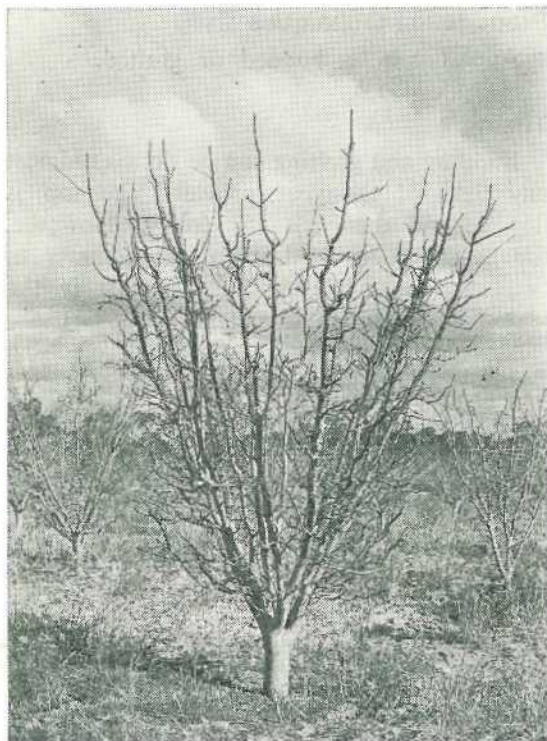
A sloping cut about 4 cm long is made at the base of the scion wood and a matching cut through the stock about 10 cm above the ground. Starting about one-third of the way back from the tip of the cut on the stock, a vertical cut is made about 1 cm deep parallel to the bark of the stock. A similar matching cut is made on the scion.

The scion piece is shortened to two buds. It is inserted in the stock and the union is tied with plastic tape. The cut end of the scion piece is sealed with mastic.

The scion wood and the stock should be about the same diameter. If this is not so, one side of the union should match exactly.

Labelling

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



Vase system of training wide-spaced trees.

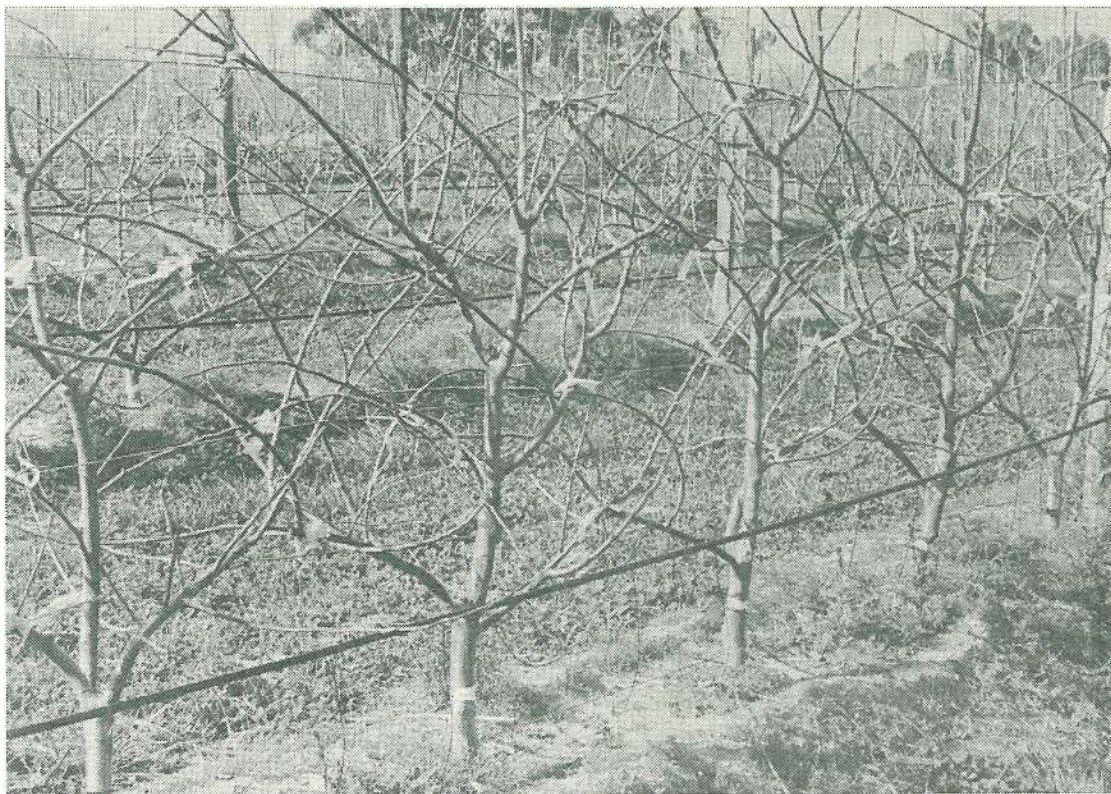
After care

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

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

With budded trees the stock is headed back with a straight cut as soon as the scion starts to grow.

Sucker growth on the stock must be suppressed from the time of grafting or budding.



Modified central leader system of training close-planted trees. Note the central leader and the laterals pulled down along the row to an angle of 40° from the horizontal.

Planting

Before planting, the soil must be in the best possible condition. It will take at least 2 years to effectively prepare replant land and at least 1 year's preparation is recommended for new land.

Trees should be ordered at least 1 year in advance of the proposed planting time to ensure supply. Virus tested planting material is becoming available and should be obtained wherever possible. Never accept poorly grown trees or those with more than one season's growth after budding.

The trees are planted during winter when they are dormant. Grade them for size and discard any stunted or damaged trees. Inspect the trees for crown gall, *Armillariella* root rot

fungus, and nematodes and reject any infected trees. While awaiting planting, trees are best 'heeled in' in a cool, sheltered spot and kept moist.

Dry land farming is the traditional method of growing apple trees on the Granite Belt. Planting 6 metres apart on the square (wide spacing) is the common planting distance used for dry land farming.

With the use of irrigation, returns per hectare can be increased by close planting of apple trees. With close planting, yields are higher and pruning, spraying, and harvesting are easier and cheaper. A hedgerow of trees where most of the apples can be picked from the ground is the aim of close planting.

Establishment costs are higher for close planting than wide spacing but this is compensated by the earlier returns with earlier cropping. With close planting it is possible to commence cropping in the third year after planting compared to the seventh year for wide spacing.

The best possible growing conditions are required for close planting. New soil is preferred but in many cases only replant land will be available so good preplanting management is essential. This includes leaving the land unplanted for several years, cover cropping, attention to drainage, liming, and fumigation. Hilling along the row before planting will provide extra soil for the roots of the young trees.

Irrigation is essential for close planting and should be laid down immediately after planting. Trickle irrigation is a suitable system. As cultivation is only possible one way, chemical weed control is necessary along the row.



Close-up of strap graft, 1 year after re-working.

Management of close planting is a major research project at the Granite Belt Horticultural Research Station. The recommended planting distances are 2 m between the trees and 4 to 5 m between the rows. The distance between the rows should be wide enough to allow equipment to pass through freely. A 2 m space between the trees is sufficient to give a hedgerow effect without causing undue shading between trees.

For both wide spacing and close planting, the planting 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. The roots are trimmed to a minimum and spread evenly around the mound.

Top soil is added until the hole is half filled. Each shovelful of soil is firmed around the roots before adding more. About 5 l of water is 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. Do not place fertilizer in the hole at the time of planting as this may damage roots and kill the tree.

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 nitrogen and phosphorus can be lightly chipped in by mid-summer.

Training and pruning

Training and pruning are essential parts of the management programme. Tree shape and size, cropping pattern and yield capacity are greatly influenced by the method of training and pruning adopted. Without some form of training and pruning, growth would be uncontrolled, cropping erratic, and insect and disease control would be extremely difficult.

The framework of the tree is formed by training, with most of it being done during the early years. Training is influenced by factors such as rootstock, soil fertility, planting distance, available soil moisture and climate.

The vase system is the standard method of training wide-spaced trees in the Granite Belt. When the trees are young, the vase system directs vigour into leader growth. It provides a strong, open framework which allows light penetration and easy access for sprays and pickers.

The single stemmed tree from the nursery is cut about 40 cm above the ground soon after planting. During the first growing season, three to four well-spaced shoots are selected for future leader development. All other shoots are pinched out when small and succulent so that they do not compete with the main shoots.

In the following winter, the selected shoots (leaders) are cut back to a half to two-thirds of their growth and to an outside bud. Two shoots on each leader are allowed to grow. Growth from other shoots is suppressed but not completely removed. Leaves around the leaders and trunk not only supply plant food but also help to prevent sunburn.

During each winter, a similar process is followed with subsidiary leaders being chosen to fill in the gaps as the vase-like framework extends. Most mature trees have 8 to 12 leaders.

After the third growing season, some well-spaced lateral growth is retained and shortened to provide future bearing wood and protection from the sun. Once the young tree begins to crop, vigour will be reduced. If the size of the tree is below that required, blossoms should be removed until the size is adequate.

During early training, the variety can effect the shape and density of the framework and the system may have to be modified to obtain optimum performance for a particular variety. Granny Smith and Delicious require opening while Jonathan is inclined to have a sprawling habit.

A modified central leader is the training system recommended for close planting. A hedgerow of trees where most of the apples can be picked from the ground and early bearing of fruit are the aims of the training system.

The single stemmed tree from the nursery is cut about 40 cm above the ground soon

after planting. During the first growing season, three shoots are selected. All other shoots are pinched out when small.

In autumn, two shoots are pulled down in opposite directions along the row to an angle of 30° to 40° from the horizontal. The third shoot is left to grow vertically and becomes the central leader.

For pulling down purposes, run a wire down the row along the ground. Plastic and string are the best materials for tying down the shoots. The best time to pull down is in April while the shoots are pliable. If left to midwinter, the shoots will be less pliable and breakages occur.

In winter, the central leader is cut about 45 cm above the first cut. Once again, three shoots are allowed to grow during summer and two shoots are pulled down along the row in autumn. The process is repeated during the third year.

During these early years, pruning is kept to a minimum to promote early bearing. Leaders along the row must be allowed to extend as quickly as possible and any other growths must not be allowed to compete with the central leader. Overcrowded shoots can be thinned out. The framework of the tree is established after 3 years and during this period blossoms must be removed.

When cropping is established, the central leader is cut back into 2 or 3-year-old wood at the desired height. A tree height of 2.5 m is ideal. Greater height causes shading and pushes the fruit up the tree to less accessible levels.

The main purposes for pruning wide-spaced and close-planted trees are:

- To maintain a balance between leaves and fruiting wood.
- To maintain the shape of the tree.
- To remove old fruiting wood which has few or no fruit buds and thereby stimulate new buds and fruiting wood.
- To allow entry of light 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.



Limbs showing bark pimpling and cracking caused by boron deficiency and manganese toxicity. This disorder can be remedied by applying borax and lime to the soil. The lime raises the pH making manganese less available and it provides calcium which prevents manganese accumulation in the bark.

- To thin out excess fruiting wood and thereby reduce hand thinning.
- To allow free movement of implements between rows.
- To remove broken branches and shoots infected with powdery mildew.

The variety influences the fruiting habit. Granny Smith has a spur bearing habit and develops few spurs if pruned too long. For Delicious, the development of spurs is enhanced by long pruning. Jonathan is slightly different and carries much of its fruit on the laterals. Each lateral has a number of blind buds towards the base and short pruning may reduce the crop considerably.

Re-working

The demand for a certain variety changes and it may become necessary to re-work trees to a more profitable variety. As well, if a block of one variety is not receiving sufficient cross pollination, re-working one tree in nine to a suitable pollinator is the most effective method of improving cropping.

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. Smaller limbs and laterals can also be grafted by using the strap graft, whip tongue graft or peg graft.

Nutrition

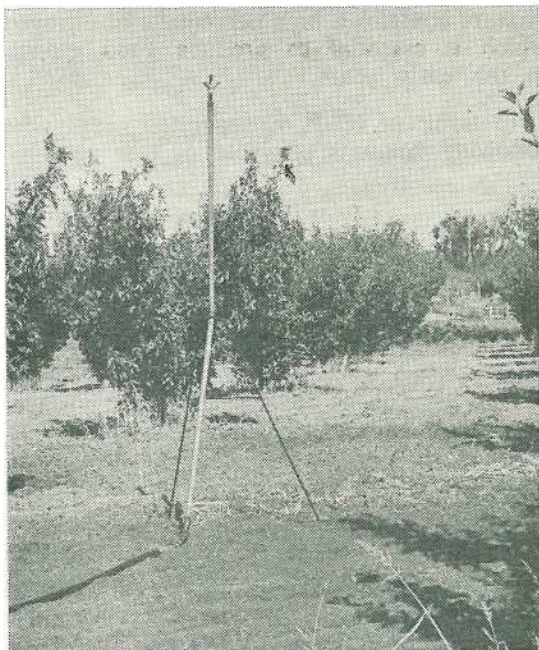
Apples may be grown on a wide range of soil types but good depth and drainage are essential. In the Granite Belt, apples are grown on coarse granitic soils which are low in organic matter and fertility. Good productivity on these soils depends to a large extent on the success of green manuring and fertilizing programmes.

Soil acidity

Granite Belt soils are moderately acidic in their natural state but after cultivation, leaching of some minerals is accelerated and acidity may become high. High acidity is hastened if acidifying fertilizers such as ammonium sulphate are used.

Under conditions of high acidity, certain essential nutrients in the soil become unavailable to the tree while other elements such as manganese become more available and may reach toxic levels. Soil acidity is highest in the summer months when plant demands and leaching are at their greatest.

Each winter it is desirable to check the pH of the soil. The pH value is a measure of the soil acidity. If the pH is low then lime or dolomite should be applied. These both supply calcium to the soil as well as correcting acidity. Dolomite also supplies magnesium, an essential element often lacking in Granite Belt soil. Tests for pH are conducted by the D.P.I.



