Queensland AGRICULTURAL JOURNAL

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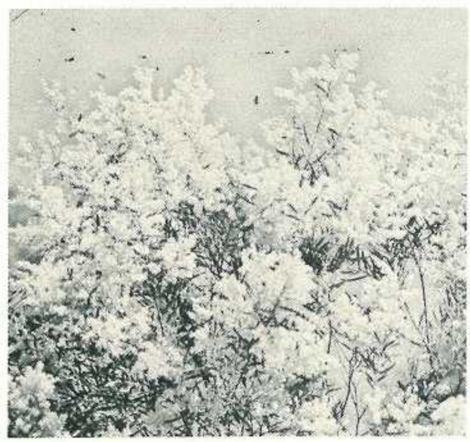

Acacia fimbriata is a common sight in many parts of Queensland. See 'The wattles of south-eastern Queensland' in this issue. Photograph—M. Olsen.

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Central Burnett cattlemen

by A. H. Milles, Beef Cattle Husbandry Branch and R. B. Hall, Extension Services Section.

DURING 1975–76, three Central Burnett graziers experimented with finishing beef cattle on irrigated ryegrass.

The three properties were situated at Biggenden, Gayndah and Mundubbera.

These cattlemen wanted to maximize the return from their irrigated areas without making the change to intensive cash cropping.

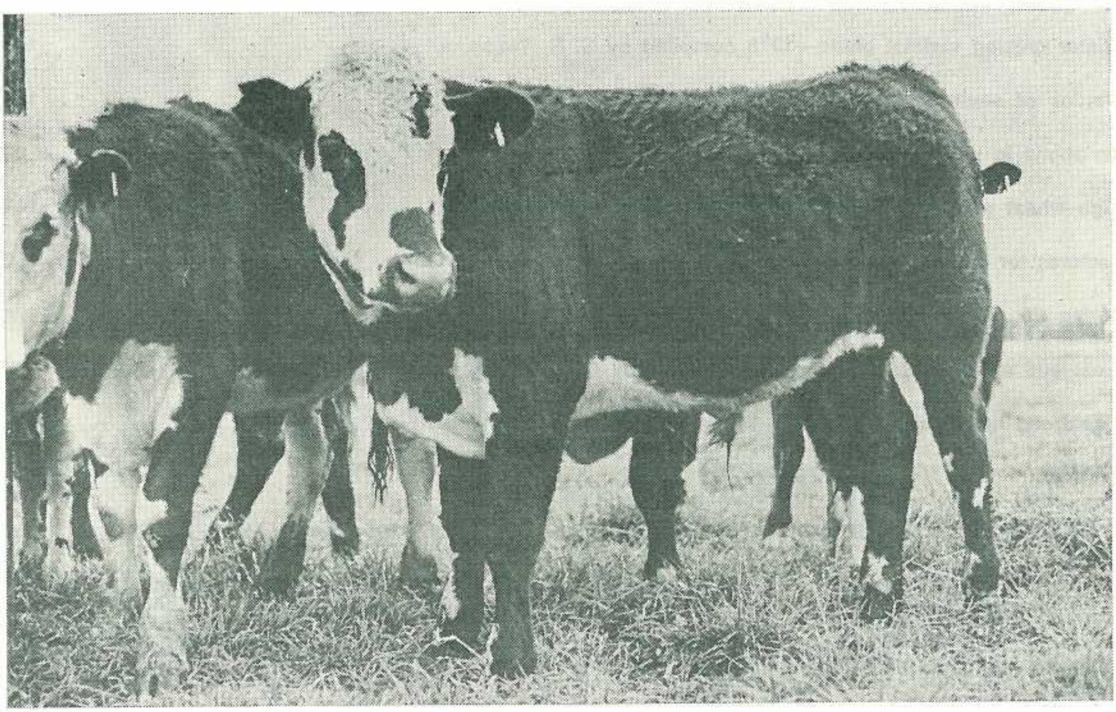
A few problems were encountered but overall an adequate profit was made. In two of the three situations, the gross margin from cattle fattening was as high as that which could be expected from intensive cash cropping.

Local officers of the D.P.I. assisted in a number of areas. Agriculture Branch officers advised on seedbed preparation, selection of ryegrass cultivars and, in association with Consolidated Fertilizer representatives, advised on fertilizer and water requirements.

The local beef cattle husbandry adviser assisted with the selection of cattle, advised on grazing technique and suitable stocking rates, recorded liveweight performance data for each individual beast, dressed weights and analysed breed performance data.

The nitrogen fertilizer, in the form of urea, was supplied free-of-charge by Consolidated Fertilizers Pty., Ltd. for two out of the three sites.

BELOW and RIGHT. Portion of the 30 Santa/Hereford weaner/yearlings which gained 702 kg per ha in 97 days rotation grazing of 4·05 ha of Tama ryegrass in two blocks of 2·025 ha. These cattle performed better than any other group in terms of gain per hectare.



make money from ryegrass

The 'fattening opportunity'

Prior to 1972, store cattle were commonly $3.00 'a hundred' dearer than fats, and store sellers had little trouble finding a ready market. This situation was reversed in 1974 and has remained so ever since. For example, in 1975–1976 store steers in the Central Burnett ranged from 24c to 33c per kg D.Wt. Fats ranged from 39c to 50c per kg D.Wt. Thus the margin in favour of finished cattle was of the order of 17c per kg or over $7 per 100 lb D.Wt.

A succession of autumn and winter seasons with below average rainfall has reduced the interest in dryland crop fattening in the Central Burnett. Many graziers are now growing summer cash crops on land where winter fodder crops were previously grown. However, if the winter-spring feed supply can be guaranteed, there should be a good margin available.

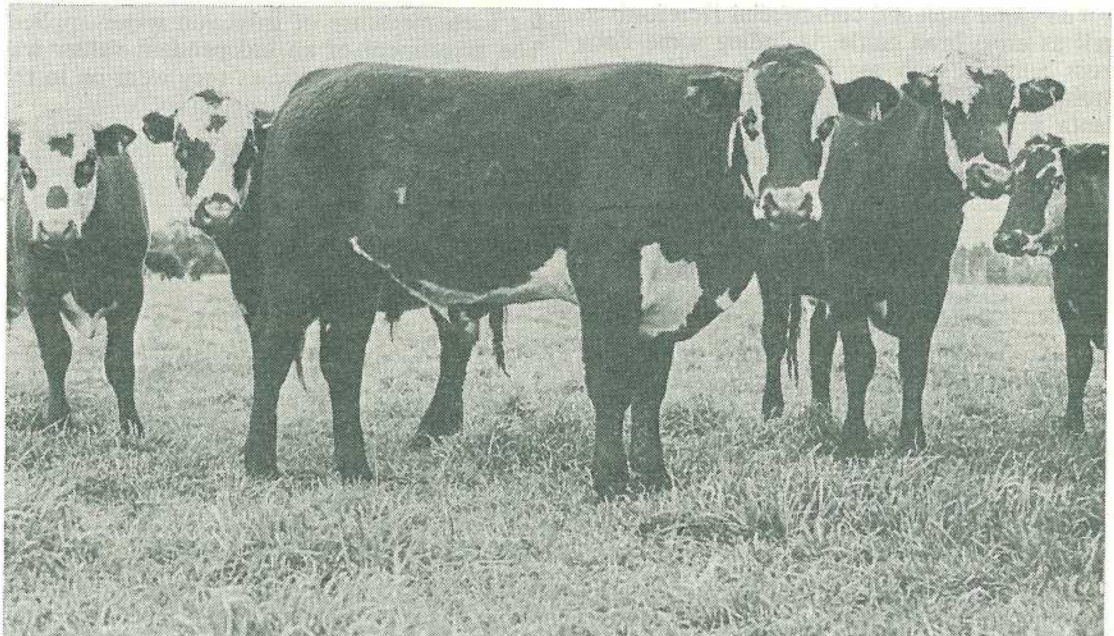
The grazing system

As with a forage crop of oats, the objective is to put high quality fattening feed in front of the right sort of cattle at the right time. Ryegrass planted in April is ready to graze from mid to late June.

The system adopted allowed the turn-off of two mobs of cattle in the one season. The first drafts went on in June and were finished in mid September. The second drafts followed immediately. At two sites, the cattle were finished in December but at Biggenden the ryegrass stand was grazed to the end of the first week in January.

In most seasons, the ryegrass can be expected to hang on until the end of December if given adequate moisture and nitrogen.

At Gayndah and Biggenden, a set stocking system was adopted. Both groups had access to adequate rough grazing for camping purposes and as a source of roughage as an alternative to the lush grazing offered by the ryegrass. At Mundubbera, the camping area was



restricted in area and quality and so the ryegrass block was rotationally grazed in halves at 10 to 12 day intervals.

Experimental method

All cattle were identified by means of eartags; they were independently valued and were weighed on to the ryegrass. As drafts of cattle finished and were ready for slaughter they were weighed off prior to sale. Subsequently, the dressed weights were obtained from the butchers and meatworks where the cattle were killed.

Details were recorded of the number of cultivations, the amount of seed and fertilizer used, the amount of irrigation water applied, the number of beast days grazing and individual beast performance in terms of weight change and health status.

Description of cattle

A wide variety of cattle was involved. They ranged from 7 to 10-month-old weaners to 3-year-old bullocks. However, weaner and yearling cattle to around 16 months at the start of fattening represented almost 80% of the total.

The cattle included commercial Herefords as well as cross-bred cattle, including some Zebu cross animals such as: Brahman x Hereford, Brahman x Charolais, Brahman x Shorthorn, Santa x Hereford, Droughtmaster x Hereford and Brangus types.

Production results

Average gains of various mobs of cattle varied from 0·52 to 1·34 kg per head per day. At the bottom end of this scale were some strongly Zebu type weaners. At the top were some three-year-old Droughtmaster x Hereford bullocks.

It was evident that weaners with more than five-eighths Brahman content were inclined to grow rather than fatten.

Dressed carcass weight gains per hectare varied from 1 158 to 1 328 kg. The average was 1 220 kg. The average length of time each beast spent on the ryegrass was 88 days. In all, 230 head were fattened on 15.39 ha.

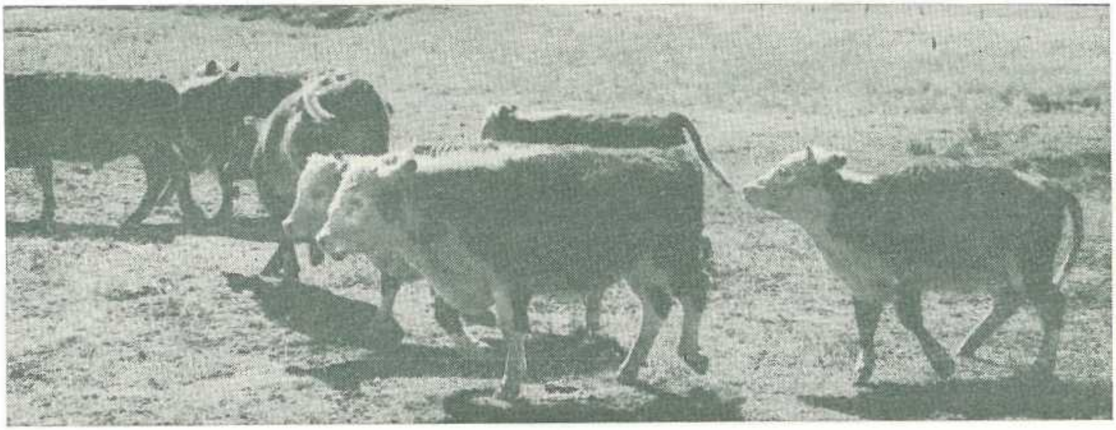
Economic assessment

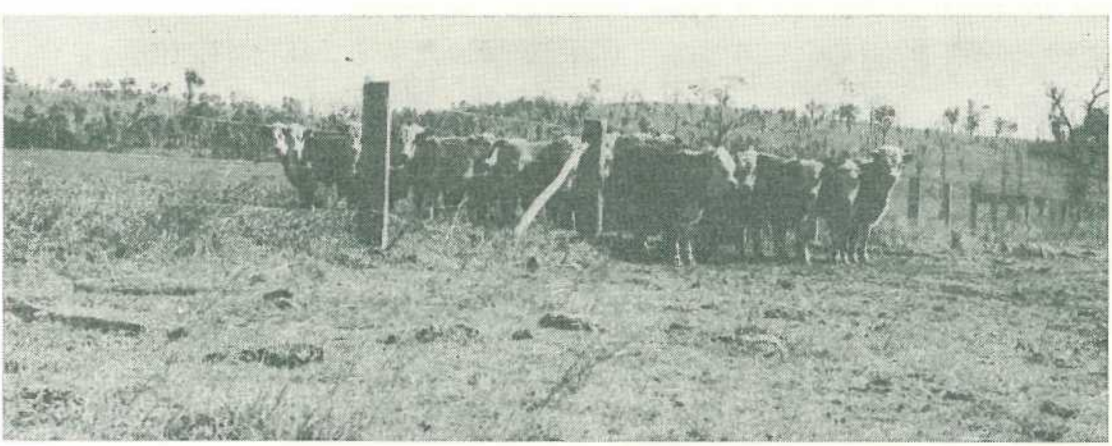
The input costs for growing ryegrass on an intensive basis and under a heavy fertilizer/water regime, are relatively high. (For details on the culture of this crop, see 'An irrigated pasture system based on annual ryegrass sowings' by O'Grady and Cassidy; *Queensland Agricultural Journal,* January–February, 1976.)

In assessing the profitability, a standard charge has been made for each cultivation and for each megalitre of irrigation water applied. The assessment of an independant valuer was used to value the cattle as they went on to the crop.

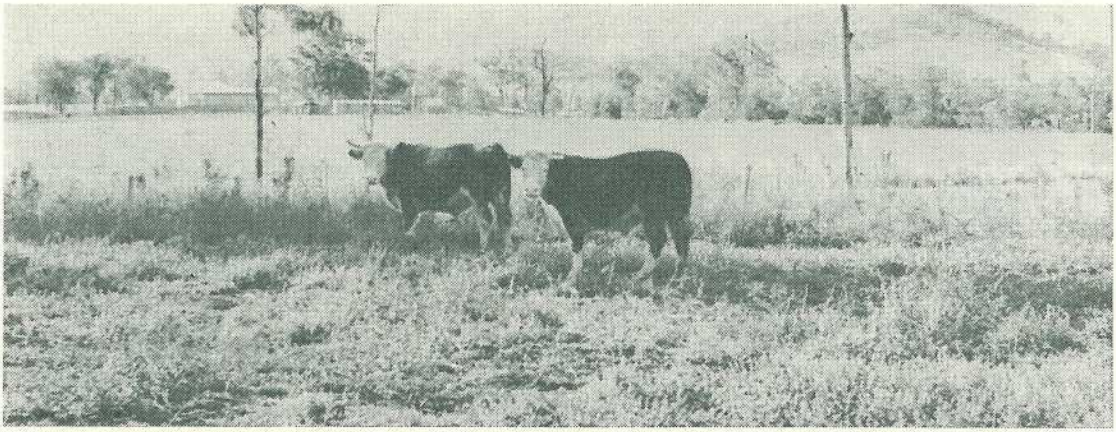
The economic details are:

Costs per hectare	Biggenden unit	Gayndah unit	Mundubbera unit
	$	$	$
Chisel ploughing at $3.50	7.00	..	..
Scarifying at $2.50	2.50	..	..
Discing at $3.50	..	10.50	10.50
Planting at $1.35	1.35	1.35	1.35
Ryegrass seed	24.21	24.21	25.07
Super phosphate	23.72	9.47	19.02
Potash	17.34	..	..
Urea	93.02	101.52	120.01
Irrigation charge	61.44	39.60	112.50
Value of cattle on	290.07	739.70	544.62
Selling charges and freight	32.04	58.96	72.26
Total costs	552.69	985.31	905.33
Gross receipts, cattle	664.67	1 607.71	1 298.42
Gross margin per hectare	111.98	622.40	393.09

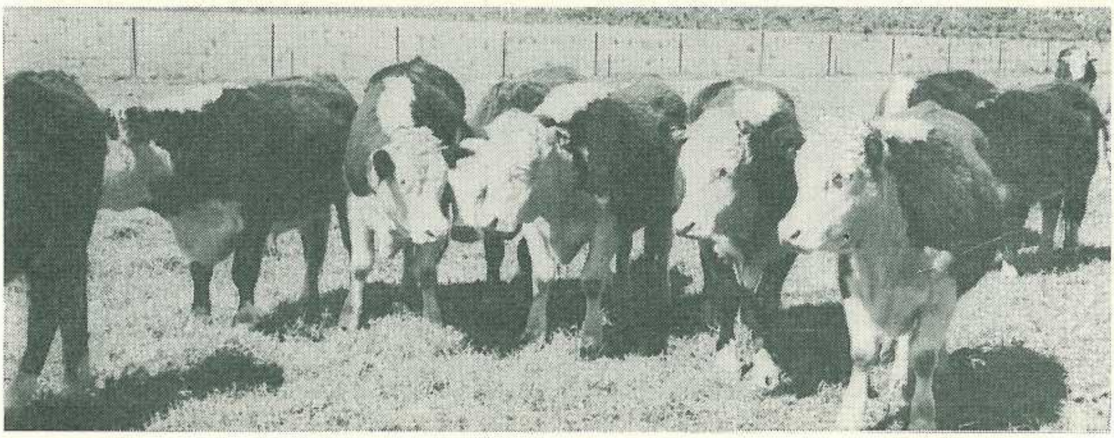




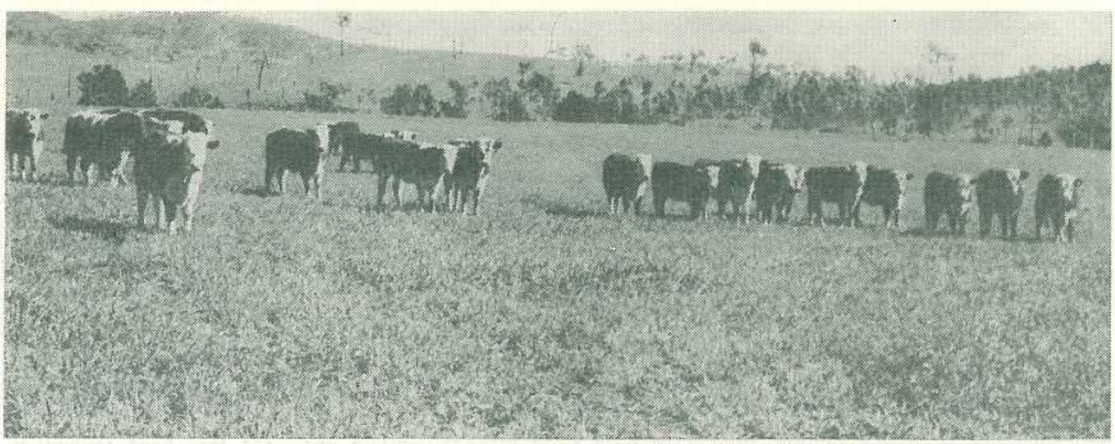
The above photographs show first quality, forward store weaner/yearling herefords that have responded very well to high density, nitrogen fertilized ryegrass.