Liming should be carried out in the winter and at least 3 to 4 weeks before fertilizer application. Close application of lime and fertilizer can result in a loss of nitrogen as a gas from the soil.

Major nutrients

(Nitrogen (N), Phosphorus (P), and Potassium (K)).

Granite Belt soils are naturally low in nitrogen and phosphorus but potassium is often adequate during the early stages of cropping. However, nitrogen remains low, potassium becomes low and phosphorus builds up in the surface soil with continuous cropping.

LEFT. Portable overhead sprinkler. Overhead systems offer the advantage of frost protection but are not as efficient as undertree systems in applying water.

BELOW. Close-up of microtube outlet on a trickle irrigation system.



Immediate responses to fertilizer applications are not always apparent. Fruit trees do not behave in the same manner as an annual crop. Parts of the tree such as the trunk, leaders and roots act as storage organs and hold food reserves. These will become depleted if fertilizers are withheld for any length of time and the health of the tree will deteriorate. Sometimes heavy rainfall or irrigation can wash the fertilizer out of the root zone or a lack of moisture can render the applied nutrients unavailable to the plant roots.

Hand distribution of fertilizers is satisfactory for young trees. However, in bearing orchards, fertilizers are broadcast through a distributor. After application, fertilizers should be lightly cultivated into the soil or watered in.

Due to the sandy nature of the soil, some nutrients in the fertilizers if not used quickly by the tree may be leached out of the soil. Therefore it is more efficient to apply fertilizer requirements as split applications rather than single dressings.

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

Fertilizer recommendations—major nutrients

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

YOUNG TREES. Fertilizers must never be placed in the planting hole of young trees as severe root burning and death can result. A light application of an N.P. fertilizer can be applied in November following the winter planting.

For wide-spaced trees (approx. 250 trees per hectare) a 16:6:6 NPK mixture is suitable. Apply up to 250 g per year of tree age up to 8 to 10-years-old. This should be split into August and November applications. This

mixture contains a high percentage of nitrogen which is essential to produce good growth in the early years.

In terms of N, P, K separately, apply the following amounts per year of tree age:

N = 40 g = 100 g nitran
or 80 g urea

P = 15 g = 150 g superphosphate

K = 15 g = 30 g muriate of potash
or 35 g sulphate of potash.

For close-planted trees (greater than 600 trees per ha) the fertilizer programme should be as above up to age 4 years. At this stage, the trees will most likely be coming into bearing and should then be fertilized as bearing trees.

BEARING TREES. For wide-spaced trees, a 10:2:17 NPK is suitable. Apply up to 2 kg per tree in August and follow with up to 1 kg urea per tree in November or December. This mixture contains less N and higher K than that used for young trees as K promotes better cropping and excessive vegetable growth is avoided by lowering the N level. At this stage, P should have built up to a high level in the soil so the P content of the fertilizer can be safely lowered.

Organic manures can also be used at the rate of half a bag per tree every 3 years. These manures are not rich in N, P or K but improve the soil structure.

In terms of NPK separately, apply the following amounts per tree per year:

N = 660 g total = 590 g nitram or 450 g urea in August + 1.3 kg nitram or 1 kg urea in November.

P = 40 g = 420 g superphosphate

K = 340 g = 680 g muriate of potash or 800 g sulphate of potash.

For close-planted trees, a 10:2:17 NPK mixture is suitable. Apply up to 1 kg per tree in August for 5 to 6-year-old trees followed by 0.5 kg urea in November. Apply up to 1.5 kg per tree in August for trees seven years and older followed by 0.5 kg urea in November.

Organic manures may be applied at the rate of one-quarter bag per tree every 3 years.



Terbacil (Trade name—Sinbar (R)) around apple trees, 4 months after application.

In terms of NPK separately, apply the following amounts per tree per year:

5 to 6-years-old

N = 330 g total = 300 g nitram or 220 g urea in August + 0.6 kg nitram or 0.5 kg urea in November.

P = 20 g = 220 g superphosphate

K = 170 g = 340 g muriate of potash or 400 g sulphate of potash.

7 years and older

N = 380 g total = 450 g nitram or 330 g urea in August + 0.6 kg nitram or 0.5 kg urea in November.

P = 30 g = 330 g superphosphate

K = 260 g = 500 g muriate of potash or 600 g sulphate of potash.

Other nutrients

Granite Belt soils are often deficient in the important plant nutrients calcium and magnesium and the minor nutrients boron, zinc, copper and iron.

CALCIUM. Calcium deficiency in the soil causes mottling and death of leaves, reduces tree growth and causes apple bark 'measles'. Bitter pit may also occur in the fruit and quality and storage life may be reduced.

Calcium deficiency is remedied through the application of lime or dolomite. Sprays of calcium nitrate (800 g per 100 L) or calcium chloride (500 g per 100 L) are also recommended in December, January, and February. Calcium chloride is preferred for use on red apples.

Calcium deficiency is very difficult to correct if soil moisture is inadequate.

MAGNESIUM. Magnesium deficiency produces yellow mottling of leaves and retards tree growth. The application of dolomite assists in overcoming shortages or magnesium sulphate may be spread at the rate of 200 kg per ha.

Sprays are also useful and magnesium sulphate or magnesium nitrate are used at the rate of 2 kg per 100 L fortnightly during the spring.

BORON. Boron deficiency retards tree growth and often causes pimpling of the bark. Pollination is often poor because of poor pollen tube development. Poor quality, misshapen fruit is common with much development of corky tissue.

Every third year in late winter, spread Borax evenly around the root zone at the rate of 50 g for young trees or 100 g for mature trees.

One foliage spray of soluble polyborate at the rate of 275 g per 100 L or borax at the rate of 500 g per 100 L each November, is also recommended.

ZINC. Zinc deficiency results in reduced shoot growth, delayed leafing in spring and rosettes of small, narrow leaves being formed. The deficiency is commonly called 'little leaf'.

Control is best achieved by annual spray applications of zinc sulphate at 2.5 kg per 100 L. This spray is applied during the winter when the buds are fully dormant. Do not spray within 3 weeks after pruning as movement of zinc into the cut surfaces can kill buds lower down the shoot. However, it is safe to prune 1 to 2 days after spraying.

COPPER. Copper deficiency can severely retard the growth of young trees through causing death of the shoots. The use of copper sulphate at the rate of 100 g for young trees or 250 g for bearing trees applied as a soil dressing will correct the deficiency.

A spray prior to bud burst of 400 g copper oxychloride or 800 g Bordeaux mixture per 100 L may be used when deficiencies occur.

IRON. Iron deficiency is difficult to correct. Leaves appear yellow and chlorotic but the main veins normally remain green.

Encouraging sod growth and adding extra soil around the trees is often helpful. Sprays of iron chelate at the rate of 100 g per 100 L may be helpful but are expensive.

Irrigation

For the maximum growth and crop yield, the soil moisture content should be maintained as close to field capacity as possible. As soil moisture stresses occur in most growing seasons, irrigation is recommended.

Systems

Movable sprinkler systems, permanent sprinkler systems, trickle systems and travelling irrigators are used in the Granite Belt. Overhead sprinkler systems offer the advantage of frost protection but are not as efficient as undertree systems in applying water.

Trickle irrigation is popular in the Granite Belt because water supplies are limited and it is cheaper than other permanent systems. Trickle irrigation is almost 100% efficient in applying water to the root zone. The general recommendations are four 4 l per hour drippers for each large, wide-spaced tree and two 4 l per hour drippers for each close-planted tree.

Microjet irrigation is similar to trickle irrigation in all respects except that the dripper outlets are replaced by small microjets which discharge the water as a fine spray. As a result, a larger surface area and a larger root zone volume is wetted. A microjet irrigation system is a larger capacity system than the average trickle irrigation system and hence costs more to install.

For both trickle and microjet irrigation systems, good filtration of the water is essential. Soluble fertilizers are easily injected through these systems.

Critical stages

If irrigation water is limited and complete irrigation is not possible, then irrigation is best used at the following critical stages:

- One month before flowering to 1 month after flowering. Adequate moisture will help to ensure a good fruit set and early fruit development.
- Midseason to colour development is the next critical stage. During this stage, lack of soil moisture will reduce fruit size. Also the initiation of fruit buds for the following season's crop occurs during this period.
- After fruit removal, irrigations up until leaf fall will help root growth, fruit bud development and store reserves for shoot growth in the following spring.

Water requirements

In an average season, wide-spaced apple trees have an irrigation requirement of about 150 mm or about 1.5 million l per hectare. Close-planted apples have an irrigation requirement of about 300 mm or 3 million l per hectare.

The water storage capacity needs to be double the average quantity required for irrigation to allow for a drought year plus a little extra capacity for evaporation loss from the dam surface. Also, allowance must be made for the efficiency of the irrigation system. The irrigation requirements given above assume 100% efficiency of application.

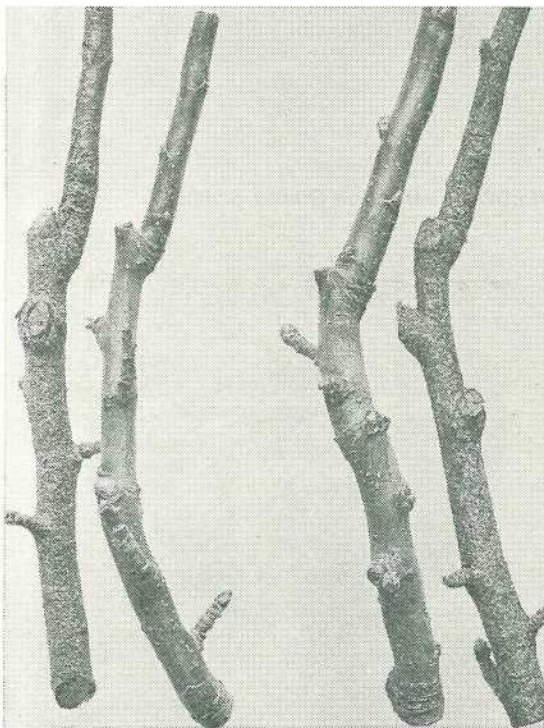
If, for example, the efficiency of applying the water to the root zone was only 70% (overhead sprinkler irrigation on a hot day), the irrigation requirement would be about one and a half times as high and the storage capacity would also have to be higher. It is also assumed that the dam fills only once each year.

System design

The system should be designed to meet the peak irrigation requirements of the crop. The peak irrigation requirement of a wide-spaced apple tree could reach 180 l per tree per day and 50 l per tree per day for a close-planted tree (4 m x 2 m).

Management

A reasonably high moisture content should be maintained in the wetted root zone without impairing aeration. This will ensure ideal conditions for active root growth in all parts of the wetted root zone.



Healthy twigs and twigs infested with San Jose scale. Scales are most commonly seen on the bark where they give an ashy appearance.

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.

Weed control around trees is best achieved by using herbicides.

Herbicides

Around young trees (up to 3 years), the herbicide dichlobenil will give pre-emergent control of annual grasses and broadleaved 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 broadleaved 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.

If cobbler's pegs are a problem, simazine can be added to terbacil to give effective control. The mixture should be applied in spring and will give weed control for 4 to 6 months.

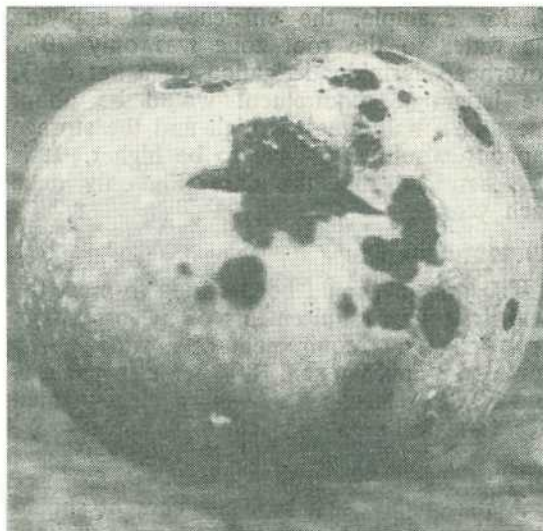
For control of perennial grasses such as paspalum, couch and kikuyu, 2,2-DPA can be added to terbacil or used alone as a spot treatment. The grass should be young and growing actively when sprayed to achieve best results.

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 regularly incorporate a well-grown winter cover crop into the soil. This green manure will help to raise organic matter levels.

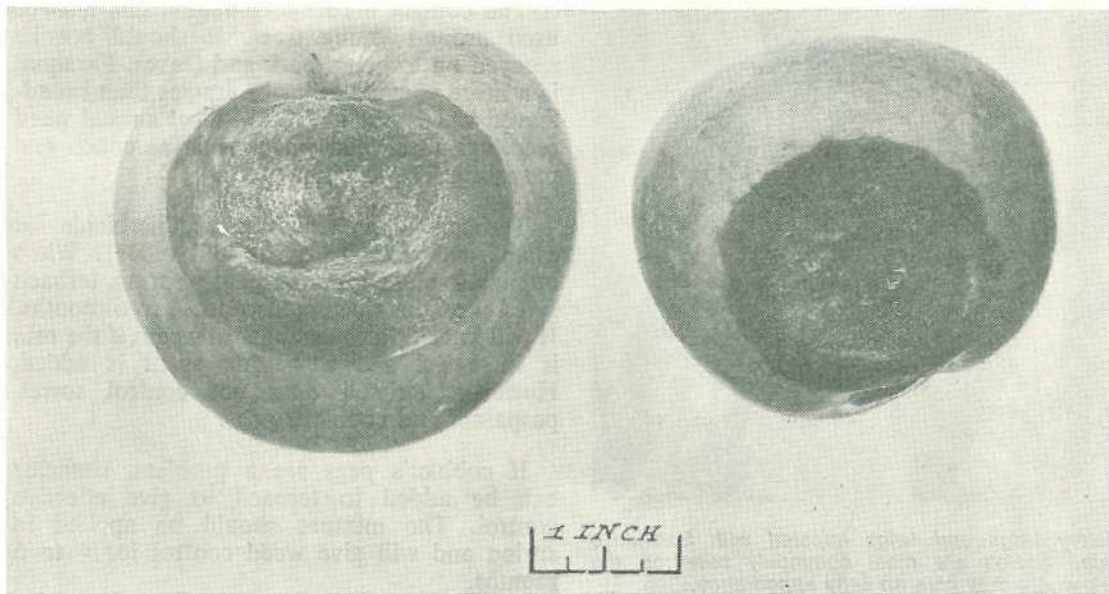
Oats is the recommended cover crop for Granite Belt orchards. Planting may take place from February to March and the soil should be moist to ensure good germination. Suitable oats varieties for the Granite Belt include Rodney, Saia, Minhafer and Garry.