Two 30-month-old steers on the run back camping area, ryegrass paddock in the middle distance. Steers of this age group made gains of 1·2 kg per day during their 3 months fattening period at a stocking rate of 5 beasts per hectare.



Good type weaner/yearlings after 56 days on nitrogen fertilized ryegrass.



Cross-breds with some Bos indicus *have usually out-performed straight breeds.*

The average for three properties is:—

	$
Cultivation costs	11.52
Ryegrass seed	24.49
Fertilizer	128.03
Irrigation charge	71.18
Value of cattle on	524.80
Selling charges and freight	54.42
TOTAL COSTS	814.44
Gross receipts, cattle . .	1190.27
Gross margin per hectare	375.83

Economic comments

If these irrigated areas had been used for lucerne hay production or for cash cropping then the gross margins could be expected to be in the range of $300 to $500 per hectare per year.

The wide variation in the gross margins is due to a number of reasons. The more important reasons are: level of Brahman blood; age of stock, stocking rate, sale price of stock and grazing and stock management practices.

No cost of labour has been included. This would vary greatly as, in one case, irrigation pipes were moved by hand. In the other two cases, semi-automatic and fully-automatic irrigation systems were used.

Lessons learned

(a) Animal health

On the Mundubbera property, one of the weaner steers developed photosensitivity and had to be held in the yards for a fortnight. It was then returned to the ryegrass with no further ill effects, other than sustaining a slight weight loss.

Photosensitivity would not normally be expected to be a significant problem when grazing ryegrass, however.

No other problems that could be associated with grazing heavily fertilized ryegrass were experienced. Indeed, no other health problems of any description were encountered.

(b) Husbandry

From the observations recorded it can be stated that heavily fertilized, irrigated ryegrass pastures have the following features:

- A long, sustained growing period allowing 23 to 26 weeks' grazing.
- A forage that will stand a fair amount of trampling.
- Apart from some rust, no plant disease problems were encountered.
- A high protein and energy content and good palatability are characteristic.
- They are relatively problem free under Burnett conditions, in regard to animal health, provided the cattle have access to reasonable quality dry fodder or forage.
- Limited evidence that rotational grazing is capable of giving slightly higher production per unit area.

(c) Best type of beast to fatten

The nutritive ratio of ryegrass is narrow during its first 90 days. That is to say it has a high protein to energy ratio. As it matures, the protein tends to make up a smaller proportion of the whole.

Young weaners will utilize lush, high protein food more efficiently than older cattle. Generally speaking, older cattle will utilize lower protein forage more efficiently than will weaners or yearlings. This appears to hold good in the case of irrigated rye grass.

At Biggenden, all the cattle fattened were young yearlings or weaners, and the performance of the first draft was superior. This was mainly in regard to shortness of time to finish. After the middle of September, difficulty was experienced fattening yearling cattle.

It is probably worthwhile to select older two-year-old cattle for the second draft.

Conclusion

These cattlemen made a profit from cattle fattening, even if it was lower in one case, than if cash crops had been grown.

It is important to select the right type of beast to fatten and to buy at the right price. At present, with store prices (per kg D. Wt.) lower than fat cattle prices it is feasible to get the right cattle at the right price.

There do not seem to be any great problems in growing the ryegrass crop and so this system can be safely recommended to progressive graziers on properties with a useful irrigation potential. More especially, this system is seen to have application where the desire is to turn-off a well finished yearling to two-year-old beast suited to local trade requirements.

Bovine brucellosis free herds

Additions as at 31-1-78

I. and D. J. Brimblecombe, 'Wyalong', Jimbour.	BF
Bundaberg Sugar Co., 'Avondale' Brahman Stud, 'Marlborough' Station, Marlborough.	BM
J. D. and H. Campbell, 'Hilden', Burpengary Road, Narangba.	MG, LM
R. T. and P. A. Craig, 'Dulong' Stud, M.S. 1096, Nambour.	MG
N. T. Crisp, Connor Street, Stanthorpe.	HF
W. D. Davis, 'Wambo' Stud, M.S. 918, Toowoomba.	AIS
C. M. and B. E. Dolding, 'Dilston', Gayndah.	DM
Eidsvold Station Holdings Pty. Ltd., 'Belvedere', Eidsvold.	SG
T. V. and P. M. A. Erbacher, 'Everush', M.S. 468, Cambooya.	JS
M. J. and M. Fitzgerald, 'M-Jay' Stud, 'Tarooma', Texas.	HF
A. J. and Y. L. French, 'Wilston Park', M.S. 181, Pittsworth.	FS
Glenrae Pastoral Co. Pty. Ltd., 'Bowenfels', Kingaroy.	PH
Mrs. L. M. Graham, 'Glenmore and Glenlea', Nanango.	BF, HF
B. and M. Hannant, 'Croalah' Stud, M.S. 243, Kingaroy.	PS
E. and R. F. Harvey, Dumboy, M.S. 918, Toowoomba.	FS
B. E. Hayward, 'Denville' Stud, M.S. 465, Cambooya.	HF
W. G. Henschell, 'Yarranvale', M.S. 1444, Brookstead.	PH
H. M. Prisons, Etna Creek, via Rockhampton.	MIXED
L. R. and E. E. Hoopert, 'Happy Valley', M.S. 212, Oakey.	SG
R. L. and S. S. Jones, 'Valley View' Stud, Samford Road, Samford.	AS
J. E. Kemph, 'Bunya Vale', M.S. 222, Oakey.	CL
R. and M. Kerr, 'Maryview', Miva.	BF
L. B. and M. Kirby, 'Kalanga' Stud, Wesley Road, Kallangur.	CL
P. A. and J. L. Lange, 'Cerana', M.S. 222, Oakey.	AIS
C. P. and E. G. Liebke, 227B, West Street, Toowoomba.	MG
K. D. and J. K. Little, 'Woodleigh' Stud, Beaudesert.	JS
S. H. and R. L. Ludwig, 'Glenvale', Boyland, via Tamborine.	GS
F. A. Mallison, 'Ganbeer' Stud, M.S. 438, Boonah.	AIS
V. and D. Mason, Deejay, M.S. 150, Pittsworth.	AIS
R. F. and R. M. Maynard, Greenfields, Jambin.	BM, CL
Mindaribba Pastoral Co., P.S. 1608, Nanango.	SG
K. B. and K. T. Muller, 'Lyndon', Clifton.	CL
G. and K. G. Orphant, 'Westbank', Paterson.	HF
J. N. Penglis, 'Pendale' Stud, Westbrook Road, Wellcamp.	PH
Perrett Graz. Partnership, Kingaroy.	PH
P. Rawson, 'Beenbah', Killarney.	SG
K. Reinhardt, 'Kenway' Stud, M.S. 906, Mapleton.	RP
C. N. Scott, M.S. 1471, Manumbar Road, via Nanango.	FS
L. Shaw, 'Padue' Stud, Kureelpa, via Nambour.	SM
W. H. and D. M. Thompson, Nanango.	AIS
J. R. Todd, 'Aberfoyle', Laravale, via Beaudesert.	JS
D. C. Tunstall, 'Hi Valley', M.S. 692, Nanango.	SH
E. M. Voight, 'Chelmadale' Stud, M.S. 825, Ipswich.	BF, AIS
E. E. W. West, 'Belmadochie' Stud, 19 Oatlands Court, Samford.	FS
E. F. and I. M. Zischke, 'Lynview' Stud, M.S. 231, Laidley.	JS

KEY

AIS—Australian Illawarra Shorthorn
AS—Ayrshire
BF—Braford
BM—Brahman
CL—Charolais
DM—Droughtmaster
FS—Friesian
GS—Guernsey
HF—Hereford
JS—Jersey
LM—Limousin
MG—Murray Grey
PH—Poll Hereford
PS—Poll Shorthorn
RP—Red Poll
SG—Santa Gertrudis
SM—Simmental

Brucellosis tested swine herds as at 17-11-77

Delete—J. A. and M. A. Clegg.

Bovine tuberculosis free herds as at 8-12-77

Delete—Klein Brothers.
Delete—J. F. Lau.
Delete—Panorama Stud.

Trickle irrigation —well suited to horticultural crops

by K. R. Chapman, B. Paxton, J. Owen-Turner, Horticulture Branch.

TRICKLE, or drip irrigation as it is often called, will be known to most people involved in horticulture.

However, it is our experience that many people do not appreciate the total concept of trickle irrigation and still believe it has many problems.

The purpose of this article is to give an appreciation of the concept and to show that the problems have been solved. In doing so, we point out the advantages of the system and show that it is a commercially viable proposition with many horticultural crops.

Delicious apples grown at the Granite Belt Horticultural Research Station, Applethorpe. Trees yielded twice as much fruit under trickle irrigation, as the unirrigated plots. Yields at 6 years of age were four times higher than the district average for mature trees.

The concept

Trickle irrigation is a technique developed for applying water to plants via small bore polythene tubing placed along the row beside the plants. The technique allows the crop to be supplied with low tension water on demand, throughout its life.

Low tension water simply implies that this water is readily available to the plant, with little energy having to be exerted by the plant to extract it from the soil. In this way, it parallels drip feeding of a patient in hospital.

The water is at low tension because the soil is maintained by trickle in a state close to field capacity (that is, the amount of water held in a soil 2 to 3 days after heavy rain or irrigation) due to the higher frequency of water application. Because water is supplied to plants at low tension with a trickle system, water containing more dissolved salts can be used for trickle. This is because the salts which also increase soil moisture tension do so to a lesser degree because the soil is moist, and kept moist by frequent water application.

There are other reasons for the success of trickle with saline water, including the non-application of water to leaf foliage, the continued movement of salt away from the plant in the soil, and the permeable soils used.

The real benefit or bonus from trickle irrigation lies in the fact that the technique is capable of providing a situation where water and nutrients need no longer limit crop production. Such a situation comes very close to what could be termed 'field hydroponics', a state rarely achieved in practice except perhaps under regular high rainfall-tropical conditions.

Brief history

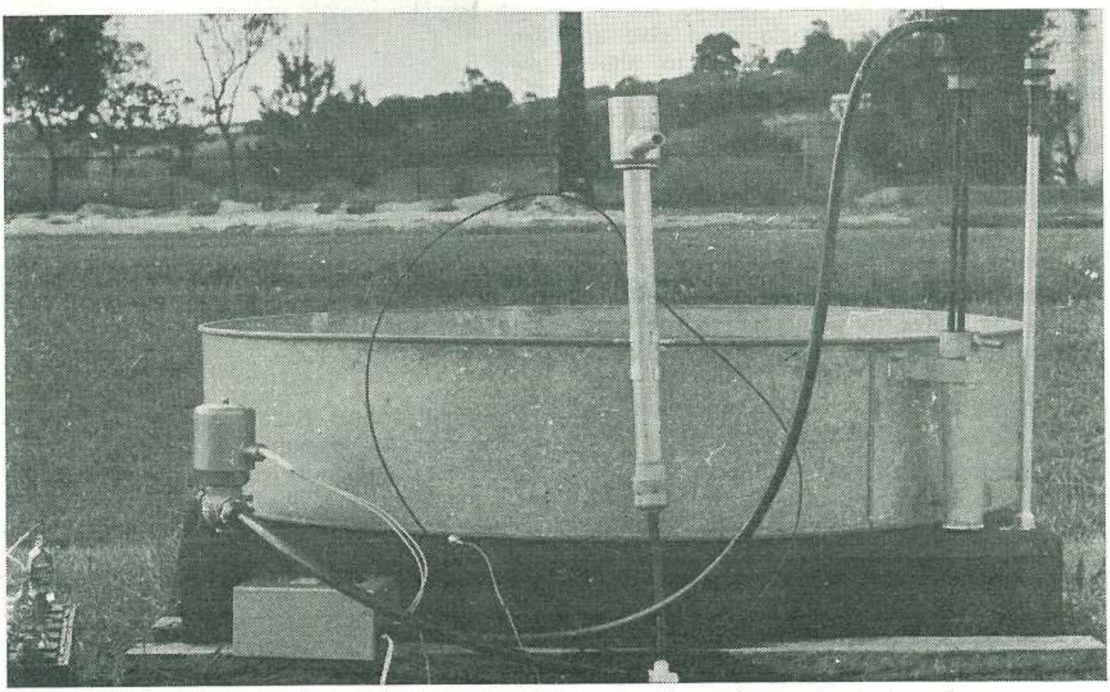
The concept of trickle irrigation seems to have been known and used for perhaps thousands of years in Ancient China. However, its appearance in the field situation in modern agriculture only came about in 1959.

Prior to 1959, the trickle concept was tried in glass houses in Britain in the 1930s and 1940s. In the 1950s, Israel commenced development using small bore polythene piping, firstly underground and then later on the surface of the soil. By 1959, the first field trickle irrigation system was developed and in use. It consisted of small bore polythene piping fitted with moulded plastic emitters to control water flow from the pipe.

Since 1959, we have seen many new developments in trickle irrigation, and both Israel and Australia in particular have shown the way in research and development.

No other modern agricultural development has been the subject of so much attention around the world in the last 15 years—no less than two International Congresses have been held in the space of three years (1971 and 1974) specifically on trickle and drip irrigation.

The use of trickle irrigation has spread at an incredibly rapid rate throughout the western nations, the Middle East and in recent times the Eastern Block countries. World areas under trickle are difficult to estimate but projections from 1974, indicate that close to 100 000 hectares are currently irrigated using trickle—with the majority of this area installed since 1969.



A fully automatic irrigation system 'Autoirrigator', developed by the senior author and co-workers, seen here controlling trickle irrigation at the Maroochy Horticultural Research Station, Nambour.

Suitability and problems

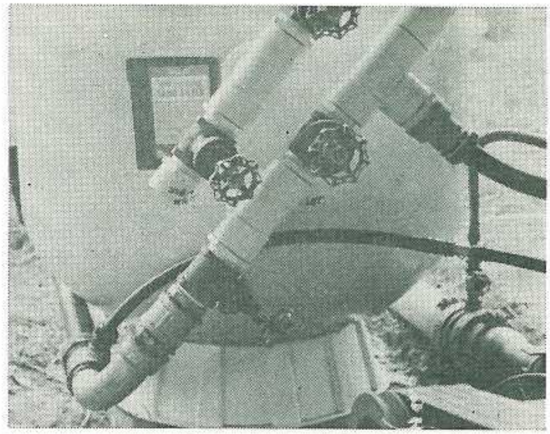
Much of the initial work on trickle irrigation done in Israel, Australia and later on in the U.S.A. was with relatively high value horticultural row crops. While trickle has now found a place in irrigation of parks, gardens, and (with new methods) sugar cane, the most economic applications involve irrigation of semi-intensive tree, vine and plantation fruits, and vegetable crops.

As row spacings become narrower, it is often more economic to use sprinkler or surface irrigation (for example, furrow) methods unless saline water is to be used on highly permeable soils (for example, desert sands). This is because piping costs increase as row spacings decrease and economic advantages with trickle are lost in all but very high value crops (for example, strawberries).

In general, with orchards and vineyards trickle costs about one-third to one-half that of permanent overhead or undertree sprinkler sytems, and about three times more than surface irrigation.

However, to make a valid costing, operational costs must be taken into account, and here trickle has distinct advantages in both costs of operation, labour, and water used compared with sprinkler and surface irrigation systems.

Thus trickle irrigation is well suited to many horticultural crops and the following listing of crops irrigated by trickle to produce economic returns bears this out: Almonds, apples, apricots, avocados, bananas, Brussel sprouts, capsicums, cherries, citrus, custard apples, cucumbers, dates, flowers, grapes, guavas, kiwi fruit, litchis, macadamias, mangoes, nectarines, papaws, passionfruit, peaches, pears, pecons, persimmons, pineapples, plums, prunes, rockmelons, strawberries, tomatoes, watermelons and zucchinis.



ABOVE RIGHT. A modern sand filter used to filter water for trickle irrigated papaws, on Mr A. Etheridge's farm at Beerwah.

RIGHT. A new look at an old crop, Persimmon, grown in research trials under trickle irrigation at the Maroochy Horticultural Research Station.

High yielding, young papaws grown with trickle irrigation under mulch film at the Maroochy Horticultural Research Station.

Hawaiian guavas grown under trickle irrigation and producing up to 50 kilograms of fruit per plant, 18 months after field planting at Nambour.

Problems with trickle irrigation have been due to the following causes:

- Blockages—due to poor filtration, precipitation of salts, algal and bacterial slimes and iron.
- Poor hydraulic design—giving rise to uneven, wetter distribution.
- Ignorance of the need to schedule irrigation, including factors of quantity, irrigation frequency and duration.
- Failure to appreciate the number of drippers per plant required and the placement of the drippers.
- Lack of knowledge on fertilizer injection.
- Poor pipe quality in the early years.
- Failure to capitalize on the advantages of automation.
- Lack of knowledge on air relief valves and suck back problems.
- Ignorance of system maintenance.
- Failure to achieve accurate water placement with emitters.
- Overwatering and underwatering.
- Lack of knowledge on water quality in relation to trickle.
- A non-appreciation of plant root development in relation to emit'ers.
- Failure of the system to cope for overhead hydrocooling and frost protection.

- Cheapness of trickle systems and components—thus a lack of incentive to sell and provide back up knowledge.

With the exception of the last two points in this list, all of the above problems have been resolved to the extent that trickle is now a well accepted and commercially viable proposition in horticultural crops throughout the world.

Trickle irrigation has, of course, advantages other than those mentioned briefly in earlier sections and growers and researchers alike should have a ready appreciation of these aspects. Listed below are the major advantages of trickle over sprinkler and surface irrigation systems:

- Increased yields of the order of 10 to 20%.
- More efficient use of water with resultant water savings.
- Access to fields at all times.
- Reduced labour costs in operation and ready adaption to automation.
- Better control over watering and nutrition.
- Lower operation costs because of the use of smaller capacity, lower head pumps used.
- Less inter-row weed problems.
- Ready adaption to poorer soils, for example, desert sands and heavy impermeable soils.
- Reduced drainage problems, because overwatering is more readily controlled.
- Water containing more dissolved salts can be used where soils are permeable.
- Above ground plant parts stay dry and are rendered less susceptible to disease and pest attack because spray materials are not washed off the foliage.
- Quicker maturity and better quality products.
- Ready adaption to soil incorporated nematocides, insecticides and fungicides.
- Lower installation costs—around half to one-third the cost of permanent overhead sprays and undertree sprinklers. Installation costs approximate that of travelling irrigators, but trickle is much cheaper to operate, and water can be supplied at all times on demand.

As a final note, we urge that farmers:

- Talk with a Department of Primary Industries officer and an Irrigation and Water Supply Commission officer with regard to their requirements prior to putting in a trickle system.
- Get the water supply tested.
- Do not attempt to design their own trickle set-up.
- Approach a reputable company to provide components and or designs.
- Have any designs checked by Irrigation and Water Supply Commission officers prior to installation.
- Seek advice on irrigation scheduling and use a schedule.

This simple advice will ensure success with trickle systems. Most criticism of trickle comes from farmers who have not used the advice available before installing a system. In short give trickle irrigation a 'fair go' and it will stand you in very good stead in future years.

Maintenance fertilizer strategies for

by J. K. Teitzel, Agriculture Branch, J. Standley, Agricultural Chemistry Branch and R. J. Wilson, Agriculture Branch.

RESEARCH carried out at South Johnstone Research Station has demonstrated that correct fertilizer application to good grass-legume pastures provides the cheapest and most efficient means of feeding beef cattle on the wet tropical coast (the coastal plain from Ingham to Cooktown).

Fertilizer application is certainly cheaper than molasses or any other form of supplementary or substitution feeding. It also produces a more vigorous, more competitive pasture which prevents weed invasion and soil degradation.

Grass-legume pastures can only be successfully established if soil mineral deficiencies are corrected. Producers generally accept this and have implemented most of the fertilizer recommendations for pasture establishment published in earlier editions of this Journal.

With the slump in the beef market, however, producers have been reluctant to purchase fertilizer to maintain soil fertility at levels required for effective legume growth and consequent nitrogen fixation. This reluctance has resulted in severe and widespread deterioration of improved pastures.

The pasture on the right of the fence received the recommended fertilizers and is carrying twice as many cattle as the weedy pasture on the left. Both pastures had a similar appearance before fertilizer application.

wet tropics pastures

How important is fertilizer?

Where phosphorus deficiency is extreme, improved pasture species will not survive; regrowth and weeds take over completely.

Other elements are also vitally important in certain areas. The applications of phosphorus, copper and zinc to one granite soil in the Tully area increased legume growth by more than 300% over that achieved by the application of phosphorus alone during the first 8 weeks from seed germination. In a grazing trial on originally poor open forest country, the application of other deficient elements as a maintenance dressing was followed by a dramatic increase in the legume content of the pasture, and stocking rates were doubled to about 3·5 beasts per ha.

The value of legumes

The legume is the more valuable component of tropical pastures. It provides the cheapest source of nitrogen for the associated grasses. A grazing experiment at South Johnstone showed that pangola grass (*Digitaria decumbens*) swards required a highly uneconomical rate of 600 kg ammonium nitrate per hectare (204 kg nitrogen) annually to give levels of production similar to those from combined pangola grass and legume, in this case, hetero (*Desmodium heterophyllum*). When grasses do not have adequate nitrogen they lose their feed value, grow more slowly and can be dominated by weeds.

Weed growth is a symptom of a run-down, nitrogen deficient pasture. The key to maintaining highly productive pastures is to correct deficiencies such as those of phosphorus, copper, zinc and molybdenum which severely depress the legume; the legume subsequently supplies nitrogen to maintain healthy grass.

Nitrogen is released temporarily when old pastures are cultivated before replanting. Many producers regard the initial flush of growth resulting from this as evidence that fertilizers are not needed. They later inherit poor, weed-infested pastures because they have ignored the long term nitrogen requirements of the grasses.

Soil sampling prior to fertilizer application with a 'Jarret' auger along a transect marked with a string.

Fertilizers required

General principles

The basic objective of the maintenance fertilizer programme is to apply just enough fertilizer to satisfy the mineral requirements of the legume. Fortunately, in our experience, this also satisfies the requirements of the grass (except for nitrogen). We have found no cause to modify fertilizer applications to alter grass-legume balance. Any tendency to grass dominance brought about by heavy phosphorus application has been overcome by grazing management.

Research has indicated that soil parent material is a reliable guide to the elements likely to be deficient and that the importance of each potentially deficient element is then indicated by remnants of the natural vegetation. Pasture soils are derived from granitic, metamorphic, marine sand, basaltic and mixed alluvial parent material. These and the natural vegetation groupings were described in earlier editions of this Journal. The maintenance fertilizer recommendations for each soil group will now be discussed.

Granitic soils

Excellent pastures have been found where soil acid extractable phosphorus is about 30 parts per million (p.p.m.) and exchangeable potassium is about 120 p.p.m. Different paddocks require different rates of superphosphate and muriate of potash to reach these levels, so sampling soils from each paddock and assessing the analyses is a necessary step in planning the fertilizer programme.

Two soil samples, one from the best and one from the poorest areas of large paddocks, will indicate the least and greatest requirements for fertilizer. Each soil sample should be taken from a thorough mixture of about 30 cores taken with a soil sampling auger—the greater the number of cores the more representative is the sample of the area being evaluated. Cores should be taken to a depth of 10 cm.

Exchangeable potassium has shown little change in 3 years on the coast and, once pasture establishment requirements have been met, muriate of potash should not be needed for several years. Soil phosphorus levels, however, gradually decline and we have found that approximately 300 kg superphosphate per hectare is required every 2 years to maintain soil phosphorus at about 30 p.p.m.

Other important deficiencies of granitic soils include sulphur, copper, zinc and molybdenum. So far, superphosphate, which contains 10% sulphur, has satisfied the requirement for sulphur. Copper deficiency occurs on well-drained sclerophyll (open forest) areas. Areas of zinc deficiency are more difficult to delineate but a zinc response has yet to be measured on those areas which once supported rain forest.

Molybdenum response by the legume has been found in pastures established for several years on some granitic soils. Where trace element deficiencies are suspected, 8 kg each of copper and zinc sulphates and 0.5 kg of sodium molybdate per hectare are recommended every fourth year.

Metamorphic soils

The phosphorus, potassium, molybdenum and sulphur recommendations just mentioned also apply to metamorphic soils. Copper and zinc deficiencies have not been discovered.

The only other fertilizer likely to be required is a single dressing of 500 kg lime per hectare to correct problems associated with high exchangeable aluminium. Your Extension Officer should be consulted on the question of whether or not lime is required.

Mixed alluvial soils

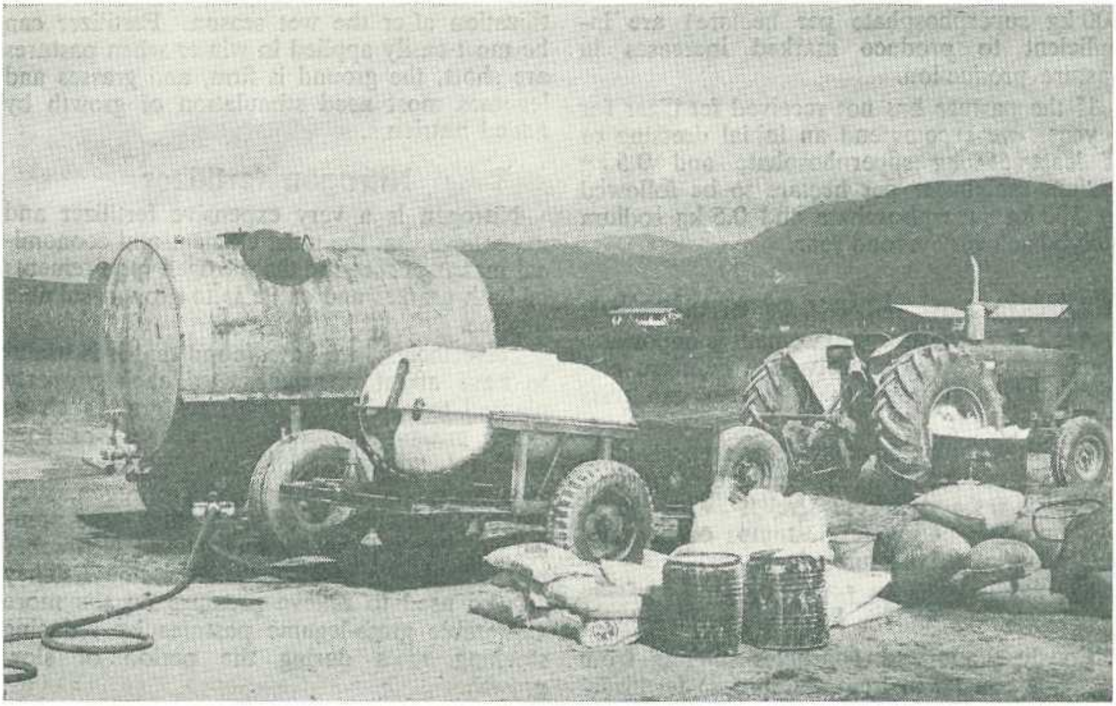
Phosphorus, potassium, copper, zinc, molybdenum and sulphur deficiencies have all been found on these soils. The variation within this broad grouping makes it more difficult to delineate where each element is deficient. Consult your Extension Officer before ordering fertilizer.

Soils derived from beach sand

These soils are extremely infertile and the golden rule is to add 'little and often'. Exchangeable potassium rarely exceeds 60 p.p.m. Annual application of 150 kg superphosphate and 50 kg muriate of potash per hectare at the end of the wet season is recommended; 8 kg copper sulphate, 8 kg zinc sulphate and 0.5 kg sodium molybdate per hectare every fourth year should suffice. High fertilizer rates are wasteful and may even be toxic on these sands.

Basaltic soils

Phosphorus, molybdenum and sulphur deficiencies have been recorded. It is difficult to get a reliable chemical test for phosphorus on these soils. However, field trials have indicated that normal rates of phosphorus (200 to



ABOVE. *Mixing zinc sulphate (paper bags), sodium molybdate (drums) and copper sulphate (sack bags) with water for aerial application.*

BELOW. *Loading the zinc, molybdenum and copper solution on an aircraft.*

58473—**24**

400 kg superphosphate per hectare) are insufficient to produce marked increases in pasture production.

If the pasture has not received fertilizer for 5 years, we recommend an initial dressing of at least 500 kg superphosphate and 0.5 kg sodium molybdate per hectare to be followed by 300 kg superphosphate and 0.5 kg sodium molybdate every second year.

Methods and timing of application

Accuracy of fertilizer placement is important. Areas which do not receive the deficient element cannot respond to it. Areas can miss fertilizer when:

- Fertilizer spreading contractors are instructed to apply fertilizers by truck to overgrown pastures, pastures strewn with large numbers of logs and stumps or partially waterlogged pastures.
- Fertilizer is spread from aircraft in breezy conditions and/or from a great height.
- Poorly granulated (particles ranging from fine powder to 1 cm dia. lumps) fertilizers are used.
- Trace elements have not been effectively mixed in mixtures which were stated to contain them.

With products presently on the market we have found that fertilizers needed in large quantities (for example, superphosphate and muriate of potash) are best applied separately. The problem of finding a suitable carrier for the trace elements then arises. We have had good results by dissolving them in water and spraying the solution on the paddock.

Copper and zinc sulphates and sodium molybdate are very soluble and the required quantities have been applied by aircraft application of 55 litres of solution per hectare. Large areas can be covered with an aircraft load. Tractor-mounted boomless power sprays have also proved to be a cheap and effective means of trace element application. Boom sprays may be used but they are not as robust as the boomless type.

If ground machinery is to operate effectively, land must be carefully prepared. Grazing management and log clearing should ensure good visibility and unobstructed travel. Rapid summer growth, waterlogging and loss in run-off during the wet season favour pasture fertilization after the wet season. Fertilizer can be most easily applied in winter when pastures are short, the ground is firm, and grasses and legumes most need stimulation of growth by added nutrients.

Nitrogen fertilizer

Nitrogen is a very expensive fertilizer and we believe that the most efficient and economical means of meeting the nitrogen requirements of both grasses and cattle is to grow a suitable legume.

Nevertheless, we have found that it is useful to have about one-quarter of each property planted to a vigorous prostrate grass such as signal grass (*Brachiaria decumbens*) or para grass (*B. mutica*).

If adequately fertilized with nitrogen, such pastures are capable of supporting large numbers of cattle between August and November when feed shortages may be serious. They can be used to relieve pressure on the more vulnerable grass-legume pastures by reducing stocking rates during the period of slow growth.

The grass-legume pastures are then more fully utilized during summer when they are highly productive. A cash crop of seed is normally possible from the signal and para grass pastures at that time.

Phosphorus, potassium and trace element fertilizer strategies for these grass pastures are similar to those for grass-legume pastures. Their nitrogen requirement may be met by applying three equal applications of urea at 150 kg per hectare, or 'Nitram' at 200 kg per hectare, in mid April, mid June and mid August. Urea is best applied just before rain to minimize losses from volatilization.

Conclusions

Most pasture soils of the wet tropical coast are inherently deficient in a number of minerals which are essential for both plant and animal growth. A regular maintenance fertilizer programme is required to keep these minerals at acceptable levels.

If soil fertility is allowed to decline to levels which are too low for legumes to survive, valuable capital investment will be lost and there will be a rapid decline to a stage where weeds invade, improved pasture species disappear and most stock must be removed.

Avocado root rot

by K. G. Pegg, Plant Pathology Branch.

An avocado plantation devastated by the root rotting fungus Phytophthora cinnamomi. *Trees have been reduced to an almost bare framework of dying branches.*

AVOCADO root rot, caused by the soil fungus *Phytophthora cinnamomi*, is the Queensland avocado industry's most serious problem.

It is also a great problem in many other avocado-producing areas of the world. Trees of any age and size from nursery stock to large, old trees may be affected.

Symptoms

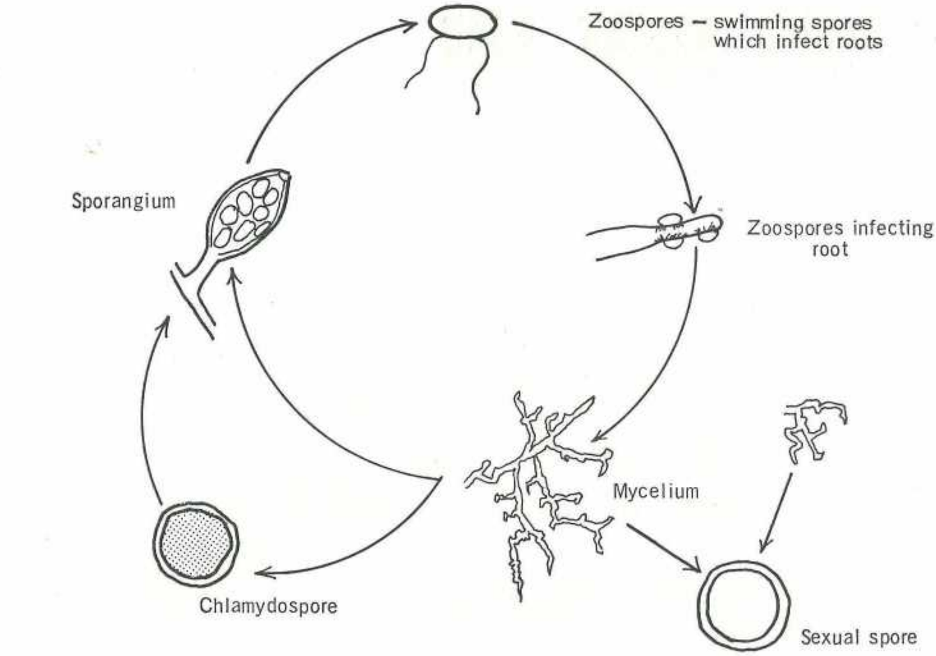
The leaves on a diseased tree first turn pale green and hang more limply than normal. This is followed by heavy leaf fall and twig dieback and eventually the tree is reduced to a bare framework of dying branches. Because of the lack of foliage, branches are prone to sunburn. It is not unusual for a declining tree to set a heavy crop of small fruit.

Below ground symptoms of root rot can be seen after scraping away the surface soil to expose the roots. Under healthy trees, white, succulent feeder roots are obvious whereas, under declining trees, most feeder roots are black and shrivelled. In advanced stages, it is difficult to find healthy feeder roots.