A rough seedbed is prepared in February and fertilizer at the rate of 200 kg per ha of superphosphate and 100kg per ha of urea is lightly worked into the soil. These fertilizers should not be mixed together. About 1 week later the seed is broadcast at the rate of 30 to 45 kg per ha and covered using spring tines or discs.



ABOVE. Apple badly infected with black spot.

BELOW. Bitter rot on Granny Smith.



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 the Granite Belt but there is scope for its increased use where irrigation is available.

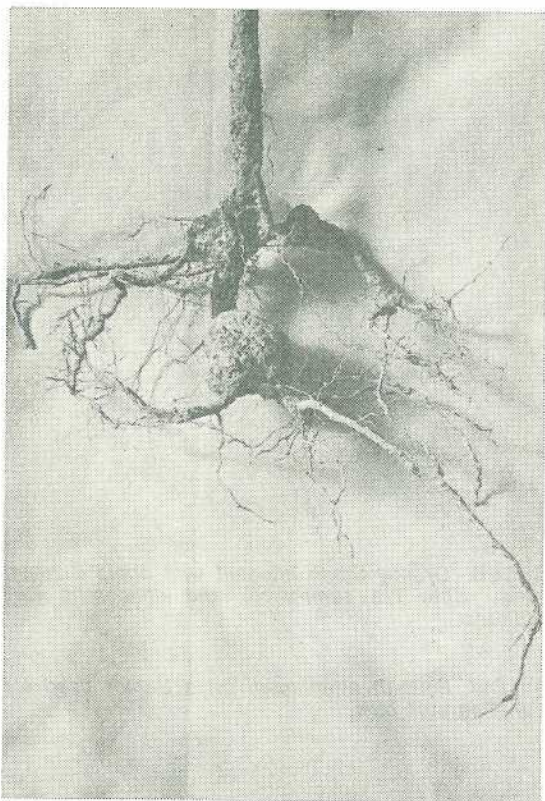
Under sod, tree roots are not cut through cultivation and the surface soil can be used by the roots. As well, soil temperatures are lower in the summer months, erosion is reduced and cultural operations can be resumed shortly after rain. Because the sod competes with the tree for moisture, it is not recommended unless supplementary water is available.

If sod is allowed to grow unchecked, not only are moisture requirements greater but the possibility of spring frosts is increased. If sod is allowed to flower around tree blossoming time, it may be preferred by pollinating bees. Frequent mowing keeps the sod down and prevents these problems.

Young trees do not like weed competition in their early establishment stages. For this reason, 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 ha, planted in March.

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

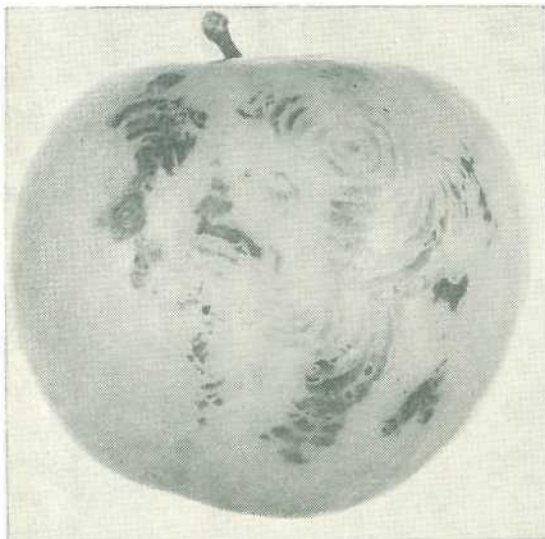


Crown gall on a young apple tree.

Mulching

Mulches suppress weeds, prevent loss of soil moisture by evaporation and modify soil temperatures particularly in the hot summer months. The surface soils become 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 to a depth of 50 to 75 mm to suppress weeds but even at this depth invasion by couch grass can occur. Sawdust slowly becomes incorporated into the soil and unless nitrogen is added it may cause nitrogen deficiencies. It has been used on the Granite Belt but supplies are limited.



ABOVE. Granny Smith infected with apple ringspot virus. Note the semi-circle and concentric ring patterns.

BELOW. Fork-lift attachment on a tractor used for handling bulk bins.



Black plastic sheets one metre square can be laid around young trees at planting time. Cultivation of the remaining soil area is carried out. Weeds develop around the margin of the plastic and should be controlled by knockdown herbicides.

Straw mulches have been used but are very expensive.

Thinning

In a normal blossoming year, only 5% of apple flowers need to set to produce a reasonable crop. Given good pollinating conditions this figure is often exceeded so the crop load must be reduced otherwise fruit size will suffer. An excessive crop load also reduces bud formation and yields for the following year's crop.

The amount of fruit that can be left on the tree varies considerably. Factors such as tree size, age and health plus past history must be considered. Trees with good growing conditions such as adequate moisture and nutrients and good soil management practices can take a larger crop load than trees with poor growing conditions. Fruit clusters are thinned to one or two depending upon tree performance and the grower's preference.

The earlier excess fruit is removed from the tree, the greater is the chance of obtaining optimum tree performance. Chemical thinning is carried out shortly after blossoming and is followed by spot hand thinning as soon as fruitlet drop ceases. Chemicals used with success in the Granite Belt are NAA and the insecticide, carbaryl.

The thinning effects of these chemicals, particularly NAA, depends a lot on weather conditions at time of application. Greater absorption takes place and hence greater thinning effect under misty weather and slow drying conditions. These conditions can be stabilized by using a wetting agent and Tween 20 has been found to be the best material for this purpose.

Current major varietal recommendations are as follows:

Gravenstein: at calyx — 5 p.p.m. NAA plus 125 ml Tween 20 per 100 L

or

15 to 20 days from full bloom—carbaryl at 125 g in 100 L

Jonathan: at calyx—7.5 p.p.m. NAA plus Tween 20

or

carbaryl as above

Delicious: carbaryl as above

Granny Smith: Normally, thinning is not necessary.

As NAA is the stronger thinner of the two, it is preferred for the hard to thin Jonathan and Gravenstein varieties. Carbaryl is recommended for the easier to thin variety Delicious. NAA is only effective around calyx and carbaryl gives its maximum thinning effect 15 to 20 days after full bloom.

Most of the apple crop is borne in the top half of the tree, particularly the strong fruit

buds at the tips of the leaders. This may require extra attention and in years of heavy set, two sprays may be required in this area.

Carbaryl is highly toxic to bees so care must be taken when spraying.

A chemical thinning programme does not mean the end of hand thinning. Spot hand thinning can be quickly followed up with advantage.

Pre-harvest drop

Some early and midseason varieties have a tendency to drop part of their crop just prior to harvesting. This pre-harvest drop can be so severe that a large part of the crop is lost. Gravenstein is the worst major variety affected but Jonathan and Delicious may be affected in some years. The fruit drop is accentuated by hot, dry and windy conditions.

Fruit drop is caused by too rapid formation of a corky barrier, called the abscission layer, in the fruit stalk which cuts off the sap flow. This natural development of the abscission layer can be slowed by the use of stop-drop sprays.

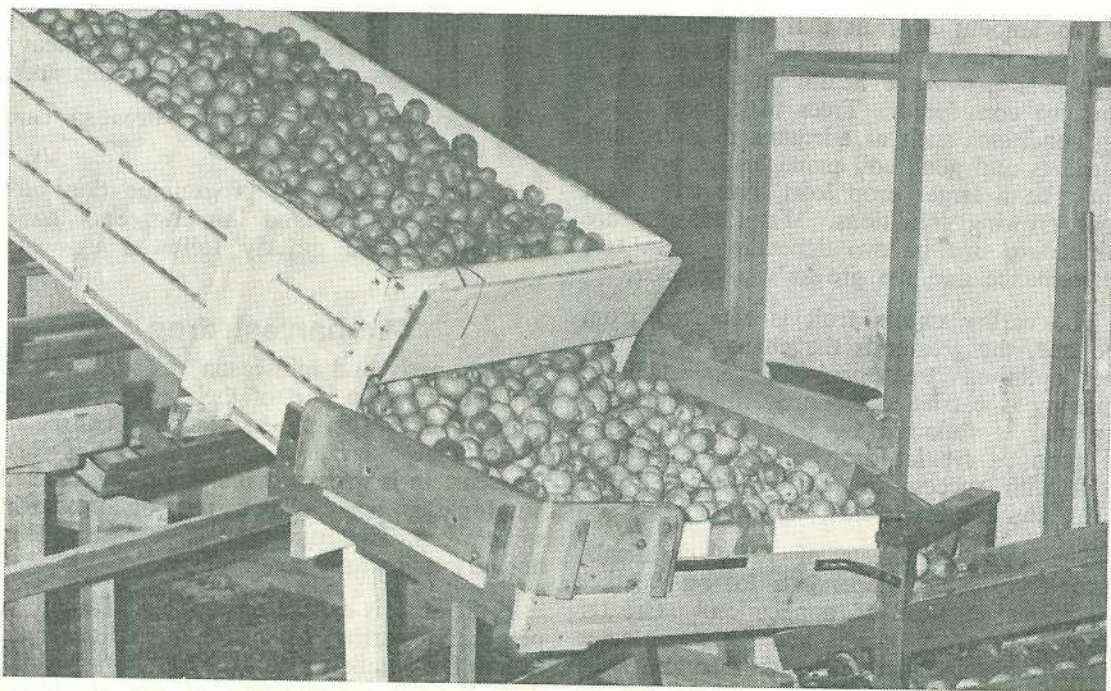
Naphthalene acetic acid (NAA) is the most widely used spray. It should be applied at 10 to 20 p.p.m. just prior to harvest or just after the first drop of healthy fruit. Its effect lasts for only 14 days so more than one spray may be required in an extended harvesting season. NAA tends to accelerate ripening and if growers wait until normal harvesting time for blush development, the fruit may be over-ripe at picking.

Alar is an alternative stop drop spray but is more expensive than NAA.

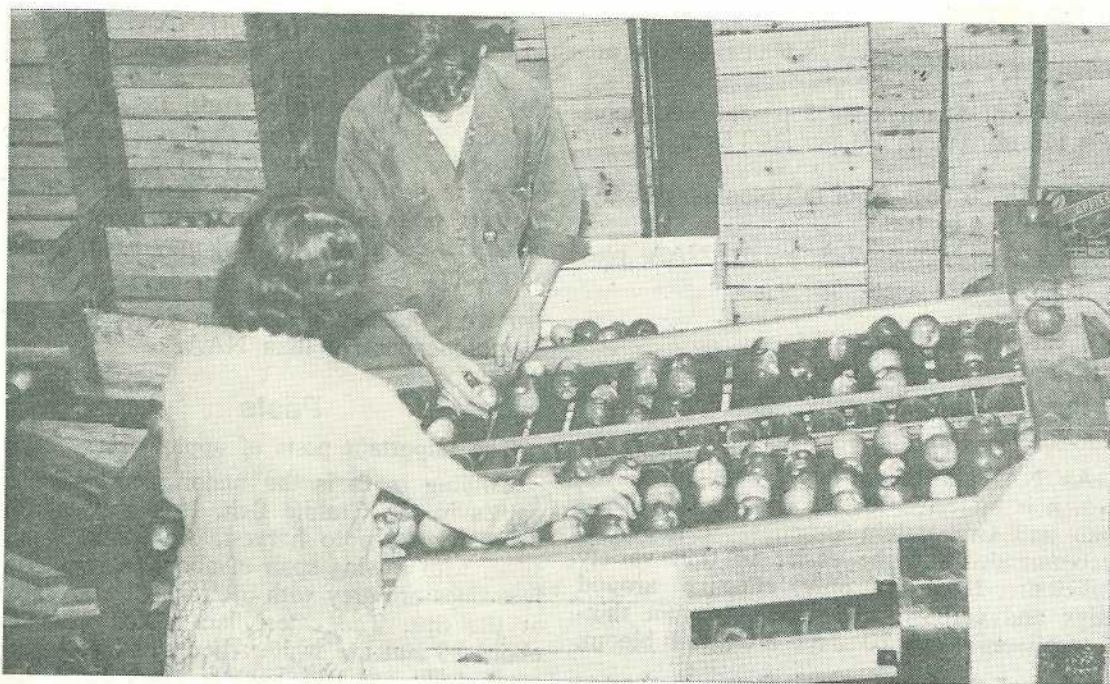
Pests

The important pests of apples are:

Codling moth is the major insect pest of apples in the Granite Belt. It is active from the calyx stage to harvest. Adult moths are small with a wing span of about 20 mm. The forewings are grey with a circular bronze area at the tips. The caterpillars which grow to about 20 mm are white when small and pink when fully fed and have a black head and black band just behind the head.



Emptying apples from the bulk bin into the grader hopper.



Spotting—culling of poor quality fruit. Only good quality fruit should reach the packers.

The moths lay eggs singly on or close to the fruit. Young larvae penetrate the skin and tunnel towards and feed on the seeds and surrounding tissues. When fully fed, they tunnel to the outside and leave the fruit to pupate. The entry and exit holes are usually surrounded by dark brown, sawdust-like frass. Damaged fruit often drop prematurely.

Two-spotted mite. Adults and nymphs are yellowish to white, spider-like mites with two dark spots on the back. Adults are up to 0.5 mm long while the eggs are clear, white and spherical. Colonies of mites produce webbing on leaves, usually on the underside. Large populations produce large amounts of webbing in trees in autumn. This mite overwinters as orange coloured adult females sheltering in litter and soil at the base of trees or as the two-spotted form breeding slowly on evergreen plants.

Two-spotted mites feed on leaves by piercing the surface and extracting sap from the underlying cells. The leaves become mottled and bronzed and drop prematurely. Fruit from damaged trees fails to colour or size properly and the juice content is reduced. Premature defoliation exposes fruit to sunburn.

European red mites are small (up to 0.5 mm long), dark red, globular shaped mites. They cause similar damage to the two-spotted mite. The eggs are orange to bright red and are spherical with a fine hair projecting from the upper surface. This mite overwinters in the egg stage on the tree. It does not produce webbing on foliage but on severely damaged trees, adult females can be seen suspended on silken threads which are blown by the wind and enable the mites to disperse.

Queensland fruit fly is a serious pest in Granite Belt orchards. 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 the fruit is ripening favour fly activity. Fruit fly lure traps provide the best guide for the timing of chemical control measures.

San Jose scale is potentially a serious pest. The adult female is a sedentary, soft-bodied, sap-sucking insect covered with a hard, grey to dark brown scale with a central raised darker area. The insect is about 2 mm in diameter. The males are covered with an elliptical scale with the raised area to one end.

Scales are most commonly seen on the bark where they give an ashy appearance. On fruit, scales are often surrounded by a red halo. Low infestations reduce the vigour of trees but high populations may cause the death of leaders and young trees.

Light brown apple moth is usually a minor pest in Granite Belt orchards. Adult moths are about 20 mm long with brown forewings. Caterpillars which grow to about 25 mm are green. They web leaves and/or fruit together to form a shelter in which they feed.

Leaves are skeletonized and have a ragged appearance. Fruit have shallow, irregular-shaped areas chewed in the skin. Occasionally, caterpillars may enter fruit at the calyx end.

Woolly aphids are soft-bodied, purplish-brown, sucking insects which are covered with a white, woolly material. Colonies are located on the woody tissues of trees and large populations reduce the vigour of trees. Laterals may be defoliated prematurely and buds destroyed. Infested wood becomes severely swollen and gnarled. The aphids also produce a sticky secretion on which black, sooty mould rapidly develops. The white 'wool' and sticky, black, sooty mould makes fruit unattractive.

Thrips are present every season in flowers from early bud burst to calyx. Mature adults are small (up to 1.5 mm), elongate, active, brown-winged insects. Young adults and nymphs are white. Thrips feed by rasping plant tissues and sucking the exuding juices. When they feed in unopened flowers, female styles are damaged and subsequent fertilization and fruit set are prevented.

Dimple bugs are small (up to 2.5 mm), active, yellow-green bugs which are found in flowers and on very young fruit. They pierce and suck sap from the developing fruit. The puncture first appears as a small, raised area of scar tissue, resembling a wart. As the fruit grows, the damaged tissue fails to grow as fast as the surrounding tissue. The damage appears as a characteristic dimple at harvest.

Native budworm (*Heliothis*) and looper caterpillars are sporadic pests in Granite Belt orchards. Budworm caterpillars are up to 40 mm long and vary in colour from green to brown with varying amounts of black colouration. Looper caterpillars are small (up to 15 mm) and dark and are characterized by their looping movement. Both caterpillars feed on young fruit.

Diseases

Successful apple growing depends on the control of diseases caused by fungi, bacteria, nematodes and viruses.

Fungi

The most important of the fungal diseases are black spot (scab), powdery mildew, bitter rot, sooty blotch, *Armillariella* root rot, and collar rot.

BLACK SPOT infects leaves and fruit. Leaf spots begin as small, light olive-green lesions about 3 mm in diameter and enlarge to become velvety and black. Fruit spots begin as small, dark lesions which combine to form large, scabbed and corky areas.

In spring, infection of the young leaves and fruit occurs in wet weather from ascospores released from old apple leaves on the orchard floor. Spots appear on the leaves 2 to 3 weeks after infection. Secondary spores produced on these spots spread the disease in summer particularly in wet, windy weather.

Spring infection can be greatly reduced by spraying the trees with 5% urea just before leaf fall commences. During the season, spraying with protectant fungicides is essential. Eradicant chemicals will give satisfactory control if they are applied within 3 days of infection.



Bulk bins of apples in cool storage.

POWDERY MILDEW reduces the vigour and yield of trees and causes russetting of the fruit. Jonathan, Gravenstein and Granny Smith are the most susceptible varieties.

The disease attacks leaves, twigs, buds, flowers and fruit and produces white to light grey powdery patches on infected tissues. Diseased leaves curl, wither and die. Shoots cease growth and may be killed at the tip. The fungus overwinters in flower and leaf buds and in the following season it infects new leaves and blossoms.

Powdery mildew control depends on thorough pruning in winter to remove all infected shoots and regular spraying during the growing season.

BITTER ROT affects fruit nearing maturity and causes severe losses in storage. Jonathan and Granny Smith are susceptible.

Fruit first shows small, brown, circular spots which rapidly enlarge and become sunken in the centre. Masses of pink spores in concentric rings develop on the spots. The disease survives between seasons on rotted and mummified fruit.

Bitter rot control requires the removal of diseased fruit from the orchard and regular spraying with fungicides.

SOOTY BLOTCH attacks ripening apples particularly in humid weather. Dark grey to dull black spots of indefinite shape develop on the skin. Granny Smith is very susceptible. The protectant fungicides used to control black spot will control sooty blotch.

The fungus causing *ARMILLARIELLA* ROOT ROT is a common parasite of native trees and attacks apple trees especially those planted in new ground.

Affected trees develop small, pale green to yellow leaves and wilt. Young trees die but larger trees may have only some limbs affected. A trunk and crown rot develops and the bark dies and rots near ground level. White, fan-shaped mats of the fungus are present beneath the bark. Some or all of the roots have thick, black threads of the fungus resembling shoestrings on the surface.

Armillariella root rot is very difficult to control. Apple trees should not be planted in newly cleared land for at least 2 years. Remove all roots and wood of native trees before planting. In replant land, treatment with methyl bromide in conjunction with fumigation with DD is also recommended.

The COLLAR ROT fungus attacks young trees producing a rot at or just below ground. Brown resting bodies of the fungus (*sclerotia*) which are about the size of cabbage seed form on the surface of the affected stem or in the adjacent soil.

Losses from collar rot may be reduced by drenching the base of young trees with quitozene as soon as they are planted and again in midsummer for three growing seasons. Older trees appear to have more resistance to the disease.

Bacteria

CROWN GALL is a bacterial disease which attacks the crown and roots of trees. It forms galls or swellings occasionally as large as

10 cm in diameter. No control measures have been developed. Do not plant nursery trees with galls at the base of the stem or on the roots.

Nematodes

ROOT-LESION NEMATODES cause slow decline and replant failure in apple orchards. Females and larvae of these small, worm-like animals which are too small to be seen with the naked eye, enter and destroy the young roots. Heavily infested trees have relatively few white fibrous roots.

These nematodes are not found in virgin land but are in the roots of most nursery trees, particularly those on clonal rootstocks. An infested tree planted in new ground and well cared for, may grow satisfactorily for years before decline becomes evident. When the tree is removed and the site replanted, the young roots of the replant tree are invaded by large numbers of nematodes and the tree remains small and unthrifty.

When replanting tree sites in an established orchard, remove all the roots of the original tree and fumigate the site with methyl bromide. This is best done before May.

When replanting orchards, remove tree roots and spell the area as long as practicable. Prepare the soil by ploughing deeply, ripping and discing. Fumigate the whole area with DD at 440 litres per hectare. Fumigation should be completed by mid April as DD is not effective at low soil temperatures.

Viruses

APPLE MOSAIC VIRUS is common especially on Jonathan. The symptoms are yellow to almost white speckles, blotches and netted patterns on leaves. Symptoms often develop on only one side of a tree or on one or two limbs and vary in intensity from year to year. In severe cases, mosaic causes lack of vigour and reduces yields.

GRAVENSTEIN GNARL OR FLAT LIMB VIRUS is a serious disease of the Gravenstein variety. Flattened areas develop along the limbs causing a twisted, gnarled appearance. Considerable loss of yield results when the disease is severe. Other varieties may carry the virus without showing symptoms.

GREEN CRINKLE VIRUS affects the fruit on Granny Smith trees. Young fruit show depressed areas later develop severe indentations and malformations. The fruit on only part of a tree may be affected and there is a great range in severity.

APPLE RINGSPOT VIRUS develops dark brown rings, semi-circles, or concentric ring patterns on maturing fruit. These symptoms vary greatly and sometimes consist only of small brown spots without conspicuous halves. In some seasons only a few fruit on a tree show well-developed symptoms. Apple ringspot has only been recorded on Jonathan and Granny Smith trees in the Granite Belt.

Viruses are spread by propagating with diseased budwood and rootstocks. They are not spread by insects or pruning. All apple viruses can be controlled by the use of virus-tested budwood and rootstocks.

Harvesting

Apples are harvested between January and May each year. The time to harvest varies with the maturity of each variety and the proposed use of the fruit.

Maturity

DESSERT. Blushed varieties should be picked when the unblushed portion of the skin (ground colour) changes from green to greenish yellow. At this stage there is also a change in the flavour from a floury to sweeter taste. For green-skinned dessert varieties, the colour of the skin should be changing from dark green to a lighter green when picking commences.

Picking of Jonathan and Delicious varieties is prohibited before 1 and 10 February, respectively, for apples 70 mm or larger. The earliest picking date for apples smaller than 70 mm is 7 and 17 February, respectively.

COOKERS. These apples can be harvested before fully mature in which case they are picked to size. However, if picked too immature the fruit will wilt after 7 to 10 days.

Dessert apples may be sold as cookers provided the skin colour is not showing any blush.

COOL STORAGE. Selection of apples for cool storage especially long term cool storage and controlled atmosphere (C.A.) storage requires careful assessment of maturity. Fruit harvested immature or overmature will be of poor quality after long term storage. The key to successful cool storage is to store only good quality fruit of the correct maturity.

Picking and handling

As fruit on one tree may vary in maturity up to 1 month, apple trees are generally picked two to three times before the whole crop is harvested.

The correct way to pick apples is to push the fruit upward and twist the fruit so that the fruit stalk is left attached to the fruit. Fruit should not be pulled off the tree as this may break a spur or pull the stalk out. A spur left on the stalk may cause bruising during handling while removing the stalk will leave an open wound.

Fruit should be handled carefully while harvesting and during placement into picking bags, emptying into bulk containers or cases and packing into cases or cartons. Fruit handled roughly will bruise easily.

There are many different systems of bulk handling in the field, movement of bulk containers in the packing sheds, and methods of emptying fruit into grader hoppers. Bulk containers usually hold about 20 packed bushel cartons. Ease of handling of bulk containers by fork lifts and a steady flow of fruit into the grader hopper over padded or smooth planed boards are the main essentials.

Grading and packing

Grading

Various types of graders are available for grading apples. Most work on the principle of a conveyor belt and sizing rollers. The basic difference between graders is that the cheaper models lack the fittings for fine adjustment in sizing which is sometimes necessary for accurate sizing of different varieties.

The efficiency of the grader is largely dependant upon the skill of the operator. For good grading, the grader should be accurately adjusted for size, well padded on corners and edges to avoid bruising, and free from dust and grit which if present may puncture the skin of the fruit.

Spotting

Culling of poor quality and blemished fruit occurs at picking, grading, and packing. Only good quality fruit should reach the packers. Pickers and spotters need to be aware of the standard of fruit required. This standard may vary annually depending upon the availability of apples.

Packing

The standard carton used is the Australian Tray Carton which has internal dimensions of 500 mm x 300 mm x 275 mm. By varying trays, this carton may be packed as an Australian Tray Carton Pack (A.T.C. or Scoresby) or the Standard Apple Pack.

Grading and packing regulations

The Fruit and Vegetable Grading and Packing Regulations require that dessert apples packed for sale be of one variety, sound, clean, well-formed, not shrivelled, mature but not overripe and free from broken skins. The fruit should not be less than 55 mm in size.

Superficial blemishes may be permitted provided that the total surface area covered by such blemishes on any fruit is smaller than a circle with a diameter of 15 mm. Where the blemishes are restricted to hail marks, the maximum surface area permitted is a circle with a diameter of 25 mm. Russetting is not considered a blemish provided that no more than half of the surface is affected.

Cooking apples must be sound, clean, well-formed, not shrivelled, free from broken skins, and of similar varieties. They must not be less than 65 mm in diameter during December, January, and February, and not less than 55 mm at all other times.

Superficial blemishes from any cause are permitted provided that the total area covered by such blemishes on any fruit is smaller than a circle with a diameter of 20 mm. Dessert apples may be sold as cookers provided that they do not show any blush colour.

Marketing

The outside of packed containers must be legibly and durably stamped or stencilled with the following:

- Name and address of grower and agent.
- The word 'apples'.
- In the case of dessert apples, the name of the variety.

- In the case of cooking apples, the word 'cookers'.

- The count, or in the case of volume fill or vibrapack, the size or the word 'unsized'.

Except when they are volume filled or vibrapacked, apples packed for sale should be sized so that the variation between the diameters of any two apples in the package does not exceed 5 mm.

Apples which are volume filled or vibrapacked can be sized or unsized. If sized, the apples should be packed so that only apples within the following size markings are contained in the package:

'Small' means fruit greater than 55 mm in diameter but less than 60 mm.

'Medium' means fruit greater than 60 mm in diameter but less than 70 mm.

'Large' means fruit greater than 70 mm in diameter.

About 60% of the apples are sold through the Rocklea Markets in Brisbane, 15% to other Queensland markets, 15% to New South Wales, and 10% are processed.

In some years, apples are exported to New Guinea and the Pacific Islands, South-east Asia and Europe. The fruit must comply with the export regulations for the country which they are being sent to.