Under conditions of severe waterlogging the foliage sometimes wilts rapidly and dies leaving the tree with a canopy of brown, dead leaves.

The avocado root rot fungus occasionally causes cankers on the lower trunk of avocado trees. These originate at or below ground level. The bark becomes discoloured and covered with a powdery, white exudate referred to as 'avocado sugar'.

Life cycle of Phytophthora cinnamomi.



Cause

The soil fungus *Phytophthora cinnamomi* produces three spore stages—motile zoospores which are formed within sporangia and non-motile chlamydospores and oospores.

Zoospores, released from the sporangia into the soil water, are attracted to the avocado feeder roots by root exudates and invade the region of elongation behind the root tip. Root injury induces greater release of exudates and enhances infection.

Chlamydospores form in the decaying roots and are a 'carry-over' stage of the fungus. High soil moisture or free water is necessary for their germination. Oospores are thick-walled, resistant spores formed in decaying roots and are probably important as survival propagules.

P. cinnamomi is widespread in eastern Queensland but not all soils are infested. The question of whether it is an indigenous or introduced fungus may never be resolved.

Host range

P. cinnamomi has a wide host range including the avocado, pineapple, peach, macadamia nut and many ornamentals. It is responsible for severe damage to native eucalypt forests in Western Australia and Victoria. Recently, it has been found associated with 'patch death' in tropical rain-forest in north Queensland. *P. cinnamomi* also causes serious root disease of pine trees (*Pinus* spp.).

Control

- PLANT NURSERY TREES FREE OF *Phytophthora cinnamomi*

Nursery trees with root rot may fail to grow satisfactorily after they have been planted out. If a large amount of inoculum is introduced with nursery trees, the ability of some soils to suppress the fungus may be swamped.

Management practices necessary to exclude the pathogen in nurseries are described in

'Disease-free avocado nursery trees' in this issue of the *Queensland Agricultural Journal.*

• Avoid shallow soils

The avocado requires a well-drained soil with a depth of at least 1.5 m above a porous subsoil.

• Improve soil drainage

Construct interception and diversion drains to reduce the quantity of water flowing or seeping from adjacent areas. The soil should be ripped to a depth of at least 0.5 metres to break up any hardpan. The final ripping should be down the slope so that the flow of underground water will not be impeded.

• Increase the organic matter content of the soils

This is particularly relevant to red basaltic soils such as those on Mt. Tamborine and the Atherton Tableland which previously supported rain-forest. Grow cover crops between the young trees. Sow maize or a forage sorghum with lablab inoculated with the appropriate strain of nodule bacteria (CB 1024) in the spring and New Zealand Blue Lupin inoculated with strain WU415 in the autumn.

These cover crops are slashed when fully grown and incorporated with disc harrows with a minimum of soil disturbance. Seed is broadcast and mixed into the surface soil and mulch with disc harrows.

Mulch to about 0.5 m outside the drip ring with materials such as wheat straw, barley straw, or sorghum stubble which are high in fibre and low in protein. Mulch initially to a depth of 12 to 15 cm in the late winter when there is little *P. cinnamomi* activity and replenish if necessary in early January.

The mulch must be in an advanced stage of decomposition before the onset of the heavy rains in late summer. Do not mulch against the tree trunks as this increases their susceptibility to canker.

• Maintain high soil nitrogen levels

Maintain a high organic nitrogen level in the soil by using poultry or other animal manures which do not change to nitrate nitrogen as rapidly as urea and some other nitrogen fertilizers. The material should be spread over the surface of the mulch so that the nitrogen produced is trapped and released slowly by the old organic residues of the mulch.

• Maintain high soil calcium levels

Maintain a high calcium level in the soil by applying 1 tonne per ha of lime or dolomite twice a year. In Queensland plantations where losses due to root rot have been negligible despite the presence of *P. cinnamomi,* the levels of exchangeable calcium in the soil have been higher than in severely affected plantations on the same soil types.

• Irrigate the entire root zone

As moisture shortage at any part of the root system will increase root exudates at that point and attract zoospores, irrigation systems should be designed to give complete ground cover. Avoid overwatering as high soil moisture increases root rot.

• Resistant rootstocks

The use of a resistant rootstock offers the most satisfactory method of combating avocado root rot. In California, some resistance has been found in Duke 6, Duke 7, Guatemalan 6, Guatemalan 22 and Huntalis. Because their resistance is limited, these stocks should be used in conjunction with improved soil management practices. These rootstocks must be vegetatively propagated, as seedlings vary in their resistance to root rot.

• Control with fungicides

Although application of fungicides such as fenaminosulf to the soil reduces the activity of *P. cinnamomi,* costs prohibit their widespread usage.

Summary of control measures

- Plant nursery trees free of *P. cinnamomi.*
- Select a site with good natural drainage.
- Deep rip soil down the slope to a depth of at least 0·5 metres.
- Construct interception and surface drains to reduce waterlogging.
- Grow cover crops between young trees.
- Mulch trees with straws which contain a high percentage of fibre.
- Maintain high soil nitrogen levels with animal manures.
- Maintain a high soil calcium level.

Disease-free avocado nursery trees

PHYTOPHTHORA root rot, caused by the fungus *Phytophthora cinnamomi* is the most devastating disease of avocados in Queensland.

During wet years it is responsible for the death of many trees.

Although *P. cinnamomi* is widespread in coastal Queensland, not all areas are infested and there are some areas where the infestation is light due to the inherent ability of the soil to suppress or buffer the pathogen. This effect may be swamped by planting severely diseased trees.

Control measures are based on the use of disease-free nursery trees and cultural practices designed to maintain high levels of organic matter and nutrients in plantations. There is an urgent need for nurserymen in Queensland to pay more attention to management practices to ensure the production of disease-free avocado trees.

Life cycle of the pathogen

The vegetative stage of *P. cinnamomi* consists of mycelium made up of fine threads or hypae. When the soil is warm and moist, spore sacs or sporangia containing motile spores (zoospores) are produced. Large numbers of zoospores are produced in a very short time. When released from the sporangia, they swim through the wet soil and infect plant roots. In addition to zoospores, the fungus produces thick-walled chlamydospores and oospores which enable the pathogen to survive in the soil in the absence of host plants.

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by K. G. Pegg, Plant Pathology Branch.

On the diseased avocado seedling (left) most roots are dead and the leaves wilted. The plant on the right with the white feeder roots and upright leaves is healthy.

Symptoms

The fungus attacks the feeder roots which become dark and brittle and, in advanced cases, white, healthy feeder roots may be difficult to find. Leaves of diseased trees are smaller than usual, pale green or yellow in colour, and have a tendency to hang downwards more than normally.

Control

The following programme has been designed for nurserymen to produce container-grown trees free from *P. cinnamomi*. It involves the use of disease-free seed, potting mixtures

Healthy avocado nursery trees are now commonly produced in black polythene bags containing media which has been treated with aerated steam.

sterilized by aerated steam or methyl bromide, chlorination of irrigation water and strict nursery hygiene.

Pathogen-free seed

The fungus can be spread in avocado seeds if the fruit from which the seed is extracted is picked off the ground. Therefore, use seeds from fruit picked from the tree or treat seeds from fruit off the ground in hot water at 49°C for 30 minutes.

A hot water tank similar to that described in Advisory Leaflet No. 924, Division of Plant Industry, Queensland Department of Primary Industries, is suitable for treating large numbers of seeds.

For small lots of seeds, a simple, efficient water bath can be constructed from a 20 litre drum with the top removed. This is placed inside a larger drum also without a top and the space between the sides of the drums is packed with insulating material. The heat is supplied by an L.P. gas burner under the drums.

After hot water treatment, immediately rinse the seeds with clean, cold running water and dry them thoroughly on a clean surface (not bare ground).

Planting mixtures

Black plastic nursery bags 38 x 20 x 15/ 150 um gauge (that is 15 in. x 8 in. x 6 in./ ·006 in. gauge), or thin plastic sleeves lined with malthoid are commonly used for avocado nursery trees.

Potting mixtures based on coarse sand with peat, sawdust, peanut shells, or rice hulls to which fertilizer has been added are suitable for growing healthy avocado trees and preferable to soil.

Two mixtures which provide well-drained growing media are:

SAND-PEAT

To one cubic metre of a mixture containing 60% coarse river sand and 40% peat add:

Dolomite 3 kg
Agricultural lime 1 kg
Superphosphate 1 kg
Blood meal 1 kg
Potassium sulphate 100 g
Sodium nitrate 100 g

SAND-SAWDUST

To one cubic metre of a mixture of equal parts of hardwood sawdust and coarse river sand or fine gravel add:

Dolomite 1·4 kg
Calcium carbonate 1 kg
Potassium nitrate 0·5 kg
Superphosphate 1·2 kg

All potting mixtures must be treated with aerated steam at 60°C for 30 minutes or fumigated with methyl bromide under a plastic cover for 24 hours. A 454 g can of methyl bromide is sufficient to treat a cubic metre of potting mixture.

Fungicidal drenches mask the presence of *P. cinnamomi* and should not be used as a substitute for treatment with aerated steam or methyl bromide.

The pH of these media should be maintained at about 6·0.

Avocado trees in either medium should be drenched with the following mixture every 4 weeks in winter and 3 weeks in summer.

	g/per 1 000 litres
Calcium nitrate	530
Ammonium sulphate ..	110
Potassium nitrate ..	270
Magnesium sulphate ..	110
Borax	1
Sodium molybdate ..	0·2

Sulphates should be added to the water before the nitrates.

Water free from *P. cinnamomi*

There is little point in sterilizing the potting mixture and then using water infested with *P. cinnamomi.*

Water from rain water tanks, deep wells and bores not fed by surface drainage, and city or town water which has been chlorinated are unlikely to be contaminated. On the other hand, zoospores of the fungus readily develop in dams which collect water from areas infested with *P. cinnamomi.*

Water can be chlorinated in two ways:

- With a chlorine gas injection unit.

A gas chlorinator allows the chlorine to flow at a constant rate from a high pressure cylinder into the water main near the pump.

- Treated with calcium or sodium hypochlorite in holding tanks.

Calcium hypochlorite is a dry white compound available in granular or tablet form under various trade names. It releases 70% of its weight as free chlorine when dissolved in water. Sodium hypochlorite is the principal constituent of liquid household bleaches which usually contain 10 to 15% of available chlorine.

Water is pumped into the holding tank, where it is treated manually with one of these chemicals. A concentration of 2 p.p.m. residual chlorine will ensure pathogen free water. Water is suitable for irrigation when the concentration has dropped to 0·6 p.p.m. Chlorine content can be determined with swimming pool water test kits.

Avocados are sensitive to chlorine and care must be taken to ensure that the recommended concentration of chlorine is not exceeded. Chlorine injury appears as a marginal burning of the leaves. Containers should be well leached with each watering to prevent any build up of chlorides in the potting medium.

Strict nursery hygiene

As *P. cinnamomi* is best controlled by exclusion, a very high standard of nursery hygiene is essential. This includes:

- Concrete or bitumen floors in the nursery. If this is too costly, at least have concrete or bitumen walkways and cover the remaining area with 5 cm of clean gravel.
- Keep containers on wooden benches treated with copper napthenate or benches with steel mesh tops. Never place clean containers or propagating material on the ground.
- Use new or sterilized containers. Store them in areas where there is no opportunity for contamination.
- Disinfect tools with steam or dip them in formalin (1 part of commercial formalin to 18 parts of water) or sodium hypochlorite solution containing 0·2% available chlorine.
- Keep the nozzle of the hose off the ground where it may become contaminated. Provide hooks on the edges of the benches to hold the nozzles when not in use.
- Install a bin to hold contaminated material for fumigation with methyl bromide or steam treatment.
- Treat floors with formalin before dumping treated potting mixtures on them.
- Segregate avocado trees or plants introduced from other nurseries as they may be diseased.
- Restrict entry of people to propagating areas. Insist on the use of foot baths containing formalin solution (1 part of commercial formalin to 18 parts of water) or copper oxychloride powder at the entrance to growing areas. Disposable plastic shoes are a suitable alternative.
- Control dust in and around the nursery. Spray dusty paths with sump oil or cover them with gravel.

Increase sunflower yields

precision planters show the way

TWO years of trials at the Biloela Research Station have shown that sunflower yields are greater from more uniform plant stands.

In 1975, a sunflower crop planted with a cotton planter yielded 6% more than that planted with a combine drill. The plant distribution, though more uniform than that obtained with a combine drill, was not satisfactory.

Hand thinning of heavily seeded plots in 1976 gave perfect uniformity in spacing and resultant yields were 33% greater than those from combine planted areas.

The trials

Sunflower was planted with a cotton planter and with a conventional combine drill in an attempt to determine if plant distribution had any effect on yield.

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by G. K. Taylor, Research Stations Section.

ABOVE. Plate 1. Sunflowers planted with a precision planter.

Results

A. Distribution effects

Treatments	Distribution	Seed yield kg/ha		Average yield increase over combine	Field Emergence	
		1975	1976		1975	1976
Combine	poor	2 242	711	..	64%	63%
Cotton planter	good	2 372	824	12·5%	70%	87%
Combine sown hand thinned	near perfect	..	945	33·0%	..	..

B. Presswheel effects

Treatments	Presswheels	Yield in kg/ha		Average yield variation from combine and harrows	
		1975	1976		
		(45 kg)	(20 kg)	1975	1976
Combine and covering harrows	No	2 242	711	..	..
Combine	Yes	2 128	785	−6%	10%
Combine and covering harrows, hand thinned	No	..	945	..	33%
Combine and hand thinned ..	Yes	..	903	..	27%

The cotton planter was equipped with twin disc openers and had side pressure presswheels of 15 cm width. The split rim presswheels had an axle weight of 18 kg.

The combine was used with and without presswheels. In the first year, an axle weight of 45 kg suppressed seedling vigour so the presswheel weight in the 1976 trial was reduced to 20 kg.

In March 1975 and January 1976, the trials were planted in 88 cm rows on a Callide alluvial clay loam. The planting speed in all instances was 8 km per hour, and the plant population approximately 30 000 plants per ha. The trials were not irrigated. In 1975, seed was sown 5 cm deep and 6 cm deep in 1976.

Hysun 30 with a test germination of 86% was planted in 1975 and Hysun 20 with a 96% test germination was planted in 1976.

Both seasons had favourable rainfall for sunflower production. Grain yield in 1976, however, was reduced by the fungus disease *Alternaria helianthi* which caused premature leaf death after flowering.

Plant distribution

The first table demonstrates the yield advantage that is obtained as the distribution of plants in the row is perfected. The very even distribution of plants in hand-thinned plots in 1976 gave an impressive 33% increase in sunflower grain yield over the combine plots. It is, however, possible to achieve near perfect sunflower stands with some precision planters. Plate I shows a sunflower stand planted in March 1976 with an imported precision planter on 'Vandeena', Biloela.

The yield advantage from precision planting over conventional combine planting is attributed to more even distribution of plants within the row. A combine establishment is typified by large gaps between groups of sunflower plants and yield is reduced by competition in the clumps and inefficient use of soil water in the gaps. A sunflower plant

Plate 2. A sunflower trial planted with a combine drill. The crop has a ragged appearance with short and tall plants pushing into spaces between the rows.

normally produces only one seedhead, and has a relatively low ability to compensate for poor plant distribution compared with a freely-tillering plant such as sorghum.

Precision planting produced 130 kg per ha in 1975 (6% increase) and 113 kg per ha in 1976 (17% yield increase) more sunflower seed than combine planting. With a current market price of $220.00 per tonne, precision planting in these conditions returned an additional $25.00 per ha. Similar yield benefits from precision planting have been reported in Argentina and the U.S.S.R.

Presswheels

Presswheels can be used to delay the drying of soil around the seed until germination and establishment are complete. On soil which crusts following rain, it is important to achieve rapid seedling establishment.

In Biloela trials, the highest percentage field germination and the fastest time to emergence was shown by the cotton planter sown plots. The addition of heavy, over-centre presswheels to the combine in 1975 actually delayed seedling emergence by 1 day. The lighter, over-centre presswheels used in 1976 did not delay seedling emergence. Over-centre presswheels marginally improved the percentage emergence of sunflowers in both years, but no yield advantage was measured in these plots (refer to table B).

It is evident that excessive weight over the seed on soils with a poor surface structure reduces seedling vigour, final plant emergence and grain yield. Side pressure presswheels have no known disadvantages on these soils and are highly recommended.

Sunflower establishment

Many factors are important for the establishment of a worthwhile crop of sunflowers. An even distribution of seed loses some significance if a high seedling establishment is not achieved.

As for most crops, seed bed preparation, high germination potential, evenly graded seed and adequate planting moisture are required for good sunflower emergence. Depth of planting is also an important factor and local recommendations are to plant between 5 cm and 7·5 cm deep if presswheels are not used. The depth varies depending upon seed size, the smaller seeds being planted at the shallower depth.

Careful attention should be paid to calibration of planting machinery. Where precision planters with plates are used, the plate with the correct cell size for a single seed drop must be selected. Sunflower seed lots vary in size from 13 000 seeds per kg to 30 000 seeds per kg. The graded size of sunflowers No. 1, 2, 3 and 4 are not standard, and vary greatly from season to season. It is, therefore, necessary to calibrate the planter for each batch of seed received.

To calibrate a combine equipped with a fluted roller metering device, a bag should be placed under a seed delivery hose and the seed dropping over a measured 100 m counted. This will pay dividends in assisting you to control the final plant populations of your crop.

The positioning of seed in the soil should be checked where the planting unit has passed at normal operating speed. If seed is getting scattered about, it may be necessary to reduce ground speed to improve placement in the soil.

Conclusion

In order to obtain top sunflower yields, uniform plant distribution is essential. Such stands may be obtained by planting high quality seed with precision planters and side pressure presswheels.