Cool storage

With the use of cool storage, fresh apples can be supplied throughout the year. Excellent results can be obtained provided careful attention is paid to a number of factors. Apple varieties vary greatly in their behaviour in cool store and management of the store is a skilled operation.

Important factors to consider when selecting and storing apples include:

- Variety and tree age.
- Maturity at harvest.
- Pre-storage treatment.
- Storage conditions.
- Removing fruit from store.

Variety and tree age

Apple varieties vary greatly in storage behaviour. In general, varieties which mature early in the season do not store as well as late-maturing varieties. On the Granite Belt, the main varieties stored for long periods are Granny Smith, Delicious, Crofton, Legana while varieties such as Jonathan and Gravenstein have only a short storage life and are generally sold soon after harvest. Fruit from trees which have settled into regular cropping are the most suitable for storage.

Maturity at harvest

The maturity at harvest is probably the most important factor in relation to the storage life of the apple and development of storage disorders. If fruit are picked too early, superficial scald, bitter pit and core flush are likely to develop while fruit picked after the optimum time often develop lenticel spotting, watercore and soggy breakdown.

There is no absolute test to determine fruit maturity but colour and firmness are often a reliable guide. Picking to a calendar date is also generally satisfactory and experience has shown that the following picking periods for the main varieties have given good results in cool store:

Jonathan	10 to 15 February
Delicious	1 to 10 March
Granny Smith	15 to 20 April

When the fruit is intended for Controlled Atmosphere (C.A.) storage it should be picked slightly earlier than these times.

Pre-storage treatment

Apples in store are susceptible to the disorder known as bitter pit where small, sunken pits develop in the skin and pulp of the fruit. The problem is more serious in early picked fruit especially from young trees or heavily pruned trees. Bitter pit is caused by calcium deficiency but the problem is aggravated by water deficiency. Under these conditions, the tree cannot supply enough calcium to the fruit and bitter pit develops.

Trees should be sprayed with calcium salts in mid December, mid January, and early February. Calcium chloride (500 g/100 L) or calcium nitrate (800 g/100 L) are used. Calcium chloride is preferred for red apples. Post harvest dipping using these salts is also bene-

ficial and is often carried out in conjunction with dipping for scald control.

Superficial scald is an important storage disorder especially in early picked fruit. This unsightly browning of the skin can be controlled by the use of diphenylamine either as a dip or impregnated in wraps.

Storage conditions

Satisfactory storage conditions can only be obtained in a well-constructed, properly-insulated cool room. Temperature and relative humidity in the store must be carefully controlled. Ventilation is also important.

TEMPERATURE. For different varieties of apples, different holding temperatures for long storage are recommended. Since it is difficult to maintain cool room temperatures at a precise figure, a range of temperature is normally specified with the mid-point of this range being the most satisfactory temperature. Suitable storage temperatures for the main varieties are:

Jonathan	2 to 3°C
Delicious	-1 to 0°C
Granny Smith	-1 to 0°C

Generally if apples are held above the recommended temperature, fungal rots and bitter pit as well as shortened storage life may result. Storing at too low a temperature can result in low temperature breakdown, coreflush and deep scald.

HUMIDITY. Fruit in store must be held at a high humidity of 85 to 90% to avoid shrivelling as a result of excessive loss of moisture from the fruit.

To maintain store humidity, water can be added to the room. It is a good practice to always have some free water on the floor. However, the only really satisfactory method of controlling humidity is to ensure that the cooling system is correctly designed for the room.

The evaporator coil (cooling coil) must operate in conjunction with a unit of sufficient size to remove the heat load from the room. In practice, this means there must be only a small temperature difference between the air passing over the coil and the refrigerant temperature in the coil. For normal apple cool stores, this difference should not be greater than about 5°C.

A high temperature difference means that moisture in the room will be continually condensing on the very cold coil and moisture may be lost from the fruit to restore air humidity. In addition, frosting of the coil reduces its efficiency and frequent defrosting becomes necessary.

VENTILATION. While in cool storage, apples respire continuously, producing carbon dioxide and traces of many gases including ethylene which is a fruit ripening agent. A build up of these gases can be toxic to the apples or at least will hasten the end or storage life.

Production of these gases is very rapid during the first weeks of storage and decreases thereafter. It is therefore important that the room should be ventilated occasionally especially if the apple "Smell" becomes very obvious. However, ventilation should not be carried out indiscriminately as temperature and humidity conditions will be upset.

Removing fruit from store

There is no reliable method for predicting the storage life of apples or any other fruit in cool storage. However, storage operators and growers should try to exercise some sort of quality control by making regular examinations of the fruit in storage. A few fruit at a time may be removed to air temperature and held for a few days noting any disorders which appear. Examinations such as this allow a line of fruit to be sold in best condition.

However, it must be remembered that the condition of fruit on removal from store will not be the same as its condition when sold to the public some days later. Many disorders such as scald and bitter pit sometimes only appear when the fruit warms to the outside temperature.

Whenever possible, growers should experiment to find the conditions which best suit their own fruit. Records of the nature and extent of wastage can be kept and an attempt made to tie this in with picking date, season, the area where the fruit was grown, pre-storage treatment, handling or other factors.

Controlled atmosphere storage

Controlled Atmosphere (C.A.) storage is now widely used throughout the world for the long storage of high quality fruit. In

normal cool storage, the respiration rate of the fruit is lowered by the low temperature and hence the life of the fruit is prolonged. In C.A. storage, the cool room is made airtight and the actual amount of oxygen available for the fruit to respire is greatly reduced. This has the effect of further slowing down the normal life process within the apple with a consequent further lengthening of storage life.

The operation of a C.A. store is a skilled process. Careful monitoring of temperature and atmosphere composition within the store must be continually carried out. It is not possible to enter the store and examine the fruit at regular intervals as in normal storage, thus the operator must be guided by his instruments. These must reflect precisely the storage conditions. Similarly, refrigeration equipment must be in first class condition and the in-store components of the system must be capable of working efficiently for many months without attention.

As the apples respire they produce carbon dioxide gas which can very quickly build up to toxic levels if not removed. Sophisticated gas generators and scrubbers are now available which can be used to maintain the correct levels of oxygen and carbon dioxide within the room. Hydrated lime scrubbers are also often used for carbon dioxide removal. The levels of oxygen and carbon dioxide gases in the store are normally recorded twice daily and appropriate adjustments made.

Granny Smith and Delicious apples are satisfactorily stored on the Granite Belt at 0°C in an atmosphere containing approximately 2.5% oxygen and 2.5% carbon dioxide.

Growers or normal store operators contemplating controlled atmosphere storage should consult officers of the D.P.I. at Stanthorpe. Advice is available on the many facets of the procedure such as store construction and sealing, temperature and atmosphere monitoring and the use of generators or scrubbers for maintaining the storage atmosphere.

C.A. stored fruit generally commands a premium price on the fresh fruit market but because C.A. storage is an expensive undertaking only high quality fruit should be considered as suitable for this type of storage.

What are minimal disease pigs?

THERE are substantial economic advantages in keeping 'minimal disease' (M.D.) pigs. However, there is often confusion about the meaning of 'minimal disease' and other related terms such as 'specific pathogen free' and 'hypar'.

This article attempts to clarify these expressions and explains the concept of breaking the disease transfer cycle between sows and their progeny.

The minimal disease concept

Many infectious diseases are transferred from the sow to her offspring after they have been born; breaking this cycle of transference is the basis of the minimal disease concept. If piglets are reared in total isolation from their mother and all other non minimal disease pigs (that is they never come in contact with or even breathe the same air as other pigs) they will not become infected with certain disease causing organisms (pathogens) that are normally present in all pigs.

As a result, the cycle of transfer of organisms from one generation (the sow) to the next (her offspring) will have been broken. For example, few sows infected with Enzootic Pneumonia show any clinical sign of the disease, but the expired breath of most sows contains the micro-organism that causes the disease in young pigs.

Techniques for breaking the cycle

There are several ways of preventing contact between a sow and her piglets. The most commonly adopted technique is by hysterectomy or hysterotomy procurement. In this

technique, a sow is killed approximately when she is due to farrow and her uterus is immediately removed. The uterus may then be placed in a special cabinet, similar to a humidicrib (see plate 1) where the piglets are removed from the uterus.

More simply, the uterus may be immersed in a disinfectant solution, moved well away from the sow's carcass, opened up and the piglets tended in a laundry basket. When the piglets are all breathing well, have had their navels clamped and need no further immediate attention, they are taken to where they are to be reared.

If the piglets are then reared in total isolation from all other pigs they are said to be primary minimal disease stock. The term 'Hypar' (Hysterectomy-Procured, Artificially-Reared), is used to describe this procedure.

More commonly nowadays, hysterectomy procured pigs are fostered on to sows that are the progeny of Hypar pigs. Such piglets are said to be secondary minimal disease stock. It is easier to rear piglets by fostering rather than in total isolation; that is, produce secondary rather than primary minimal disease stock. However, the whole object of the hysterectomy is lost if the disease status of the foster mother is unsatisfactory.

Artificial rearing of hysterectomy procured piglets is now only used to establish a M.D. piggery when foster mothers of satisfactory health status are not available.

Contact between mother and piglets can also be prevented by performing a hysterectomy (caesarian section) operation on the sow. The advantage of this technique is that the sow is not killed. However, the procedure is more complicated and there is an increased risk of diseases being spread from the mother to the piglets.

Of historical interest, a third technique allows the sow to farrow normally in the open air. As each piglet emerges from the birth canal it is immediately removed, swiftly carried at least 50 m away against the air flow and fostered on to a sow of satisfactory health status. This is known as the 'snatch' method and it is vital in this procedure to ensure that both the farrowing pen of the donor sow, and

by W. R. Webster, Veterinary Services Branch.

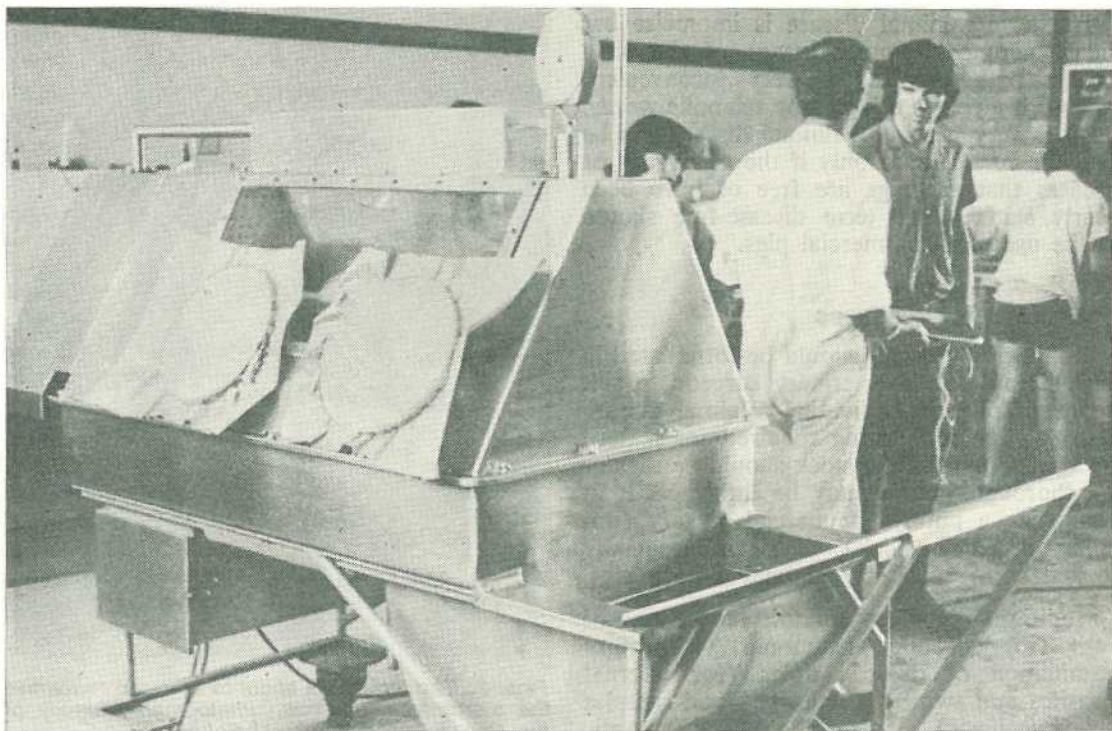


Plate 1. The equipment receives the uterus through the disinfectant bath on the right. The uterus is opened and the piglets are revived inside the cabinet. Photograph courtesy of the Queensland Agricultural College.

the area where the piglets are reared have not been previously contaminated by other pigs. Snatched piglets can also be artificially reared.

Definition of terms

The term minimal disease can only be applied to pigs that have been obtained by one of the above techniques or their progeny. They must also be raised in such a way as to maintain this health status. Herds claiming M.D. status should be periodically checked to confirm that the diseases have been eliminated as claimed, and that they have not been subsequently introduced.

Minimal disease pigs should be free of:

- Enzootic pneumonia (previously known as virus pneumonia).
- Swine dysentery (blood scours or vibronic dysentery).
- External parasites including sarcoptic mange, demodectic mange and pig lice.

- Internal parasites including the large round worm (*Ascaris*), the nodule worm (*Oesophagostomum*) and the stomach worm (*Hyostrogylus*).

- Brucellosis.

The term 'specific pathogen free' (S.P.F.) means that the pigs are free of certain specified pathogens (disease-causing organisms). By itself, S.P.F. means nothing. The specific pathogens that the pigs are free of must also be stated. For example, pigs from a unit might be described as being free of the following specific pathogens:—*Sarcoptes scabiei var suis* (the cause of sarcoptic mange), *Brucella suis* (the cause of brucellosis in pigs), *Treponema hyodysenteriae* (the primary cause of swine dysentery) etc. Quite a mouthful!

Herds that have a low disease rate but were not stocked with pigs obtained by one of the above techniques cannot be called minimal disease. However, many herds can justifiably claim to be free of certain specific pathogens, for example, brucellosis.

The term minimal disease is imprecise but widely adopted. Correct usage of the term specific pathogen free is very inconvenient because it involves using many scientific words, but it is very precise. Minimal disease can be used for convenience only if the pathogens or diseases that the pigs are free of have been clearly stated. The term disease-free should not be used for commercial pigs.

Monitoring for diseases

Monitoring routines should be formulated in consultation with a veterinary surgeon to suit the needs of each individual minimal disease piggery. The monitoring required for a herd selling minimal disease stock should be regular and thorough. There may be little benefit in monitoring a purely commercial piggery (not selling breeding stock) that was originally stocked with secondary minimal disease pigs.

Monitoring involves abattoir inspections of lungs (for enzootic pneumonia), laboratory examination of dung samples (for internal parasites and swine dysentery), blood samples (for brucellosis), skin scrapings (for sarcoptic mange) and clinical examinations. Also post mortem examinations should be performed on pigs that die.

In all piggeries, it is recommended that certain precautions should be taken to prevent the entry of disease. Such precautions are especially important in M.D. piggeries. It is advisable to erect a pig-proof perimeter fence around minimal disease piggeries and to attempt to make the piggery bird and rodent-proof.

Despite rigorous precautions, diseases or parasites are sometimes introduced into M.D. piggeries. However, the appearance of round worms does not mean that enzootic pneumonia and swine dysentery have also been introduced and that all the health advantages of the herd are lost.

Diseases not excluded

Piglets can be infected with parvovirus while in the uterus and survive. If such piglets are derived by hysterectomy, living virus can still be present in some piglets and therefore hysterectomy does not exclude parvovirus

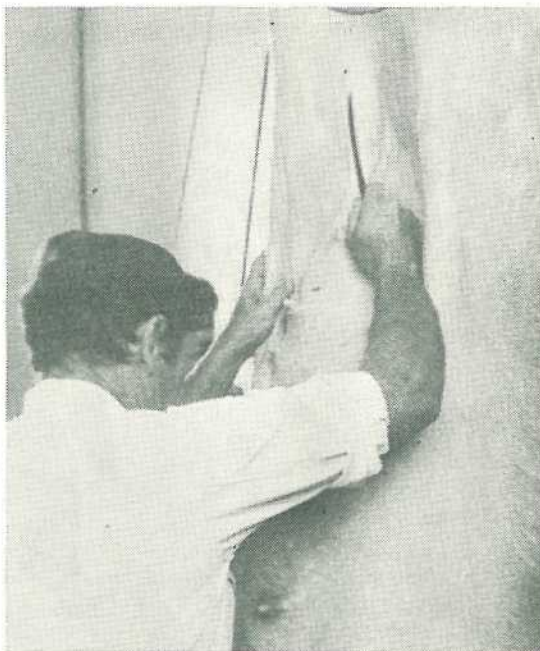


Plate 2. The incision is about to be made to remove the uterus from the sow. Photograph courtesy of the Queensland Agricultural College.

infection. Hysterectomy alone also does not totally eliminate leptospirosis.

Many other diseases, including infectious diseases, by virtue of the way they spread, may occur as regularly in hysterectomy derived pigs as in other pigs, if adequate precautions are not taken. These diseases include erysipelas (vaccination recommended), baby piglet scours, weaner scours, oedema disease and haemorrhagic bowel syndrome.

Minimal disease pigs are not normally more susceptible to diseases than other pigs. However, there is a higher death rate in Hypar pigs mainly because they are deprived of colostrum. On the other hand, M.D. pigs are not more resistant than other pigs to diseases, their health status is better purely because they have not had contact with certain pathogens (disease-causing organisms).

M.D. pigs can be successfully introduced into non-M.D. herds, but they will contract the diseases present in the non-M.D. herd that are not present in the herd of origin.

Stocking a new piggery

When a new piggery is being established, it is strongly recommended that very serious consideration be given to stocking it with M.D. pigs; provided M.D. pigs of satisfactory genetic makeup are available. This is usually the only opportunity that a pig farmer has of establishing a minimal disease piggery. Occasionally, a second opportunity presents itself when a piggery has been depopulated after a devastating disease. The diseases that are absent, the method of establishment and the monitoring routines adopted of prospective suppliers of stock should always be thoroughly checked before purchase.

Minimal disease pigs are free of diseases that strongly influence the cost of production. It is difficult, if not impossible, to accurately assess the economic advantage of keeping minimal disease pigs. However, the savings in freedom from sarcoptic mange alone are substantial.

Gnotobiotic pigs

Gnotobiotic pigs are pigs that are reared in a virtually sterile environment and are used for research work only. They have no application in commercial pig keeping.

Summary

- There are enormous advantages in owning M.D. pigs.
- Minimal Disease is an imprecise term.
- Specific pathogen free is a meaningless term when the pathogens claimed to be absent are not specified.
- Hysterectomy is the removal of the whole uterus.
- Hysterotomy is the removal of piglets from the uterus of a living sow.
- Hypar stands for Hysterectomy (or hysterotomy) Procured and Artificially Reared.
- Hysterectomy (or hysterotomy) procured pigs may also be fostered on to a sow of satisfactory health status.

New sweet corn variety developed for fresh food market

THE Minister for Primary Industries, Mr V. B. Sullivan, has announced the development of a new hybrid sweet corn variety, QK 467S, for the fresh food market.

This variety should be suited particularly for summer months production.

The new hybrid combines satisfactory yield with high resistance to sugar cane mosaic virus disease and good resistance to turcica leaf blight and maize rusts. It was bred at the Department's Kairi, North Queensland, Research Station.

But, in a Departmental team effort, QK 467S has been tested for yield, agronomic and quality characters by horticulturists at the Redlands Research Station, near Brisbane, and field-tested for disease resistance by plant pathologists from the Indooroopilly (Brisbane) laboratories.

Mr Sullivan said the new variety was most suited for cob production for the fresh food market and should be grown where disease risks, especially from mosaic virus, were high.

In the absence of mosaic virus, other commercial varieties would give higher yields.

QK 467S did not appear to be suited to the processing industry because of variation in kernel colour.

It is a tall variety maturing slightly later than other commercial types, germinates well and grows vigorously.

Full kernel coverage of cobs is maintained during hot, dry weather when problems usually are encountered with most commercial varieties.

Limited seed quantities were available for planting at the present time, but most already had been ordered. A seed production area had just been planted in North Queensland and supplies from this block should be available for commercial plantings in spring this year.

False wireworms in Southern and Central Queensland

by P. G. Allsopp, Entomology Branch.

MANY graingrowers in southern and central Queensland have in recent years become familiar with the damage caused by both larvae and adults of false wireworms.

False wireworms are larvae of beetles which belong to a group with the scientific name of Tenebrionidae. In southern Queensland, three similar species *Gonocephalum macleayi*, *Pterohelaeus darlingensis* and *Pterohelaeus alternatus* are pests. Only *G. macleayi* and *P. alternatus* occur in central Queensland. Other species are considered pests over a wide area of the world, being found in the U.S.A. and Canada, Eastern Europe and the U.S.S.R., Southern Africa, and the Indian subcontinent as well as in other parts of Australia.

In most cases where growers have a false wireworm problem, plant residues have been incorporated into the soil or allowed to remain on the surface in the form of a mulch. Because of the obvious need to retain stubble, the Department of Primary Industries has set up a major research programme on false wireworms. These investigations are centred on determining which factors influence the development of the pests with an overall goal of providing a method for predicting future population levels.

Although this programme is not completed, enough information is available to provide guidelines for growers.

Recognition of species

Larvae of false wireworms can be distinguished from most other soil-inhabiting animals by a few features. They are coloured yellow-brown (with or without black markings), have a tough outer skin, are long and slender, and have three pairs of legs just behind the head. True wireworms (larvae of click beetles) are similar but have a wedge-shaped head in contrast to the rounded head of false wireworms.

Adults of false wireworms are black, rather nondescript beetles which are usually found under piles of trash or low-growing weeds.

The two types of false wireworms found in southern Queensland, *Gonocephalum* and *Pterohelaeus*, are sufficiently different in size, colour and shape to allow easy identification.

Larvae of *Gonocephalum* grow to a maximum size of about 20 mm and always have black markings near the head and rear end. Around the rear end they also have 16 to 18 spines. *Pterohelaeus* larvae are larger (up to 50 mm), have orange markings around the head when young, and have only 4 spines on the rear end.

The adults of both types differ in general shape and in size. *Gonocephalum* adults are 6 to 8 mm long while *Pterohelaeus* are between 16 and 20 mm long. Although basically black, *Gonocephalum* adults have a covering of small hairs and hollows which hold soil. Therefore they tend to appear brown in red soils and grey in black soils.

Development cycle

Eggs of false wireworms are deposited in moist soil by mated females. Unmated females can lay eggs but these are infertile and fail to develop. During its life, each female has the capacity to lay at least 1 000 eggs, but the rate of egg production is dependent upon temperature. Up to a certain temperature, the

rate of egg production increases with increasing temperature. Eggs are laid during summer and autumn.

Development of newly-laid eggs proceeds rapidly in warm conditions, and emergence of the small larvae normally occurs within 7 to 14 days. Because eggs are usually laid beneath the clumps of trash under which the adults shelter, young larvae are often initially found in loose clusters. However, as development continues, the larvae become more dispersed.

Each larvae passes through several growth stages, which are marked by a shedding of the skin or moult. Development is once again dependent mainly on temperature and usually lasts through the winter and into the spring and summer. In the field, larvae are found on the top of the moist layer of the soil. As this moist layer moves up and down with wetting and drying, so do the larvae. This contributes to the sampling and control difficulties which farmers sometimes encounter.

When fully grown, larvae move from their normal habitat on top of the moist soil, down into the wetter area. Here, they construct a pupal chamber, curl into almost a circle and transform into pupae. Emergence of the adult takes place 7 to 21 days later.

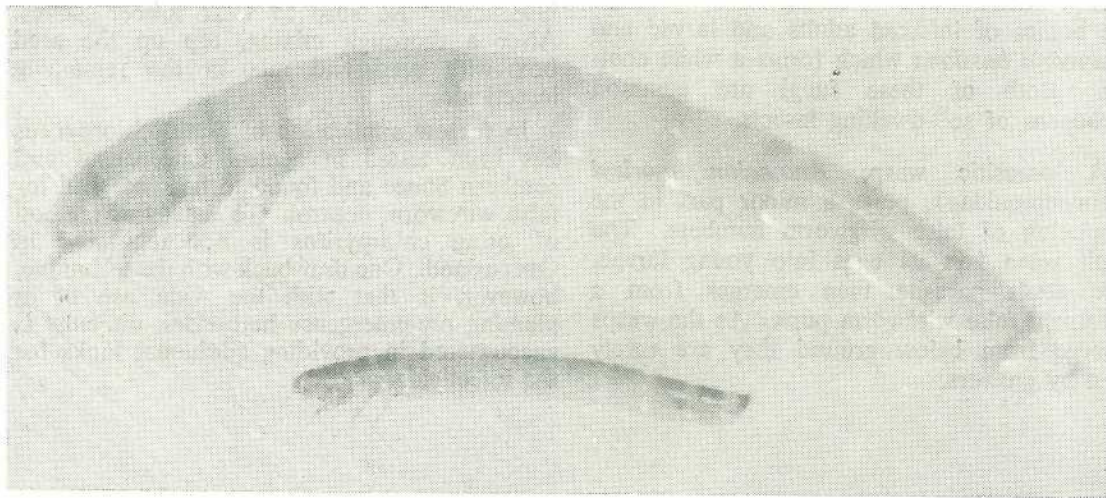
Initially the adults are soft and coloured brown. After about a week, they darken and

harden and begin to feed voraciously. It is also during this period that they disperse either by walking or by short flights. Eggs are developed 3 or 4 weeks after emergence and laying commences. Eating continues during this egg-laying period but at a much reduced rate. Although this period may last 10 to 20 weeks it is usually cut short by cooler weather. In southern Queensland, few adult beetles survive the winter.

In short, the life-cycle of false wireworms involves one generation per year with adults present and egg laying taking place in the summer and autumn. Larvae develop through the winter and into the spring and summer. However, with warmer temperatures in central Queensland larvae are present right through to February and adults are present as early as October. Temperature, therefore, is the main factor controlling the rate of development.

Plant damage and host species

Larvae of false wireworms feed on newly-planted and newly-germinated seeds of a wide variety of crops. Among the hosts in southern Queensland are sorghum, maize, wheat, barley, oats, millets, canary, sunflower, safflower, tobacco, cotton, soybeans and tomato. Damage is caused to both the actual seed and the growing points and results in 'patchy' stands.



False wireworm larvae. The larger specimen is *Pterohelaeus darlingensis* and the smaller *Gonocephalum macleayi*.

In laboratory tests, larvae have also fed and developed on a diet of dry wheat or maize straw. Damage often occurs in the field when there is a situation of declining crop residues—the larvae being forced to find alternative food.

Over the past few summers, adults have also damaged plants, especially sunflower and navy beans. Damage to these crops is in the form of 'ringbarking' or cutting of plants at or below ground level. The young plant then either falls over or withers while standing. The cotyledons and the growing point also can be eaten so severely as to cause death. Damage by both larvae and adults necessitates replanting in many cases.

Natural causes of false wireworm death

Natural mortality factors are probably responsible for the death of a considerable proportion of the false wireworm population.

Rainfall may have two types of effects on the pests. Firstly, heavy falls may drown young larvae and adults. It may also force older larvae to the surface where chances of being eaten by predators are higher. Secondly, high humidity associated with wet weather promotes the spread of fungal diseases. Important fungal diseases in Queensland are *Metarrhizium anisopliae* which forms a blue-green coating on the bodies of infected adults and larvae and *Beauveria bassiana* which forms a white coating. Both of these fungi are common pathogens of soil-dwelling insects.