Agricultural Census 1977-78 season

PRIMARY producers in Queensland are reminded that their annual statistical returns for the year ended 31 March 1978 are now due for lodgment with the Australian Bureau of Statistics, 345 Ann Street, Brisbane, 4000.

The statistics from this collection provide a reliable picture of production trends in rural industry, and are extensively used by growers' organizations, government authorities, and private enterprise.

It is in producers' own interests that comprehensive and factual information should be available to anyone interested in the advancement of rural industry and the analysis of its problems.

Producers interested in trends in rural industry generally, or in particular segments, are invited to inquire about the Bureau's statistical service relating to the free issue of annual bulletins covering most items of production in Queensland.

Collection forms together with reply-paid envelopes have been posted to primary producers. If a form has not been received, producers should write to the Deputy Commonwealth Statistician, Brisbane or telephone (07) 33 5011, extension 5403.

The return is compulsory under the provisions of the Census and Statistics Act 1905, which also guarantees the confidentiality of information on individual returns. Statistics are published only in the form of aggregates prepared from the figures supplied by individual producers.

Co-operation in forwarding returns without delay will assist in the completion of the 1977–78 Agricultural Census and early publication results.

Progress and possible developments in tobacco pest control

by R. H. Broadley, Entomology Branch.

FOR many seasons, tobacco growers relied on regular applications of residual insecticides for control of tobacco pests in the field.

However, in the last 7 years, this system has changed considerably following the replacement of residual pesticides by chemicals which break down comparatively rapidly on the plant and the introduction of an insect activity forecasting service in the Mareeba-Dimbulah tobacco district.

In addition, researchers are looking more closely at a wider spectrum of control techniques as chemicals are not the complete answer to pest control. Insecticides are fast-acting, relatively cheap, may be used as required and can control large populations of larvae (grubs).

However, disadvantages are associated with their use. These include the development of resistance in the target pest (for example, endrin resistance in the tobacco looper and DDT resistance in one of the two tobacco budworm species), destruction of beneficial parasitic and predatory insects which can influence the build-up of pest species and the formation of chemical residues on the plants.

Insect build-ups in the Mareeba-Dimbulah district are monitored by twice weekly counts of unsprayed, marked plants—such as the one illustrated. Results are incorporated into an insect activity prediction service.

Pest management system

A pest management system is currently being offered to growers in the Mareeba-Dimbulah district of north Queensland. It is based on the enforcement of a closed season when tobacco plants are absent from the district and on strategic applications of non-residual chemicals to control existing infestations in field crops.

Closed season

Under the stipulations of the Tobacco Industry Protection Act 1965, there are certain times when tobacco may not be planted into the field and when any volunteer plants, regrowth, etc. must be destroyed.

This period varies with the location of tobacco growing areas. In the Mareeba-Dimbulah district, for example, the 'closed' season presently extends from November 1 to March 31.

The effect of this 'closed' season is dependent on the pest species involved. For example, the tobacco stemborer has been recorded from tobacco and egg plants only, and as there are few wild tobaccos in the Mareeba-Dimbulah district, the pest can be eliminated almost completely before the commencement of a new tobacco season.

On the other hand, budworms can breed and develop on a wide range of cultivated and uncultivated hosts, or may enter a state of arrested development during the winter months. Detrimental effects on budworm populations are, therefore, not as marked as those on the tobacco stemborer.

Insecticidal control

Pest control with chemicals is primarily dependent on three inter-related factors—correct timing of spray applications, correct placement of insecticides, and the characteristics of the insecticides used.

Destroying unwanted plants like this one during the 'closed season' eliminates the breeding sites of several major tobacco pests.

- TIMING—Spray applications should be timed to coincide with the appearance of young larvae on the plants. Young larvae cause little damage, and are easier to control than are larger larvae.

  Growers are advised to follow the recommendations of the insect activity forecasting service which indicate when new infestations are developing. The service should not be seen as a total replacement for grower's individual assessments of pest activity on their own farms.

  The service eliminates problems that a grower may have in deciding whether or not to spray and up to five insecticide applications may be avoided by following the prediction service. Costs of production may, therefore, be substantially reduced, chemical residues on the cured leaf may be minimized and beneficial insect species such as wasp and fly parasites can be given better opportunities for survival.

  The temptation to spray more often than necessary as insurance against pest damage is attractive to growers of high return per hectare crops such as tobacco. Excessive applications and excessive dosages of insecticides are, however, not only economically but also entomologically unsound as they must lead eventually to compounding of problems such as residues and resistance development.

- PLACEMENT—Studies on the distributions of the major insect pests of tobacco have shown that coverage of both surfaces of all leaves is required for control of the total pest complex. Factors which influence the achievement of such coverage include type and adjustment of spray machinery and conditions prevailing at application.

  The tricrop and boom sprayer with droppers attached give best coverage if spraying occurs during cool, calm conditions. Misting machines and boom sprayers without droppers are more suited to a regular spraying schedule and growers who use such machines are advised to change or modify them, so that the insect activity forecasting service can be employed to advantage.

- INSECTICIDES—These are selected on the basis of efficacy and non-residual properties. The use of residue-producing chemicals such as DDT is actively discouraged. Growers should consider consumer and manufacturer preferences when deciding which chemicals to apply. Emphasis by these groups is placed on production of cured leaf without significant chemical residues.

Other control techniques

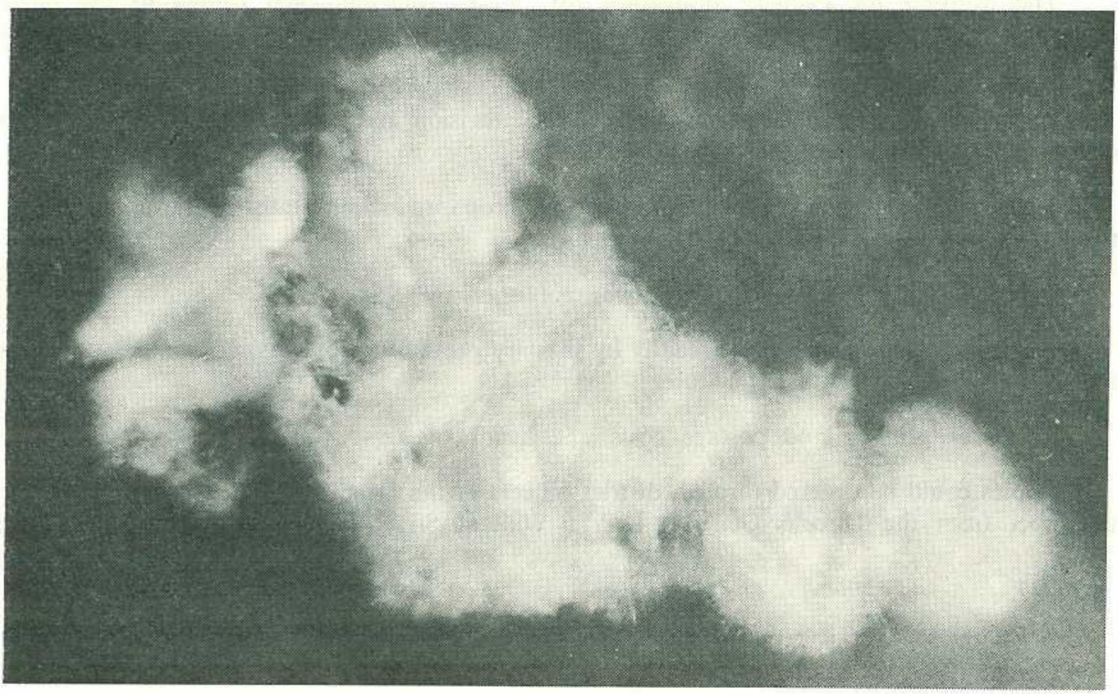
The Department of Primary Industries is continuously seeking control methods to supplement those already in existence. Potential methods include the use of plant resistance, parasite and predator augmentation and biological pesticides.

Parasites and predators

An intensive study of the effect of beneficial insects on major pest species has been made. The tobacco looper, for example, has at least 20 parasites and predators in the Mareeba-Dimbulah district. Some appear to have potential in tobacco pest control, in either mass release or conservation programmes.

Plant resistance

There is no plant breeding programme aimed specifically at producing insect-resistant tobacco varieties at the present time. However, trials have shown that there are differences in tobacco looper infestations on different breeding lines. There is a potential for reducing pesticide applications if breeding lines which are partially or completely resistant to major insect pests can be found and incorporated in commercial varieties.



These are the pupal cocoons of Apanteles *sp., an important wasp enemy of tobacco looper larvae in north Queensland. Beneficial species can be 'conserved' by a limited number of non-residual insecticide applications.*

Biological pesticides

Formulations of bacterial and viral diseases of insect pests have a potential for use in tobacco pest control as they leave no undesirable chemical residues on the leaves, and do not cause mortality of beneficial species. Health hazards to spraying operators are also minimized. Local and overseas data indicate that if these 'biological insecticides' are incorporated in baits or mixed with non-residual chemicals, control of pests such as budworms may be achieved more effectively.

Scientific names of pests mentioned in this article are as follows:

Tobacco budworms	*Heliothis armigera* (Hubner) and *Heliothis punctigera* Wallengren
Tobacco looper ..	*Plusia argentifera* Guenee
Tobacco stemborer	*Scrobipalpa heliopa* (Lower)

New Farm Management Handbook Available

A new edition of the Farm Management Handbook, providing a ready reference to technical and financial data used in primary production, is now available.

The Minister for Primary Industries, Mr. V. B. Sullivan, paid tribute to the many firms and organisations whose co-operation in supplying information had made compilation of the handbook possible.

The new fifth edition represents a substantial revision and contains detailed information on a wide range of topics.

These include livestock nutrition, irrigation, crop production statistics, farm machinery, rural finance and valuation.

The first edition of the handbook was published in 1964.

All editions had been sought readily by primary producers, students, accountants, bankers and others concerned with agriculture.

To cover printing and postage costs, the handbook was available at $4 a copy.

Copies could be ordered through district officers of the Department of Primary Industries, or direct from the Director-General, D.P.I., William Street, Brisbane, Queensland, 4000.

Identifying insects Order Lepidoptera–butterflies and moths

Part I—Butterflies

THE insects belonging to the Order Lepidoptera probably need no introduction to most of us. Butterflies, because of their size, their beautiful colouration and because they fly by day are well known to everyone.

Moths which in warm months are attracted to household lights at night are equally familiar.

Butterflies and moths are probably best characterized by their large wings and stout bodies covered with overlapping scales. In many species, these scales are very colourful and are arranged in delicate patterns. However, the scales are easily rubbed off, and old specimens are often quite dull compared to fresh individuals of the same species.

The adults are almost all nectar feeders which is why they are often seen clustered around flowers. They suck up the plant juices through a tube formed by the apposition of two long, flexible blades. This tube is tightly coiled beneath the head when not in use.

The immature stages of almost all Lepidoptera are plant-feeding caterpillars. After mating, adult females seek out a suitable host plant and deposit their eggs. As the larvae grow they shed their skin several times, finally changing to an immobile pupa (chrysalis).

Since pupae cannot defend themselves, the last larval instar often makes a shelter of leaves, frass etc. in which it pupates. Some others leave the plant and bury themselves in the soil. In the pupa, the larval tissues are broken down and replaced by adult organs and in due course the adult insect emerges.

by B. K. Cantrell, Entomology Branch.

Lepidopterous larvae all possess silk glands in the head. The silk is used primarily in the construction of shelters, attachment of pupae etc. Because of the plant-feeding habits of the larvae, many species are of economic importance and must be controlled when they invade crops.

The Lepidoptera is one of the largest groups of insects including some tiny moths with a wing span of only 3 mm and other giants up to 25 cm. There are two important sub-orders, the Monotrysia and the Ditrysia, the latter containing the majority of species.

To briefly explain the differences between butterflies and moths, it can be generally regarded that butterflies are active by day as adults while moth adults are only active at night. There are of course a few exceptions to this rule and as another guide butterflies all have antennae with a swelling or 'club' at the end. Most moths have simple antennae, tapering uniformly to the tip, bearing in mind that males of certain species have large, feathery antennae. Just to further confuse the issue, the skippers (Hesperiidae) which are intermediate between the two, but usually regarded as closer to butterflies, have antennae with a terminal swelling and a hook.

In this article, only the butterflies are discussed. The moths will be covered in Part 2.

The first Australian butterflies were collected by Banks and Solander when Cook discovered Australia in 1770, and many of Banks' specimens are still preserved in the British Museum, London. Since then, many Australian and noted overseas workers have studied our butterflies with the result that, of all the insect groups, the butterflies are probably the best known.

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Family Hesperiidae

Skippers

Skippers are mostly small butterflies which owe their common name to their characteristic rapid, jerky flight. They are less brightly coloured than other butterflies, most being a sombre brown with yellow or white markings on the wings. Skippers normally have hooked antennae which are placed wide apart on the head. In all other butterflies the antennae arise close together. At rest, the wings are usually held vertically above the body.

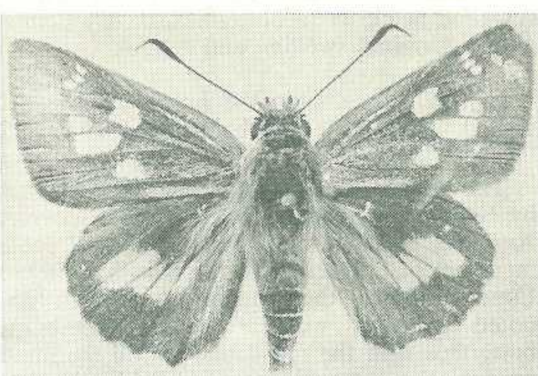
Generally speaking, the skippers are of little economic importance although *Pelopidas lyelli* has been recorded as defoliating sorghum in Western Australia and is also a pest of rice in the Northern Territory and Queensland.

Family Papilionidae

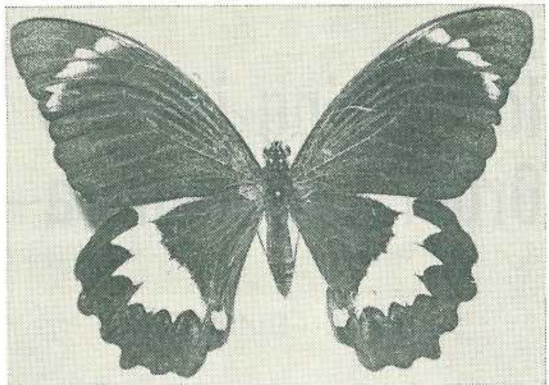
Swallowtails

Most of the butterflies in this family are large and brightly coloured. The popular name swallowtail arose more than a century ago in Europe where the species have tailed hind-wings. However, not all of the Australia species have tails.

The orchard butterfly (*Papilio aegeus*) is also known as the citrus butterfly since the larvae often feed on citrus trees. The adults are very large butterflies, often with a wing span of 70 to 90 mm. The sexes are quite different in appearance. The males are characterized by predominantly black fore-wings, while the females have large, pale areas on the forewings.



A typical skipper.



Orchard butterfly (male).

The young larvae are armed with fleshy spines and are mottled white and brown in colour, changing to green and white as they mature. When disturbed they rear up and push out two bright-red sacs which emit a pungent odour from behind the head. A smaller species whose larvae also feed on citrus is *Papilio anactus*.

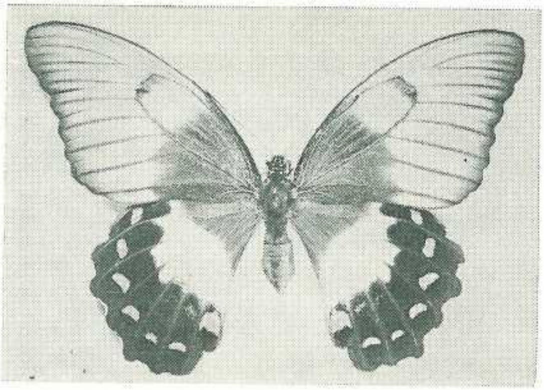
Another familiar butterfly in coastal Queensland is the blue triangle (*Graphium sarpedon*). The adults are fast flying and even when feeding at flowers the wings are constantly in motion ready to take off in an instant should they be disturbed.

In Queensland, the species most prized by butterfly collectors are the ulysses butterfly (*Papilio ulysses*) sometimes also called the mountain blue, and the birdwing (*Ornithoptera priamus*). To such an extent has the trade in these two species developed that they are considered to be in danger of extinction and have now been placed on the list of protected fauna, making it an offence to collect specimens. The larvae of both species feed on rain-forest plants, and the adults are never found far from the forest. Both are spectacular in appearance, ulysses with brilliant metallic blue and birdwings with rich green and yellow markings.

Family Pieridae

Whites and yellows

Pierids are mostly small to medium-sized butterflies with white or yellow wings, often with black markings. Most of the smaller species fly close to the ground on sunny days, often settling if a cloud obscures the sun.



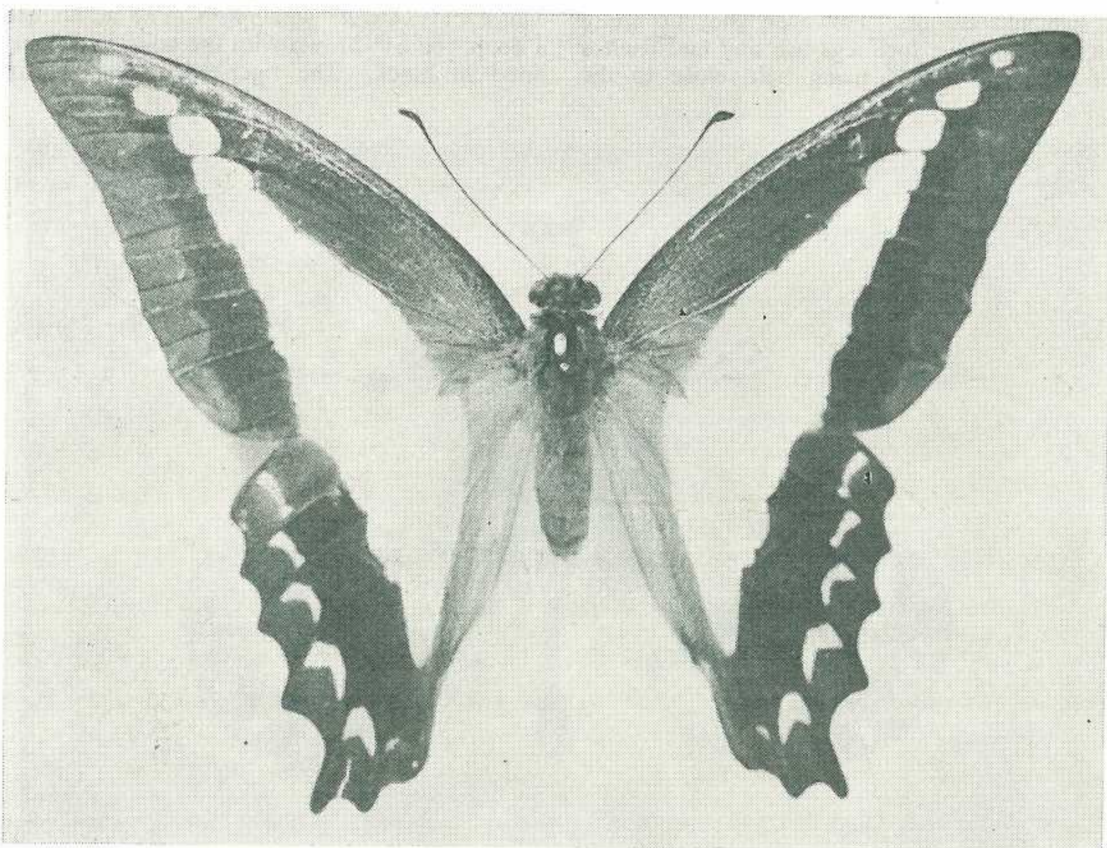
Orchard butterfly (female).

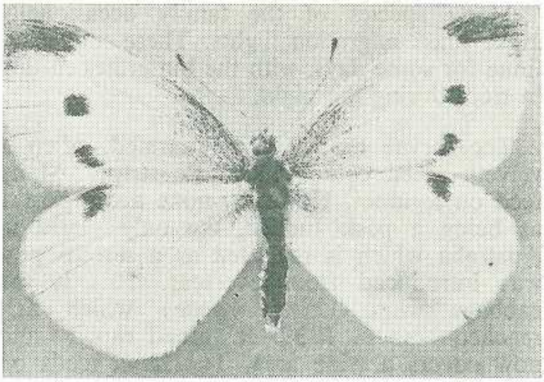
Many species of the family occasionally make mass migration flights. These may continue for some days, with the butterflies resting in trees during the night.

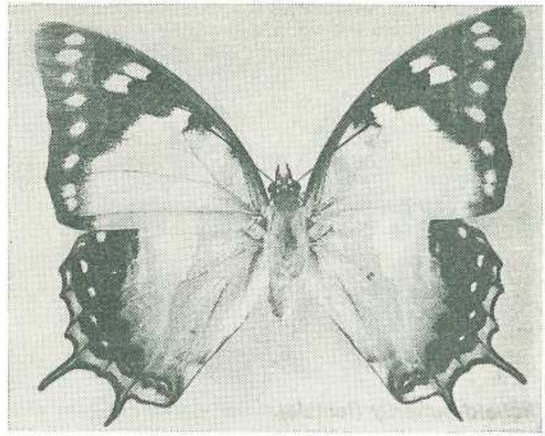
The larvae are slender, unarmed, often a velvety green colour with pale stripes. Many feed on legumes. However, none are regarded as being a pest. Indeed, the only pierid in Australia which is regarded as a serious pest was introduced from overseas. This is the cabbage white (*Pieris rapae*) which first reached here in 1939. It spread rapidly and now covers a wide area. The larva feeds on crucifers—cabbage, cauliflower etc. and can do considerable damage. An alternate host is nasturtium and the larvae are often found on this back-yard plant.

Common native species are the lemon migrant (*Catopsilia pomona*) and the common grass yellow (*Eurema hecabe*).

Blue triangle.







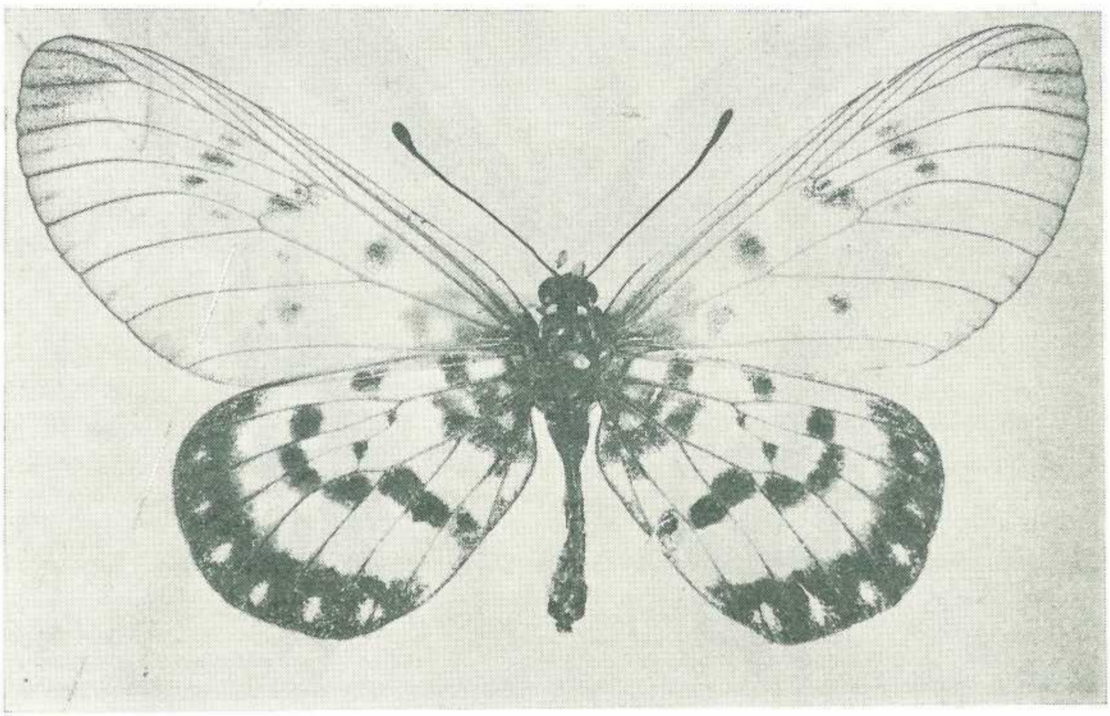
ABOVE. Cabbage white.
RIGHT. Tailed emperor.
BELOW. Clearwing.

Family Nymphalidae

Danaids, browns and nymphs

The species in this group are difficult to describe concisely as they exhibit a great range of size and colours. However, they do share one feature—the fore legs are tiny and useless for walking, always being held close to the body, and are quite difficult to see. This has resulted in some reports in the popular press of 'rare' four-legged butterflies—after all, everyone knows all insects have six legs.

Probably the best known danaid is the wanderer (*Danaus plexippus*). The adults are a deep, reddish-brown with the wing veins outlined in black. The tiger-striped larvae are



often found on the wild cotton milkweeds on which they feed. The wanderer is a wide ranging species being common throughout the Pacific islands and in North America where it is called the monarch.

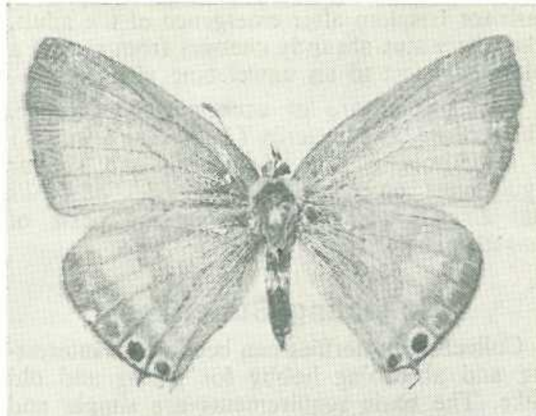
In the United States, the monarch migrates south to the warmer States in winter and gradually moves back northwards during the summer. Such seasonal migrations have not been noted in Australia although local movements of a lesser degree are known, and entomologists at the Australian Museum in Sydney have begun a tagging program to study movements of individuals. The paper tags are stuck over the fore-wing margin. They bear a number and should a tagged specimen be encountered the collection data (locality and date) and the number should be passed on to the Museum. In this way, you will assist these scientists in their research.

Another well known species is the common crow (*Euploea core*) so named because of its black wings with white markings. It often breeds on oleander bushes and in some areas is known as the oleander butterfly.

The Browns are a group of butterflies that unlike most of their sun-loving relatives prefer moist, shady gullies. The evening brown (*Melanitis leda*) is active mainly at dawn and dusk and flies in short hops resting on the ground in between flights. When it is on the ground it becomes almost impossible to see as it holds the wings together above its back, exposing the undersides which closely resemble a dead leaf. The larvae feed on grasses at night.

The tailed emperor (*Polyura pyrrhus*) is a common sight in gardens and can be recognized by the twin tails on each hindwing. Adults often rest on foliage, with their head pointed downwards. The larvae have fearsome heads with four horns on top and are greenish with two yellow stripes on each side. Native hosts are wattles but they are commonly found feeding on introduced cassias, crepe myrtle and leopard trees.

When a clearwing (*Acraea andromacha*) is caught it may appear to be of little value as most of the wing scales have rubbed off. However, this species is unusual in that it has large areas of the wings devoid of scales—hence its popular name. The larvae feed on wild passionfruit but will not develop on the commercial varieties even though the females may lay their eggs on them.



Lucerne blue butterfly.

Family Lycaenidae

Blues and coppers

Lycaenids are mostly small to very small butterflies often with brilliant blue, violet or orange colours, but sometimes also greens and browns. They fly rapidly—mainly close to the ground and settle often. However, they are normally only active on sunny days.

Lycaenids have most unusual larvae, which are unlike all other butterflies. They are oval in shape with the head hidden beneath the thorax, and are usually closely pressed against the surface they are resting on. They also have a tougher skin than most butterfly larvae.

The larvae of most Lycaenids are associated with ants, which seem to be attracted to fluids produced by glands in the larval skin. The relationship between the larvae and the ants is not properly understood, but it has been suggested that the ants offer protection. In fact, many larvae shelter during the day in the ants nest, and the ants accompany the larva when it moves out at night to feed on foliage.

In some species, the larvae are carnivorous and eat the young of their ant hosts. It is thought that the thick skin of the larvae helps to protect them against ant bites. Some species pupate within the ant nest and make a quick dash for freedom after emergence of the adult, when its status abruptly changes from one of a tolerated guest to an unwelcome visitor.

Few species are of economic importance. The lucerne blue butterfly (*Lampides boeticus*) is sometimes a pest of lucerne and similar leguminous crops while *Candalides absimilis* and *Erysichton lineata* are minor pests of macadamia nut trees.

Collecting Butterflies

Collecting butterflies can become an interesting and absorbing hobby for young and old alike. The basic requirements are simple and inexpensive and can be purchased from entomological supply houses or made at home.

Several popular books which allow easy identification of Australian butterflies by coloured illustrations are now available and are listed below. They also contain helpful information on the collecting and subsequent treatment of specimens.

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Common, I. F. B. and Waterhouse, D. F.—'Butterflies of Australia', Angus and Robertson 1972.

D'Abrera, B.—'Butterflies of the Australian Region', Landsdowne Press 1971.

McCubbin, C.—'Australian Butterflies', Nelson 1971.

Entomological requirements (pins, nets etc.) are available from Australian Entomological Supplies, Post Office Box 314, Miranda, N.S.W. 2228, who will supply a catalogue on request.

For more information on butterflies, see the back cover of this issue.

Research into cattle problems in South Australia

BEHIND the boost in cattle numbers and beef production in the southern regions of Australia has been a growing programme of research into beef production problems—a programme outlined in the latest publication of the Australian Meat Research Committee.

Entitled 'Cattle Research—1962–1975. No. 3. The South', it is the final publication of a trilogy reporting on research into cattle problems—research supported by the Australian Meat Research Committee and its predecessor, the Australian Cattle and Beef Research Committee.

The previous booklets in this series dealt with diseases and pests of cattle in general, and with the problems of cattle production in the north.

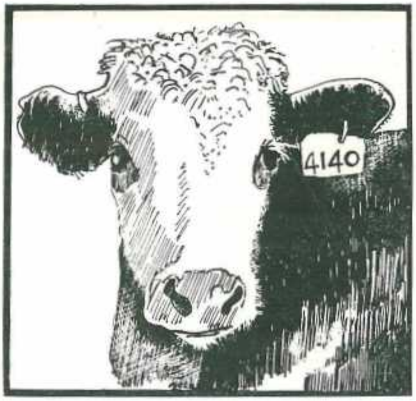
This booklet deals with cattle production in the southern regions of Australia, where two-thirds of Australia's cattle live, and which produces about three-quarters of Australia's beef. It points to the fact that cattle and beef production in the south doubled during the 13 years reviewed, and to the enormous expansion of research effort which helped to achieve this.

Overall, the research programme described is very comprehensive. Much of it is devoted to regional problems, as well as overall projects such as those of the Bureau of Agricultural Economics.

A feature of the publication is the section on meat research, ranging through meat quality, carcase composition, carcase classification schemes, problems such as bacterial contamination, processing and by-products and new products of the beef industry.

'Cattle Research—1962–1975. No. 3. The South' is available from the Australian Meat Research Committee, 5 Elizabeth Street, Sydney, 2000, at a cost of $4.50 to cover publication, distribution and postage.

Also available in this series are 'Cattle Research—1962–1975. No. 1. The North' and 'Cattle Research—1962–1975. No. 2. Diseases', each at the same price of $4.50.



Discontented beef?

MOST of us laugh at the old saying 'tough beef comes from a discontented beast!' However, there may be more truth in it than we realise.

A beast may be discontented for many reasons—the prospect of dying is only one! More seriously, a beast may be exhausted by a long journey, severely stressed or nervous because of the unfamiliar surroundings. All of these deplete the energy (glycogen) reserves of muscle and indirectly affect muscle quality—its tenderness, colour, flavour and keeping time.

During rigor mortis the glycogen is converted to lactic acid. This increases acidity (that is, lowers pH), which is associated with tender muscle (see figure 1).

Muscle should be tender at a pH of about 5·5 if no shortening or contraction of the muscle occurred during rigor mortis to cause toughness. At this pH, the muscle will be a bright red cherry colour and should keep for a reasonable time with refrigeration. It should also have its greatest possible flavour.

If glycogen reserves are reduced immediately before slaughter, less lactic acid is formed. The normal fall in muscle pH does not occur. The pH may only fall to 5·8 or it can stay even higher. Such muscle is tough, not tender.

Muscle is toughest at a pH of about 6·0 if no shortening has occurred (see figure 1). It is a dull red colour and in extreme cases may be almost black when the pH is above 6·0. Such carcasses are called 'dark cutters'.

In addition, high pH muscle is very susceptible to bacterial spoilage and so does not keep for very long. The only benefit from high pH muscle is that less weep or drip occurs.

It is very difficult to measure the effects of stress on an animal under experimental conditions. For example, any attempt to determine glycogen reserves immediately before slaughter imposes a stress. Furthermore, animals, like humans, vary in their response and reaction to stress.

Recently an opportunity occurred to observe a steer obviously very upset and highly agitated before slaughter. Steer No. 4140 was a 2-year-old Simmental X Hereford that had travelled 650 km the previous day. He was due to be slaughtered at about 8.00 a.m.; but had other ideas.

by JENNIFER R. WYTHES,
Beef Cattle Husbandry Branch.

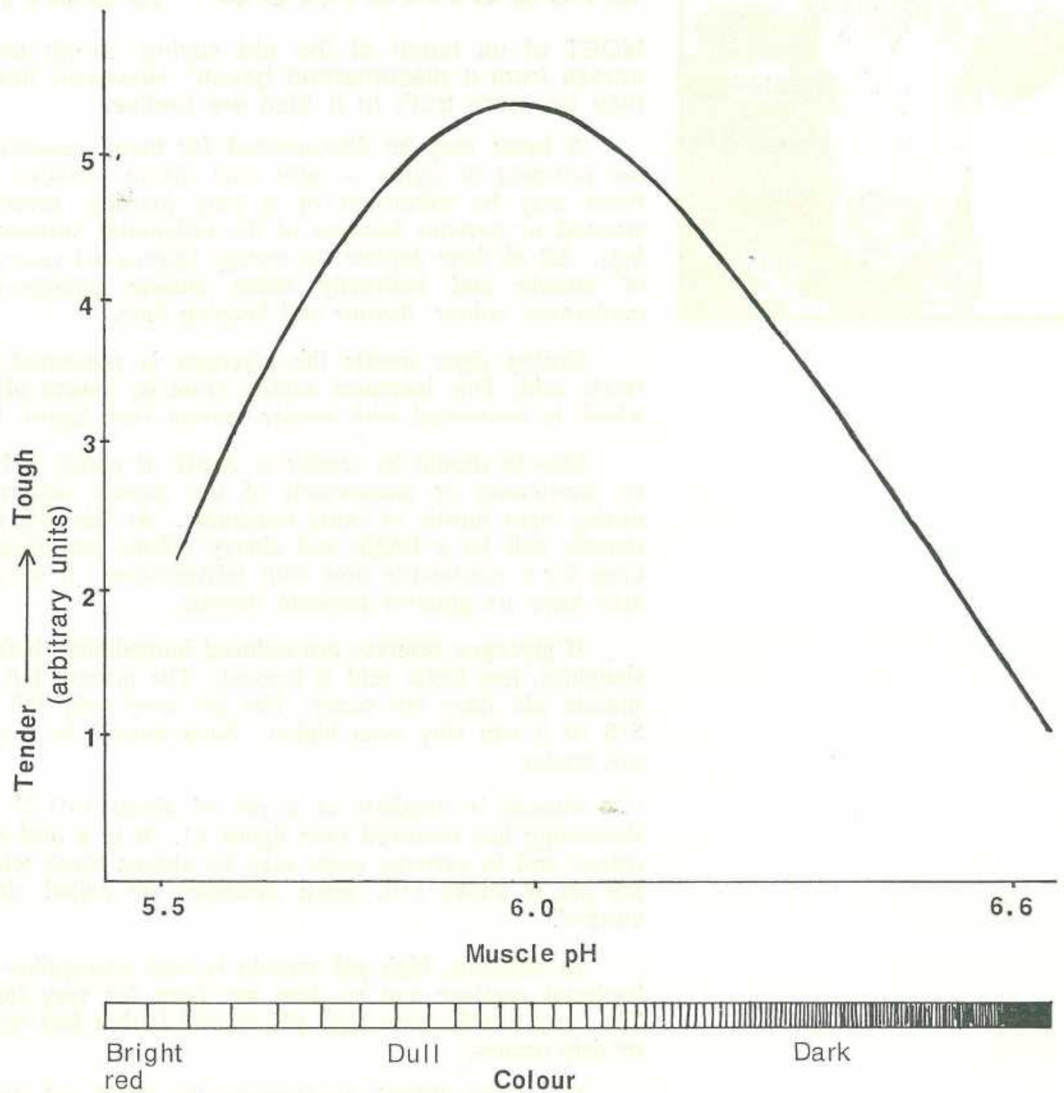


Figure 1. The relationship between tenderness, muscle pH and colour.