A parasitic wasp, *Anomalon morleyi* (Ichneumonidae), plays a minor part in the regulation of false wireworm numbers. The adult wasp lays its eggs into young larvae. The adult parasite then emerges from a deformed false wireworm pupa. As the wasps emerge from below ground they are rarely seen by growers.

Other false wireworm predators include a variety of predatory beetles, spiders, earwigs and birds such as crows and magpies.

Control of adults

Insecticide sprays have not given satisfactory control of adult false wireworms in Queensland. Baiting has been suggested as an alternative method but it has not yet been fully evaluated. A recommendation for control of adults is not, therefore, available.

Control of false wireworm larvae

Prior to planting, false wireworms are likely to develop in weedy fallows and in paddocks carrying stubble residues from a previous crop. Growers should examine small random areas in paddocks to be sown to check populations of larvae. A garden fork or shovel is useful to turn over the soil in looking for larvae.

If they are present, treatment of seed with chlorpyrifos (sold as Lorsban 25W or Nabsol 25W) at the rate of 160 g of product per 100 kg seed should be implemented. At this rate, the cost of the insecticide for winter cereals is approximately 70 cents per hectare (1978 prices). If the farm does not have a history of false wireworms activity it is inadvisable to apply insecticide as a routine planting procedure if larvae are not present.

If control is necessary, the best method is to half-fill the seed box of the planter with seed and then mix in half the quantity of insecticide. Be sure to wear rubber gloves. After a thorough mixing, top up the seed box with seed and mix in the remaining insecticide.

In furrow application of liquid chlorpyrifos has been tested in central Queensland and southern States and found to be successful for false wireworm control. To date, this method of using chlorpyrifos is not registered in Queensland. One drawback with the technique, however, is that with the wide use of at planting pre-emergence herbicides, difficulty is encountered in providing additional tanks for the insecticide.

Aflatoxin . . . a potential danger to livestock

AFLATOXIN is one of a range of toxins that may be found in mouldy feedstuffs. Aflatoxin kills animals and can cause cancer.

Different dose levels may contribute to loss of production and poor performance in all animal species.

Aflatoxin is produced by the common mould *Aspergillus flavus*, when this grows on insufficiently dried or badly stored feedstuffs. Moulds can be a problem with all commodities; but peanuts, corn and oil seed products are particularly susceptible to aflatoxin contamination.

Formation of aflatoxin can occur during different stages in the production of the feed:

- On crops in the field—water stress, over maturity at harvest and insect damage may contribute to *Aspergillus flavus* invasion.
- During harvest—if drying to a safe storage moisture level is not achieved quickly.
- During storage—when leaky roofs, driven rain, condensation or vermin excreta allow the feed to become damp.

Effects on stock

The effects of aflatoxin depend on dose rate and duration of exposure, and the type of livestock involved. In general, young animals are more susceptible than adults. With species such as ducks, low levels can result in high mortalities. With more resistant livestock (for example, adult pigs or cattle) aflatoxin may demonstrate its effects in other ways such as production losses or poor feed conversions.

by B. J. Blaney, Biochemistry Branch.

Low doses may also render the animals more sensitive to the effects of other poisons or to infections.

While perhaps less important a factor with livestock such as slaughter cattle, pigs or broilers, it must be remembered that trace levels of aflatoxin fed over a long period of time will cause cancer of the liver and other organs. This could be significant with breeders, or in dairy herds.

Problem feedstuffs

At the Animal Research Institute in Brisbane, officers of the Department of Primary Industries have been testing for levels of aflatoxin in feedstuffs for many years. The feed component most likely to contain the toxin is peanut meal, obtained after the removal of oil from lower quality kernels. This is a valuable protein supplement for stock, but care should be taken in its use when feeding susceptible species, or very young animals of any species.

Other crops which occasionally become contaminated include corn, sorghum, cottonseed, sunflower and safflower.

Amounts tolerated

The following guidelines are offered as maximum levels of aflatoxin in complete feeds which should be tolerated for reasonable periods without adverse effects:

- Feeds for ducks, turkeys, other poultry less than 4 weeks of age, and pigs less than 8 weeks of age—10 micrograms per kilogram of feed.
- All other complete stock foods—20 micrograms per kilogram of feed.

Individual feed components such as oilseed meals containing higher levels of aflatoxin should be well mixed and added at concentrations such that the levels recommended for complete feeds are not exceeded.

It must be noted that adult cattle, pigs, sheep and chickens can tolerate much higher levels than 20 micrograms per kilogram for short periods, provided they are well fed, in good health and not exposed to other poisons.

Human hazards

Aflatoxin eaten by stock is rapidly eliminated from the system and eating the meat of such animals does not present any problems. However, dairy cows pass a small fraction of ingested aflatoxin on in their milk. Although commercial bulking of milk supplies generally reduces the concentration to non-detectable levels, mouldy feed should never be fed to dairy cows as a precaution against this type of contamination.

Detection of aflatoxin

Unfortunately, aflatoxin cannot be detected in the field. Although any growth of mould must be viewed with suspicion, aflatoxin can be present in a crop without visible fungus. Levels down to 1 microgram per kilogram (one part in 1 000 000 000), can be detected at the Animal Research Institute provided a suitably-sized sample is provided to the laboratory.

Moulds tend to grow in clumps, and aflatoxin can have a very irregular distribution. A pocket of mould weighing 1 kg may contain greater than 1 000 000 micrograms of aflatoxin, sufficient to produce a significantly high level in one tonne of feed, if mixed throughout the bulk. Therefore, all samples must be as representative as possible.

Suitably-sized samples are as follows:

- Finely powdered meals 2 kg
- Small seed (for example, wheat) 5 kg
- Large seed, nuts etc. 10 kg

If pockets of mould can be seen, these may be submitted separately, along with the representative sample.

Diagnosis of poisoning

If the feed is available, this can be tested for both the presence of aflatoxin and the fungus that produces it. This may not give a definite result since the toxin may have been present in a small portion of feed already consumed by the animal. Post mortem examina-

tion of the animal will usually demonstrate characteristic lesions, particularly in the liver. In the absence of this information, a history of bad storage or wetting of the feed may be significant.

The characteristics of any mould-produced problem can be listed as follows:

- The outbreaks are associated with a specific feed or additive.
- Examination of the feed reveals signs of mould activity.
- Drug or antibiotic treatment has little effect.
- Field outbreaks are often seasonal, since climatic conditions affect mould development.

Prevention of aflatoxin poisoning

The key to preventing problems of this nature is to prevent growth of moulds on feeds, since aflatoxin is very difficult to remove once formed.

To control mould growth:

- In the field—Take recommended measures to control insects which attack grain. Minimize moisture stress in crops. Irrigation and good farming practices such as weed control and correct planting rates will assist, although this may be largely outside the control of most growers in a drought year.
- During harvest—Achieve safe storage moisture levels by uninterrupted drying, carried out as rapidly as is consistent with preservation of quality.
- During storage—Protect from moisture, insect and rodent damage. Provide adequate ventilation to avoid pockets of overheating and the danger of condensation. Mould-inhibiting agents may be useful in some situations with formulated rations.

Finally, it is wise to remember that with any toxic agent, the dose makes the poison. When economics dictate that a suspect feed must be used, this should be diluted as far as possible with uncontaminated feed and used without delay, in order to minimize chances of further mould growth and contamination of the clean feed.

The Australian Carcass Bruise Scoring System

by B. Anderson, Slaughtering and Meat Inspection Branch and J. C. Horder, formerly of the Australian Meat and Livestock Corporation.

A subjective scoring system known as the Australian Carcass Bruise Scoring System has proved to be successful as a means of recording bruises by visual appraisal.

The system was developed and established by the combined efforts of officers of the Australian Meat and Livestock Corporation, C.S.I.R.O. and the Queensland Department of Primary Industries.

Prior to the advent of this system which enables the bruising of carcasses to be reliably and accurately recorded, much of the information collected by various surveys was incomparable. Similarly, reports were often based on somewhat suspect methodology with often unsubstantiated conclusions. The many and varied systems which have been used to record bruising are described elsewhere (Meischke, H. R. C. (1975) 'Bruising in Cattle', report to A.M. & L.C., April).

The Australian Carcass Bruise Scoring System was first used in Queensland in 1973. Since then, it has been used in each subsequent cattle bruising trial run by the Australian Meat and Livestock Corporation, C.S.I.R.O., the Queensland Department of Primary Industries, and other State Departments of Agriculture. The system has definite advantages over previous visual scoring systems and the collection of bruise trim weights.

The system makes use of diagrams to record bruises and is easy to learn and implement. Information is recorded by one person and does not interfere either with the carcass or the flow of the meatworks slaughter chain.

Bruises are recorded on a specially prepared sheet by an assessor who makes a judgment as to the site and severity of each bruise. The information obtained from sites of the carcass has helped to isolate causal factors associated with bruising (for example, knocking box).

In the hands of an experienced assessor, this scoring system can be related to bruise trim weight information which normally takes up to six men to collect. In effect, this means that the scoring system provides a relatively accurate and quick way of estimating the extent of bruising in any carcass or number of carcasses.

The most consistent or reliable results will be obtained if the same assessor is used. It can be expected that there may be variability between bruise scorers and between works. These minor shortcomings which also apply to the collection of bruise trim weights do not, however, reduce the overall effectiveness of the system.

It is intended that the Australian Carcass Bruise Scoring System will become standard throughout Australia and thus provide all interested parties with an effective system to record bruises. This in turn will help to establish valuable information on both the causes and losses of bruising.

The system

The severity of bruising on the carcass is classified into three basic categories according to the surface area of the bruise as follows:

- 'Slight'—from 2 to 8 cm in diameter signified by the letter S.
- 'Medium'—From 8 to 16 cm in diameter signified by the letter M.
- 'Heavy'—Of a greater diameter than 16 cm signified by the letter H.


Bruises below 2 cm in diameter are not recorded.

The basic categories are divided into three further categories to incorporate those bruises which are considered to involve other than surface muscle tissue. This type of bruise is signified by including a small letter 'd' after the basic surface area category letter (for example, 'Hd'). This then makes a total of six categories signified in the following way: S, Sd, M, Md, H, Hd.

OUTSIDE INSIDE OUTSIDE INSIDE

Right hand side Left hand side

Beef Carcass Bruising Record Sheet

Published by the 

CARCASS NUMBER:		
S:	D:	F: mm
ORIGIN:		
TREATMENT:		
RHS WEIGHT:		
LHS WEIGHT:		
C/S WEIGHT:		
RHS BRUISE WT:		
LHS BRUISE WT:		
C/S BRUISE WT:		
SLT BRUISE NO:		
MED BRUISE NO:		
HVY BRUISE NO:		
TOT BRUISE NO:		
BONING ROOM:		
R FORE:		
L FORE:		
R HIND:		
L HIND:		
TOTAL:		
TIME LOST ON SLAUGHTER FLOOR		
	MIN	SEC
COST:		
COMMENTS:		

Figure 1.

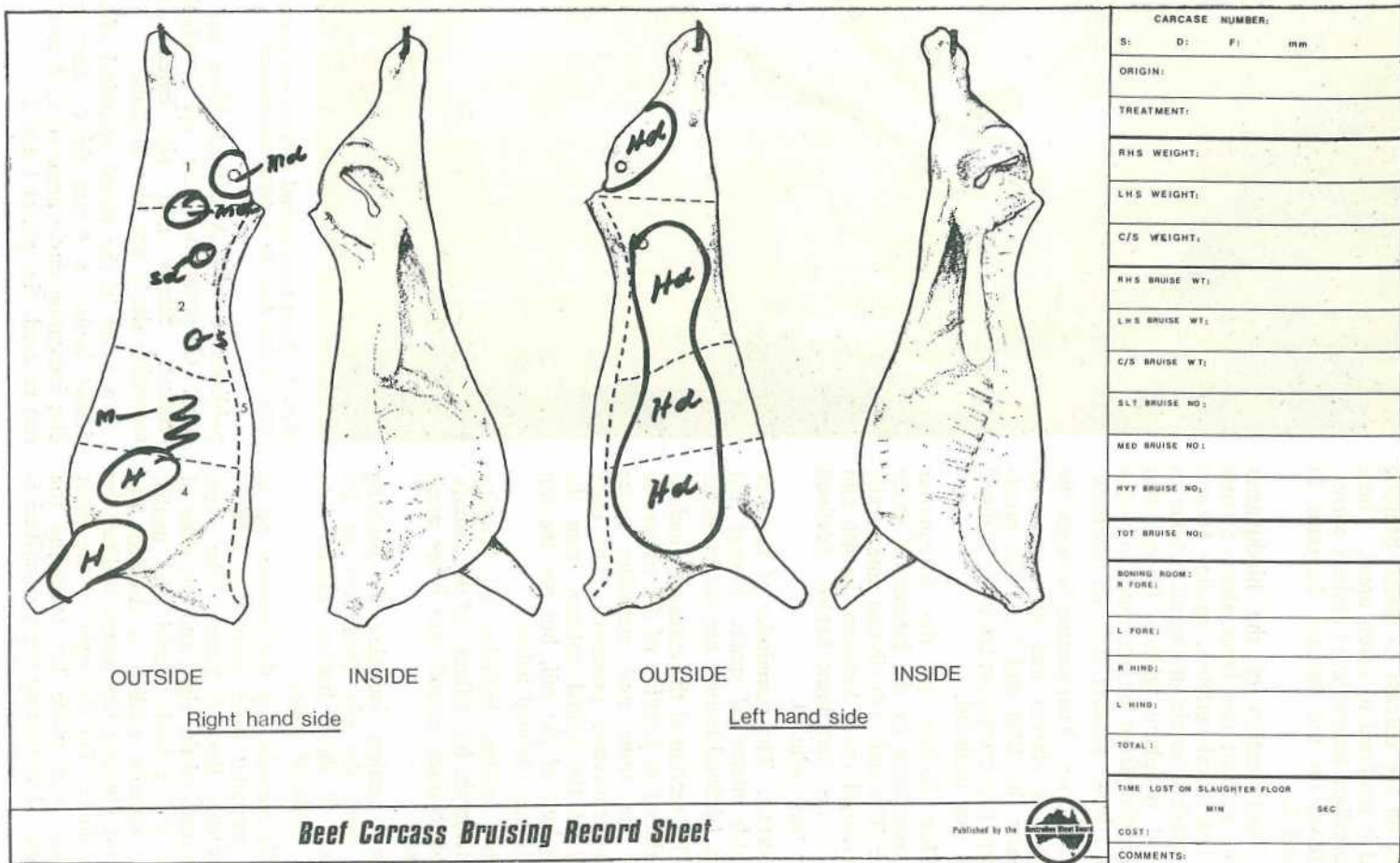


Figure 2.

The sites on the carcass to which bruising is recorded is confined to seven areas. These sites are described below; site numbers correspond to those on the carcass diagrams in figures 1 and 2.

- **BUTT.** That section of the hindquarter distal to the straight line from about 50 mm above the last sacral vertebra, passing 50 mm below the pubic tubercle of the aitch bone to the precrural lymphatic gland. Except that bruises originating from the pin bone (ischium) and the hip bone (ilium) are not included.

- **RUMP AND LOIN.** That section between the butt distally (as above) and the intercostal space between the 10th and 11th ribs proximally. Except that bruises on the back (defined below) are not included.

- **RIB.** That section of the forequarter bounded posteriorly by the intercostal space between the 10th and 11th rib and anteriorly by the intercostal space between the 4th and 5th ribs. Except that back bruises (defined below) are not included.

- **FOREQUARTER.** The remainder of the side below the 4th intercostal space. Except that back bruises (defined below) are not included.

- **BACK.** This section of the carcass to include all bruises dorsal to junction of the transverse process of the spine and including tissue covering the transverse processes. The back includes all of the spinal column from the neck to the butt of the tail, but not the hip or the pin bones (defined below).

- **HIP.** This section includes all bruising originating from the hip (ilium) of the carcass, even if these bruises extend into other areas defined above.

- **PIN.** This section includes all bruising originating from the pin (ischium) of the carcass, even if these bruises extend into other areas classified above.

Bruising is recorded by the assessor on to a specially prepared sheet known as a 'Beef Carcass Bruising Record Sheet'. The sheet provides outlines of the right and left sides of the carcass giving both lateral and medial views. The carcass outline is divided into five sites with pin and hip bones outlined by means of a circle. On the right of the sheet provision has been made for recording the technical data. The scoring sheet described is



Plate 1. Even experienced scorers will occasionally refer to the disc to ensure consistency.

published by the Australian Meat and Livestock Corporation—these are available on request. Sheep and pig carcass bruise recording sheets are also available.

To assist in the visual appraisal of a particular bruise, a 6 mm thick, clear perspex disc indicating circle areas of 2, 8 and 16 cm can be used. See plates 1 and 2.



Above. Plate 2. This bruise would be recorded as 'heavy' to the left hip.

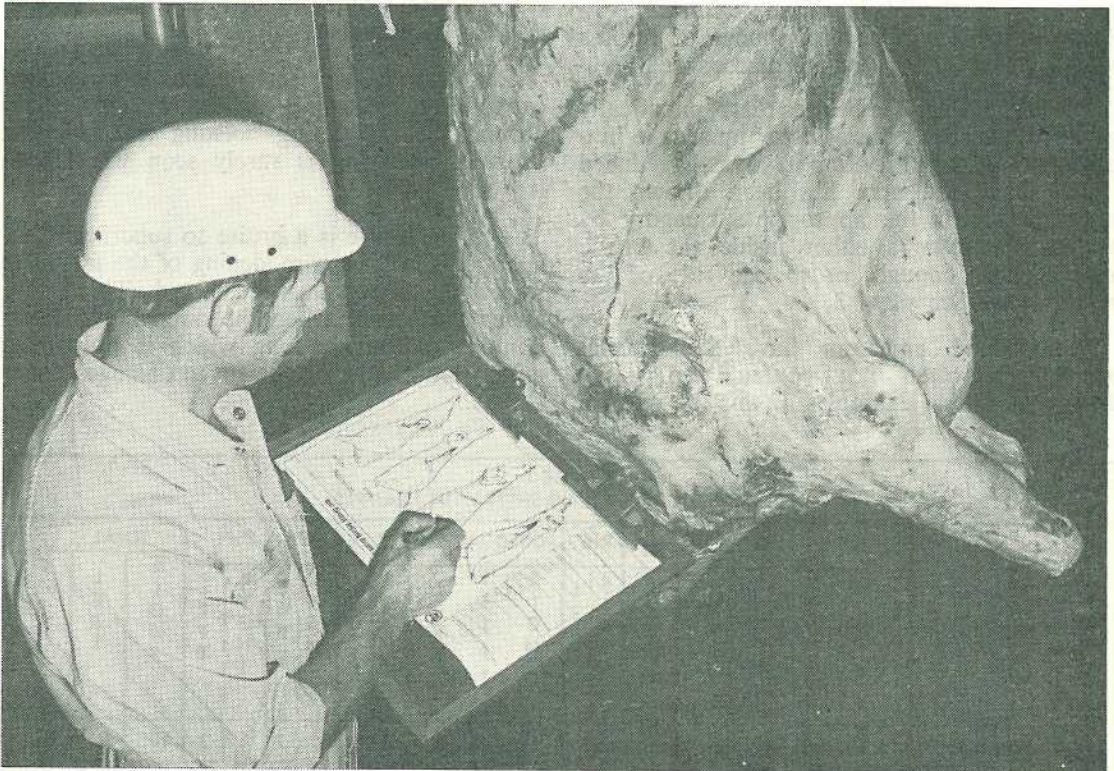
Below. Plate 3. An assessor carrying out bruise scoring on the slaughter floor.

Practical application of the scoring system

Equipment to enable recording to be carried out includes a double foolscap size clip board and a thin point insoluble ink felt pen.

The clip board holds the sheet/s in place and provides a firm surface on which to draw the bruise/s. A red ink felt pen is the colour preferred for the diagrams as this colour stands out from the black outlines of the carcass which assists later data collation.

When subjective scoring is to be carried out at a particular works, the assessor will first have to determine the most suitable place on the slaughter-floor where he can see the carcass from all angles and in a good light. Each works is different, some being more congested in the proposed viewing area than others. It is difficult to carry out an assessment if you are continually in the way of work employees. The co-operation of the works management; in particular, the slaughter-floor foremen, go hand in hand with a successful assessment.



The rate of throughput is another important factor which the assessor has to consider. This applies whether the works operate on a chain or rail system. A point to remember is that it will take approximately 60 seconds to appraise a carcass or longer if bruising is heavy.

In practice, it has been found that an experienced assessor can carry out scoring at a rate of 40 to 50 carcasses an hour. If carcass numbers are in excess of this, then two assessors will be required to score alternative carcasses.

A useful exercise is to carry out a 'dry-run' before commencing on the assessment proper. This will give the assessor the required knowledge as to the suitability of the work area in terms of throughput, light, and ease of operation.

When carrying out his appraisal, the assessor is best advised to start from the butt and work down through the other sites, first on one side and then the other. In any case, whichever way the assessor decides to carry out his appraisal, it should be done uniformly. In this way there will be less chance of bruises being missed and therefore unrecorded.

When recording the bruises diagrammatically on the score sheet, the assessor must take into account that he is working to a vastly reduced scale. Once the area has been drawn, the assessor records the appropriate category by placing the letter/s either inside the bruise area if large enough, or to one side of the bruise area. See plate 3.

Experienced assessors have found that bruising is often not confined to easily designated sites. Examples of this are when a

bruise may extend into another site or be on both sides of the carcass.

Figures 1 and 2 hypothetically illustrate typical bruises and how they are scored.

It will be noted that a bruise extending to both sides of the carcass on the back site is recorded as one bruise. While a bruise which is purely of a surface nature and irregularly defined, is recorded by means of a zig zag line.

When determining whether a bruise is superficial or deep, the assessor has to use his judgment—experience is the best teacher. Often a bruise will show little on the surface but will extend over a large area in the underlying tissues.

A troublesome dilemma for the assessor is what constitutes a trimmable bruise and here it must be stated that this is all we wish to record. The assessor may find advantage in watching the bruise trimmers at work before commencing an assessment.

Two common conditions which come into the doubtful trimming category are 'red leg' and the 'fire bruise'.

Red leg is an ecchymotic haemorrhage caused by tightening of the shackle chain around the leg during hoisting and prior to sticking. Red leg is rarely seen when both legs are shackled.

The fire bruise is a bruise so superficial that it appears only as a reddening of the fat. The underlying tissues are not affected. This bruise appears to occur when the animal sustains a bump/s during handling which is only of a minor nature and insufficient to damage deeper tissues.

TABLE 1
SITE COLUMN RECORDING SHEET WITH EXAMPLE

CARCASS NO.	CARCASS WT. KG.	BRUISE WT. KG.	BUTT		RUMP & LOIN		RIB		FOREQUARTER		BACK		HIP		PIN		TOTAL		
			R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	C
			G	H	G	H	G	H	G	H	G	H	G	H	G	H	G	H	R
20	300	5.375					5	5	4	7	2	2	7	7	1	3	19	24	43

TABLE 2 THE WEIGHTING FACTORS USED TO CALCULATE BRUISE SCORES	
Area/Depth	Weighting Factor
S	1
Sd	3
M	3
Md	5
H	5
Hd	7

Reference: Baxter R.I.
Paper given to the 1975 National Workshop on
Livestock Bruising.

For the sake of uniformity, the above conditions are not recorded on the score sheets as it is generally considered that they are outside the scope of that which constitutes a trimmable bruise. Both conditions can be recorded if necessary if or when this information is required for a special purpose.

Assessment after trimming

Occasionally, it may not be possible to carry out an assessment before trimming. In this event, assessment can be carried out after trimming.

This method is probably not as accurate, but it does not present too many difficulties for the experienced assessor. The areas where small bruises have been trimmed are not so readily defined but medium and heavy areas are normally recognizable.

Analysis and presentation of data

Once the information has been collected on the carcass bruise scoring sheets, it can be transferred either to site column sheets (see table 1), or directly on to computer punch cards for analysis and later storage. There is then no need to retain the original score sheets.

Each of the bruise categories as described in the section on 'the system' above is attributed to a weighted factor (see table 2). These factors have been derived from the regression equation of scores to actual bruise trim weights recorded over a series of trials. The application of these general factors enables each site, side or whole carcass, to be allocated a numerical value which reflects the amount of bruise tissue trimmed. It has been estimated that 8 bruise score points approximate 1 kg of bruise trim, that is, the data recorded on the carcass sheet in figure 1 has been transferred to the site column sheet shown in table 1, so that the bruise score total of 43 represents approximately 5.375 kg which is above average bruising for one carcass (the national average has been estimated at 2 kg per carcass).

The system has been employed by researchers to establish certain factors which relate to the incidence of bruising in cattle in Australia. Most notable has been the knocking box effect on bruising analysis whereby the importance of differentiating site and side levels of bruising can be seen. There is some evidence to suggest that external influences, for example, transport and yard design) affect the site distribution of bruises over the carcass while animal factors such as horn status, sex, weight, and temperament affect the severity of bruising.

Every subjective appraisal system has its short-comings, but they do not by themselves invalidate the findings. This system is not totally consistent between scorers at any one time or over a period of time. There are, however, statistical techniques which can be employed to analyse any real differences which may occur.

The Australian Carcass Bruise Scoring System can be used to evaluate the incidence of bruising in any number of animals.



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Some Queensland Wattles

Leichhardt's wattle (*Acacia leichhardtii*)

This wattle is confined to Queensland. It is always found growing on sandstone, on ridges, slopes or sometimes on creek banks. It is an erect, spreading shrub which can grow to a height of between 2 to 3 metres, with spreading or pendulous branches. It was named after the explorer Leichhardt, who first discovered it in 1844 on an expedition from Moreton Bay to Port Essington. It flowers from mid autumn to mid winter.

Acacia attenuata

This wattle also grows only in Queensland, on the coastal plains to as far north as Maryborough. It is common on the margins of peat swamps in eucalyptus forests and on sandy wallum. It is unusual in having bipinnate leaves as well as phyllodes on adult plants. It blooms during autumn and early in winter. The flowers have a faint, sweet perfume.

Maiden's wattle (*Acacia maidenii*)

In the eastern mainland States, this wattle is common on the edges of rain-forest, in open eucalyptus forests and in dry sclerophyll forest. It grows as far north as Proserpine and as far west as Oakey. Corky spots called lenticels are scattered on the young stems. It flowers from early in summer to early winter.

by Beryl A. Lebler, Botany Branch

Acacia falcata

In the coastal lowlands of Queensland and New South Wales to as far south as Port Jackson, this wattle is common in open eucalyptus forests. It grows on dry, stony hillsides, ridges or on sandstone hills. It is a shrub which seldom exceeds 3 metres in height and flowers from late autumn to mid winter. The flowers have a slight, pleasant perfume.

Acacia glaucocarpa

This wattle is also found only in Queensland and is common in mixed eucalyptus forest on sandstone and gullies. It is found as far north as Emerald and as far west as the Carnarvon Gorge National Park. It is a slender, erect tree up to 7.5 m high, with attractive blue-green leaves and flowers from early autumn to winter. The flowers have a fairly strong 'wattle' perfume.

Acacia julifera

From the middle of autumn to the beginning of spring, the rocky sandstone slopes and ridges where this wattle is common are a picture. It grows only in Queensland to as far north as Proserpine and as far west as Pentland. The dense spikes are sweetly perfumed.

Some Queensland Wattles



Leichhardt's wattle (*Acacia leichhardtii*)



Acacia attenuata



Maiden's wattle (*Acacia maidenii*)



Acacia falcata



Acacia glaucocarpa



Acacia julifera