No. 4140 attempted several times to go over the top of the race leading to the knocking box. When temporarily released, he rushed the gate escaping into a nearby paddock. Returned to the yards about 40 minutes later, No. 4140 repeatedly tried to climb out again. He trembled for some considerable time following stunning at approximately 10.00 a.m.

Next day, quartering of the carcass revealed very dark-coloured muscle. Using a scale from 1 to 5 for muscle colour, with 1 bright cherry red and 5 very dark, No. 4140 scored 4. Both his front legs were drawn in and bent at the elbow instead of being relaxed and extended.

Dr W. R. Shorthose of the C.S.I.R.O. Meat Research Laboratory at Cannon Hill assisted by measuring the effects of stress on muscle pH, Warner-Bratzler shear force and moisture losses with cooking. The pH of the rib eye muscle (*Longissimus dorsi*) was 6·28. Two muscles from the rump, the 'superficial' and medial gluteal, had a pH of 6·36 and 6·18 respectively.

The Warner-Bratzler shear force is a mechanical test of toughness. It was 6·8 kg for the 'superficial' gluteal muscle; indicating some toughness (see figure 1). A colleague, Mr W. R. Ramsay purchased the rump and his family agreed that No. 4140 was tough eating.

The weight loss in cooking was 27·7% for the 'superficial' gluteal muscle. While normal values are not available for this muscle, Dr Shorthose commented, 'it seems low, as would be expected with high pH muscle'.

One swallow does not make a summer nor one beast verify an old saying, but each one helps.

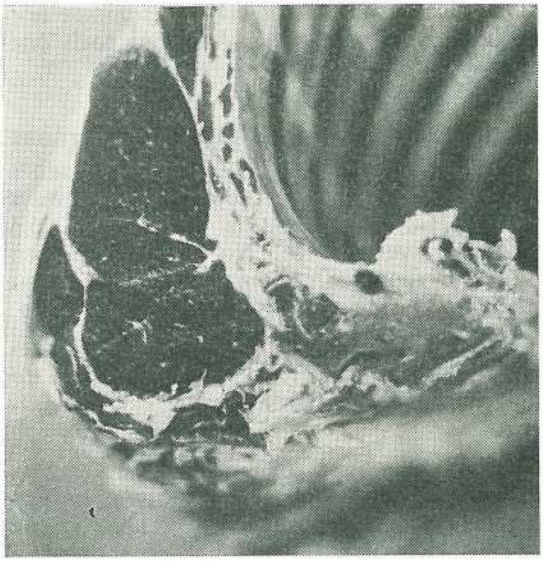
Good processing—the key to tenderness

Above all else, beef eaters demand tender meat. Unfortunately, they do not always get it. However, stress is only one of the reasons. Even if steer No. 4140 had been quiet and dignified, he may still have been toughened during chilling and storage.

Muscle tenderness is responsive to improvement during rigor. It is also susceptible to damage. Good processing is the key to tenderness.

Within an hour of death, the carcass muscles begin to contract or shorten, if they can do so. The posture of the skeleton is one factor determining the amount of shortening during rigor (usually complete in 24 hours).

Normally the front legs are extended, No. 4140's were drawn in. This indicates the early onset of rigor mortis.



The eye muscle was a dark red instead of being a bright cherry red colour.

Tenderstretch

Tenderstretch is a simple and cheap way to ensure tender meat. It is suitable not only for the big meatworks but also for station-killed beef or mutton. During rigor mortis, the carcass is hung by the pelvis instead of the conventional way by the Achilles tendon. Straightening the backbone physically restrains or stretches the muscles and counters cold shortening. Tenderstretch improves the tenderness of the rump, topside, loin, round and, to a lesser extent, the silverside.

Temperatures of less than 15°C during rigor mortis cause cold shortening. The colder the temperature, the more shortening occurs and toughens the muscle. Above 19°C, another form of shortening occurs called rigor shortening. When carcasses are held at 14 to 19°C during rigor mortis—a process called 'conditioning'—shortening is minimal. However, bacterial spoilage is a problem.

Electrical stimulation

New Zealanders and more recently CSIRO researchers at Cannon Hill have developed a new method to avoid cold shortening. They give the carcasses an electrical shock soon after death. Electrical stimulation speeds up the onset of rigor and in doing so reduces the effects of temperature. The efficiency of this method relative to tenderstretch has still to be determined.

Ageing

Ageing or storing chilled beef at low temperatures for several weeks improves tenderness. It is the oldest and best known of all tenderizing methods. Hanging cuts of beef in the domestic refrigerator for 3 to 5 days makes use of this principle.

Vacuum packaging is the modern equivalent. Because it is expensive, vacuum packaging is most suited to beef for specialized markets. Cuts of beef are sealed in a special gas impermeable bag after the evacuation of all air. Ageing is usually for 3 weeks at 0 to 1°C. Vacuum packaging will not improve the tenderness of muscle that is severely shortened.

The cattleman can influence tenderness to an extent. Finishing of young cattle and avoiding stressful situations are perhaps the most obvious. Remember the tale of steer No. 4140.

Handling

Quiet handling during an animal's life should pay dividends at marketing. It is good insurance against toughness, and bruising. Temperament may be important because of its apparent relationship to stress and excitement, but no research has been done to prove this. We do know that social stress among bulls is a problem.

Although tenderness decreases with age, it is rarely the criterion determining age at turn-off. Young, immature bulls have muscle of a similar tenderness to steers; provided pre-slaughter stress is avoided. Older bulls have tougher meat.

Breed

Only small differences in tenderness exist between breeds, with Brahmans and their crosses being slightly tougher than British breeds. Considerable variation in tenderness occurs within the same breed. However, processing effects can override breed differences. For example, tenderstretching will negate the slightly greater toughness of Brahmans.

Neither fatness nor nutrition, including feedlotting, are directly related to tenderness. However, it could be that a heavy cover of fat may slow down the rate of cooling so that less cold shortening occurs.

Good processing above everything else will ensure muscle is tender.

Winter grazing varietal guide—1978

Compiled by S. R. Walsh, Agriculture Branch.

IN Queensland, oats are the main winter grazing crop; others include barley, wheat and canary.

The main plantings are south of the Tropic of Capricorn.

Oats are usually classified according to their rate of growth as either quick-growing or slow. The accompanying table provides details of the characteristics of a number of oat varieties.

The varieties Bentland and Minhafer are examples of quick-growing types which have an erect plant habit and high, early growth rate. These may present grazing management problems under normal seasonal conditions.

Algerian and Camellia, on the other hand, have a slower growth rate and are semi-prostrate in habit. They are usually easier to manage in a forage programme than the quick-growing types.

Stout, a new oat variety introduced from America, is an erect-growing, crown-rust resistant variety released by the Department of Primary Industries in 1977. Seed supplies are very limited.

As a result of adverse seasonal conditions prevailing in 1977, seed supplies of some recommended varieties may be in limited supply for the 1978 season.

Where seed of a recommended variety is unavailable, farmers should contact their local Agricultural Extension Officer or consult the table of oat varietal characteristics to determine a useful alternative.

The barley variety corvette is a useful grazing crop suitable for sowing from April to August and is recommended for most districts.

If late planting in July and August is necessary, barley will give faster grazing and higher grazing yields than oats.

Canary is also recommended for sowing from February to April as an alternate grazing crop.

Under irrigated conditions, the use of rye grass and nitrogen fertilizer could be considered.

Planting time

Slow-maturing varieties require a longer period before the first grazing, especially when planted early.

Quick-maturing varieties may suffer from frost damage if planted too early and managed so that they flower in mid-winter.

Planting rates

Planting rates fall between:

Oats	Rain-grown	30 to 50 kg per ha
	Irrigated	40 to 70 kg per ha
	Irrigated Sod seeded	50 to 90 kg per ha
Barley	30 to 60 kg per ha	
Rye	up to 30 kg per ha	

The rates should be adjusted to the variety, type of crop, soil moisture, soil type, district, irrigation or rain-grown and planting time. These rates are dependent on local conditions and your Local Agricultural Extension Officer will be fully aware of them.

Fertilizer

The type and rate of fertilizer is related to soil type, soil moisture, irrigation or rain-grown, cropping history and planting time. Your Agricultural Extension Officer will understand the crop requirements for your soils and district.

Recommendations

Region	Planting guide
Northern Region	(Ayr, Bowen, Proserpine, Hinchinbrook, Dalrymple, Thuringowa) *Irrigated* Camellia, Saia, Stout
Capricornia	(Livingstone, Fitzroy, Broadsound, Nebo, Calliope, Emerald, Peak Downs, Belyando, Bauhinia, Banana, Duaringa) *Grazing* Algerian, Camellia, Minhafer *Hay* Minhafer, Bentland, Stout
Burnett	(Miriam Vale, Kolan, Gooburrum, Woongara, Isis, Perry, Biggenden, part Tiaro, Woocoo, Hervey Bay, Monto, Eidsvold, Gayndah, Mundubbera) *Grazing* Algerian, Camellia, Minhafer, Garry, Saia, Bentland, Stout Corvette-(Barley)
South Burnett	(Kingaroy, Nanango, Wondai, Murgon, part Kilkivan, part Rosalie) *Grazing* Algerian, Cooba, Camellia, Minhafer, Stout Corvette-(Barley)
Near North Coast	(Widgee, Noosa, part Tiaro, Maroochy, Landsborough) *Grazing* Algerian, Camellia, Minhafer, Saia, Stout
East and West Moreton	(Caboolture, Pine Rivers, Redlands, Albert, Beaudesert, Moreton, Esk, Kilcoy, Boonah, Gatton, Laidley) *Grazing* Algerian, Camellia, Minhafer, Saia, Bentland, Stout Corvette-(Barley)
Darling Downs	(Chinchilla, Wambo, Pittsworth, Millmerran, Jondaryan, Crows Nest, part Rosalie, Cambooya, Clifton, Allora, Glengallan, Rosenthal, Stanthorpe, Inglewood) *Grazing* Algerian, Cooba, Camellia, Minhafer, Garry, Stout—Rodney and Saia in selected areas Corvette-(Barley)
Near South-west	(Waggamba, Balonne, Murilla, Tara, Taroom, Bungil, Bendemere, Warroo) *Grazing* Algerian, Camellia, Minhafer, Garry, Bentland, Stout Corvette-(Barley) *Hay* Minhafer, Bentland, Stout

Characteristics of Oat Varieties

Variety	Growth to Flowering	Early Plant Habit	Growth to First Grazing	Frost Tolerance	Rust Resistance		Seed Colour	Awns	Tillering Ability	Grain Yield
					Crown	Stem				
Recommended Varieties										
Algerian	SL.	Prostrate	Sl.	Good	S.	S.	Brown	Fine X	Good	Fair
Bentland	Med.–Sl.	Erect	Q.	Fair	S.	S.	Yellow	Few fine	Fair	Fair
Camellia	Med.–Sl.	Semi-prostrate	Med.–Sl.	V. good	S.	V.S.	Yellow	Few fine	Good	Fair
Cooba	Sl.	Prostrate	Sl.	V. good	V.S.	S.	Light brown	Nil	V. good	V. good
Garry	Sl.	Semi-erect	Q.	Fair	Mod. R.	Mod. R.	Yellow	Few strong*	Fair	Fair
Minhafer	Mod.–Sl.	Erect	Q.	Fair	Mod. R.	Mod. R.	Cream	Few strong	Fair	Fair
Rodney	V. Sl.	Erect	Q.	Fair	S.	S.	Cream	Few strong*	Fair	Fair
Saia	Med.–Sl.	Semi-erect	Medium	Poor	S.	V.S.	Black	Medium	Fair	Poor
Stout	Medium	Erect	Q.	Fair	R.	R.	Cream	Nil	Fair	V. good
Others may be sown when seed of above not available										
Avon	Medium	Erect	Medium	Poor	S.	V.S.	Cream	Nil	Poor	Poor
Belar	Medium	Semi-erect	Medium	Fair	S.	S.	Light brown	Strong*	Good	Good
Benton	Med.–Sl.	Erect	Q.	Fair	S.	S.	Yellow	Fine	Fair	Fair
Blackbutt	Slow	Semi-prostrate	Medium	Good	S.	V.S.	Light-brown	Strong	Good	Fair
Coolabah	Medium	Semi-erect	Medium	Good	V.S.	S.	Cream	Strong*	Good	Fair
Fulghum	Q.–med.	Semi-erect	Medium	Good	V.S.	S.	Light brown	Nil	Fair	Good
Klein	Sl.	Prostrate	Sl.	V. good	S.	S.	Light brown	Fine X	V. good	Fair
Lampton	Sl.	Semi-erect	Medium	Poor	S.	S.	Light brown	Strong	Fair	Fair
Landhafer	V. Sl.	Semi-prostrate	Medium	Good	S.	S.	Brown	Fine X	Good	Fair

V.Sl—very slow Sl—slow Med. Sl—medium slow Q—quick R—resistant Mod. R—moderately resistant S—susceptible V.S.—very susceptible
X—awns on both grains *—strong awns indicated by twisted, black base

Wattles of south-eastern Queensland

by Beryl A. Lebler, Botany Branch.

THE name *Acacia* was first given in 1754 to the plants whose flowers are our national floral emblem.

It is derived from the Greek word *akis,* meaning a sharp point or thorn and refers to the spiny stipules which are common in many of the African or Asiatic species. The common name 'wattle' which Australians apply to all species of *Acacia* dates from Anglo-Saxon times and means twigs, saplings, or flexible sticks plaited or interwoven together.

This method was used by the early settlers in the construction of the framework of the walls of their dwellings. The operation was called 'wattling' and the material used was known as 'wattle'.

Overhanging the watercourses near Sydney Cove, a small tree with thin, flexible stems grew in abundance. It was frequently used for the purpose and so was called wattle or black wattle. It had cream-coloured flowers in heads but was actually a species of *Callicoma.* Subsequently, *Acacia* plants were used for the same purpose and the common name was also applied to them. It is now used only for *Acacias.*

More than 700 species are native to Australia, making this genus by far the largest in the Commonwealth. Almost all of them are found only in Australia, some being extremely rare and localized.

All wattles have bipinnate leaves in the seedling stage. Some retain this bipinnate foliage throughout their lives. In the majority of wattles, these juvenile leaves are replaced by phyllodes. These are derived from the whole leaf axis. They take over the functions of photosynthesis and transpiration normally carried out by leaves and look like the entire leaves of some other plants. The number of prominent veins in a phyllode can vary from none to ten.

Many wattles have glands on the upper margin of the phyllodes. In bipinnate leaves, these glands are on the rhachis, between one or more pairs of pinnae or on the petiole. The presence or absence of glands, their number and their position varies in different species.

Wattles with phyllodes are confined almost entirely to Australia and the Pacific Islands. Those with bipinnate leaves are scattered over the warm parts of the world.

Most wattles are trees or shrubs, rarely undershrubs or climbers, with or without prickles or stipular spines. They range in height from 0·3 to 3·5 m. The stems can be terete, flattened or winged.

The phyllodes vary greatly in shape, size, colour and texture. They may be terete, linear-subulate, narrow linear, ovate, oblong or falcate. In texture, they vary from soft and thin to leathery or rigid. Their colour varies from pale or bluish-green to dark, glossy green or silver-grey, and a few are quite sticky.

The whole plant may be completely glabrous or short, erect, white hairs may be present. In only two species, the hairs are stellate and golden. The phyllodes can be less than 1 cm long or up to 25 cm long.

Individual flowers of *Acacia* usually have four or five sepals, five petals and an indefinite number of stamens, usually very numerous. Both sepals and petals can be free or united and the staminal filaments are completely free.

Variation is found in both flower colour and the amount of perfume produced by the blossoms. In south-eastern Queensland, the colour varies from a very pale creamy-yellow or pale lemon-yellow to bright, golden-yellow or rich orange-yellow. Even in those wattles with inflorescences which appear almost white, the corollas of individual flowers are creamy-yellow and the anthers lemon-yellow. It is the staminal filaments which are white. Pale, almost colourless, inflorescences contain many flowers with long staminal filaments while, in brightly coloured inflorescences, the staminal filaments are deep yellow.

In other parts of Australia and the world, pink or red flowers are found. These is even one wattle in north Queensland with purplish flowers which have glossy purple petals.

Some wattles have no perfume, some are faintly perfumed and some are very strongly scented.

In wattles, the individual flower structure is not as important a character in classification and identification as the form of the inflorescence. One group of wattles has the flowers massed in narrow, cylindrical spikes. In a much larger group, they are crowded in globular heads which may be few-flowered and small or contain 30 or more flowers and be 1 cm in diameter.

The pods are also very variable. Some are linear or nearly cylindrical and straight, others are flattened and oblong. Other wattles have pods which are falcate, or twisted or coiled, sometimes forming a complete spiral. They may be indehiscent and hard and woody or thinner in texture and opening in two valves.

Fifty-nine wattles grow in south-eastern Queensland. They are listed here in two main groups: those with pinnate leaves only in the adult stage, and those with phyllodes only in the adult stage. (*Acacia attenuata* in the second group is one exception. In addition to phyllodes, it has bipinnate leaves and phyllodes in various stages of transition.)

Wattles with phyllodes can be further divided into two groups: those with flowers in cylindrical spikes and those with flowers in globular heads. In the latter group, a further division can be made into wattles which have phyllodes with only one prominent nerve and those with two, three or more parallel nerves.

Bipinnate leaves

A. farnesiana

A. glaucocarpa

A. irrorata

A. leucoclada subsp. *argentifolia*

A. loroloba

A. oshanesii

Phyllodes

1. Flowers in spikes

A. aulacocarpa

A. blakei

A. cincinnata

A. concurrens

A. floribunda

A. granitica

A. julifera

A. leiocalyx

A. longissima

A. maidenii

A. obtusifolia

A. orites

A. sophorae

2. Flowers in globular heads

(a) Phyllodes with 1 nerve

A. adunca
A. attenuata
A. brachycarpa
A. buxifolia subsp. *pubiflora*
A. decora
A. falcata
A. falciformis
A. fasciculifera
A. fimbriata
A. hispidula
A. hubbardiana
A. leichhardtii
A. myrtifolia
A. neriifolia
A. paradoxa
A. penninervis
A. perangusta
A. podalyriifolia
A. resinicostata
A. salicina
A. saxicola
A. suaveolens
A. ulicifolia

(b) Phyllodes with more than 1 nerve

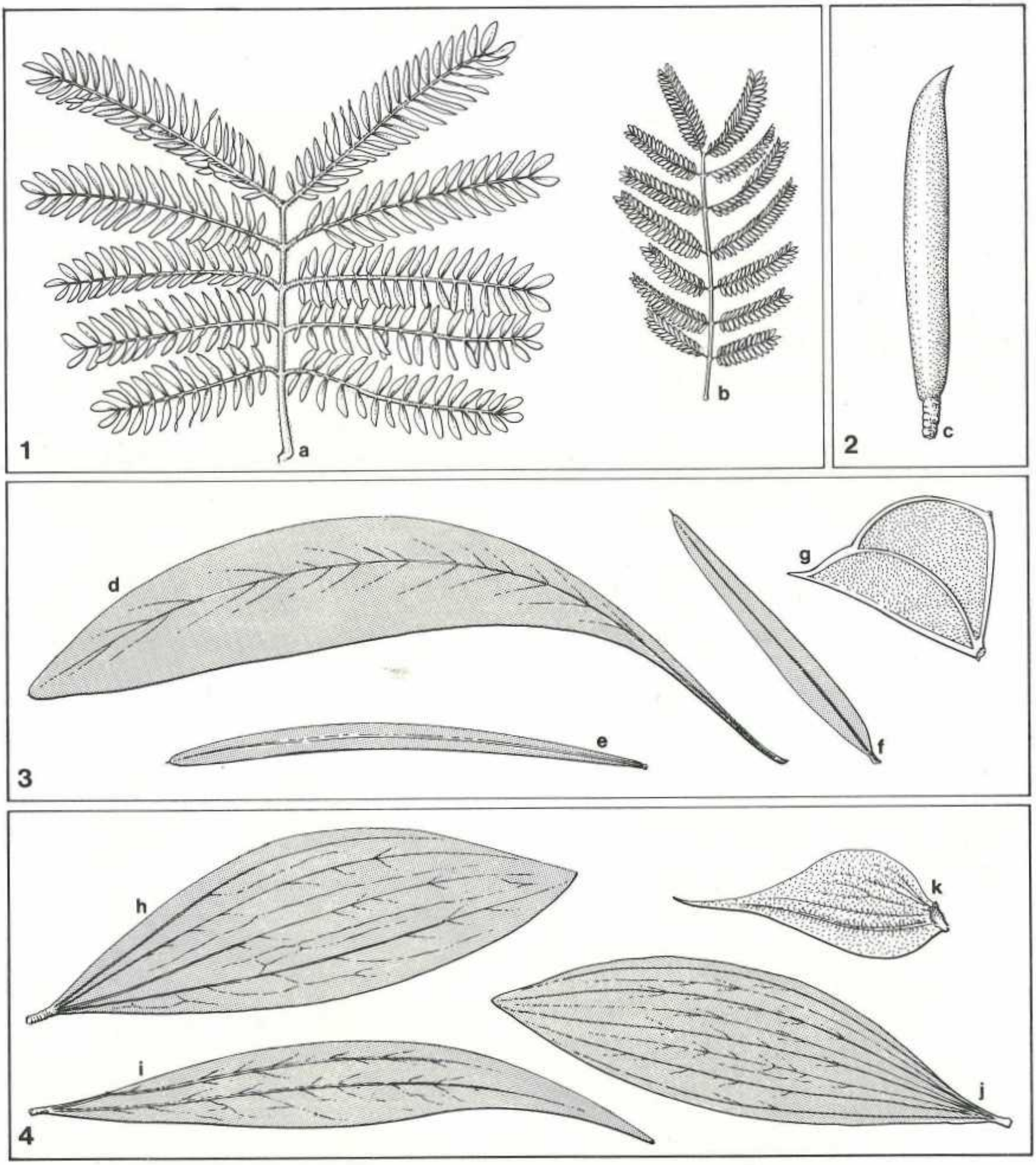
A. amblygona
A. bakeri
A. baeuerlenii
A. binervata
A. complanata
A. flavescens
A. harpophylla
A. implexa
A. ixiophylla
A. juncifolia
A. melanoxylon
A. pravifolia
A. quadrilateralis
A. venulosa
A. viscidula

(c) Phyllodes more or less terete with no prominent nerves

A. baueri
A. brunioides

Note:

Because of the large number of species involved, it is obvious that the articles on the wattles of south-eastern Queensland must, of necessity, be published in five or six parts. It is hoped that the first of these will appear in this journal within a few months.



Variation in wattle leaves

Bipinnate leaves

1 a. *A. glaucocarpa* b. *A. farnesiana*

Phyllodes

2 No veins c. *A. brunioides*

3 One nerved
d. *A. falcata* e. *A. suaveolens* f. *A. fimbriata* g. *A. hubbardiana*

4 Pluri nerved
h. *A. leiocalyx* i. *A. binervata* j. *A. complanata* k. *A. amblygona*

Variations

cia leucoclada ssp. argentifolia

Acacia neriifolia

Acacia farnesiana

Acacia brunioides ssp. brunioides

Acacia floribunda

in wattles

Photographs by M. F. OLSEN and J. R. CLARKSON, Botany Branch.

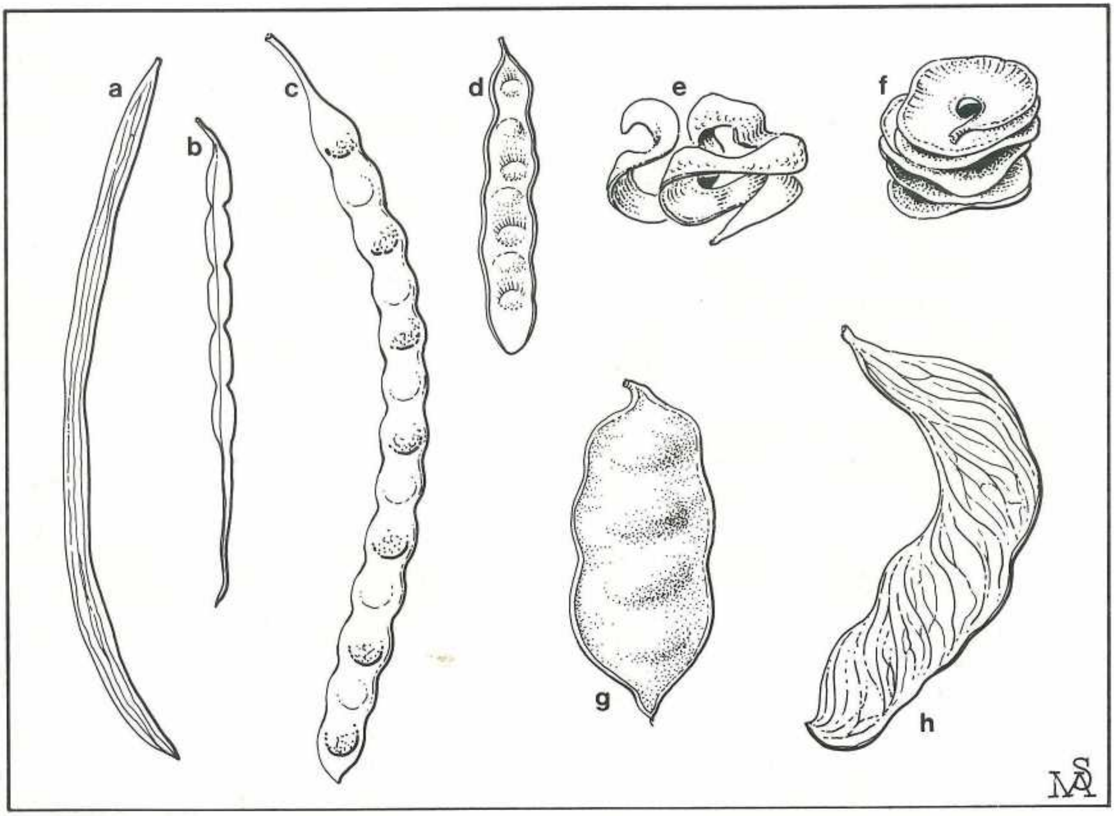
Acacia quadrilateralis

Acacia myrtifolia

Acacia baeuerlenii

Acacia buxifolia ssp. *pubiflora*

Acacia implexa



Variation in wattle pods

a. *A. julifera*

b. *A. juncifolia*

c. *A. complanata*

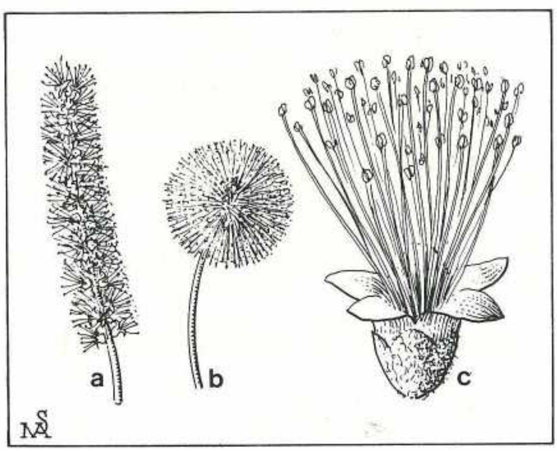
d. *A. brunioides*

e. *A. melanoxylon*

f. *A. cincinnata*

g. *A. suaveolens*

h. *A. aulacocarpa*



Drawings by MARGARET A. SAUL, Botany Branch.

Flower and types of inflorescences

a. *Spicate inflorescence*

b. *Globular heads*

c. *Flower*

High wheat yields at Emerald

ENCOURAGING results were obtained with irrigated wheat at the Emerald Rural Training School in 1977.

The new variety Cook yielded 5·712 tonnes per hectare (12% moisture) from an area of 6·2 ha.

Planting rate—79·7 kg per ha.

Planting date—May 27.

Harvest date—October 24.

Fertilizer—178 kg N per ha as urea prior to planting; 20 kg N and 37 kg P per ha as M.A.P. with seed at planting.

Irrigations—3.

A test area harvested under the supervision of the Department of Primary Industries yielded 8·000 tonnes per ha at 12% moisture.

An adjoining area of Oxley (12 ha) which received similar cultural treatment yielded 6·640 tonnes per ha (12% moisture) in a test area and 5·065 tonnes per ha overall (variable moisture below 12%).

Both crops were classified Prime Hard.

by G. D. Keefer, Agriculture Branch.

A further area of Oxley yielded 4·367 tonnes per ha from an area of 19·8 ha.

Planting rate—65 kg per ha.

Planting date—April 29.

Harvest date—October 19.

Fertilizer—127 kg N per ha as urea prior to planting; 15 kg N and 29 kg P per ha as M.A.P. with seed at planting.

Irrigations—4.

The grain from this crop was classified A.S.W. due to mottling.

These results support the predictions and recommendations outlined in the 1977 March–April issue of the *Queensland Agricultural Journal* (pages 149 to 156).

At the same time, not all the 1977 irrigated wheat crops at Emerald produced such encouraging results. The poorer yields from the same varieties were associated with inadequate nutrition.

Some crops to which 130 kg N per ha and 29 kg P per ha were applied yielded only 3·0 to 3·5 tonnes per ha and were badly mottled. Heavy rain and wet soil conditions soon after planting reduced nitrogen uptake in 1977. However, in irrigated wheat trials at Emerald and on the Darling Downs, applications of 180 to 200 kg N per ha (with 30 to 40 kg P per ha) have given economic yield responses.

It will be noted that the highest yields of Prime Hard wheat on the Training School were obtained with a total of 198 kg N per ha and 37 kg P per ha.

Some of the poorer Emerald crops were fourth or fifth year of continuous irrigated wheat. A wheat-soybean rotation would be economically attractive and would also reduce nitrogen fertilizer requirements of the wheat phase.

Many cultural factors are involved in the production of record crop yields but with varieties such as Oxley, Cook and Kite yields of 4·0 to 5·0 tonnes per ha should be readily attainable under irrigation provided adequate fertilizer is applied.

Pastures for the Gympie district

Part 2—Pasture species

by B. G. Cook, Agriculture Branch.

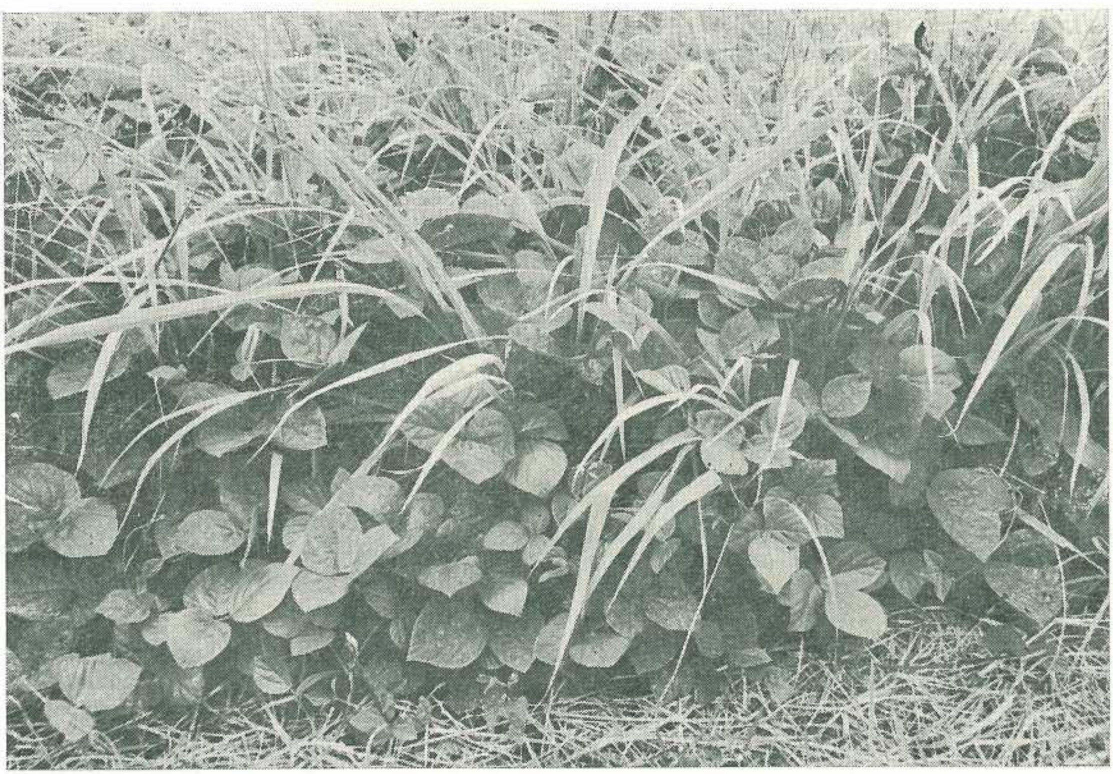
THESE pasture species are described in alphabetical order by common names.

With such species as kikuyu, lucerne and Safari clover it is difficult to categorize into 'tropical' and 'temperate'. Hence, no distinctions are made beyond grass and legume.

Legumes

Axillaris (*Macrotyloma axillare* cultivar (cv.) Archer)

Axillaris is a trailing, twining perennial with greenish-yellow flowers. Its main attributes are early spring growth (almost irrespective of moisture conditions), fairly late autumn growth, and a high degree of drought tolerance.



Malawi glycine and Makueni guinea grass—promising new pasture species.

As with most tropical legumes, the foliage is killed by frost but the crown survives. However, in frosted situations, progressive stand decline occurs. When situated out of frost, axillaris retains its leaf extremely well into the winter. This makes it a good standover forage.

The plant is very intolerant of poor drainage but undemanding in other soil requirements. A strongly competitive nature and rapid establishment, even in old cultivations, make it ideally suited to those situations where weed growth is a problem. Axillaris has shown great potential as a pioneer species for sowing with little or no cultivation.

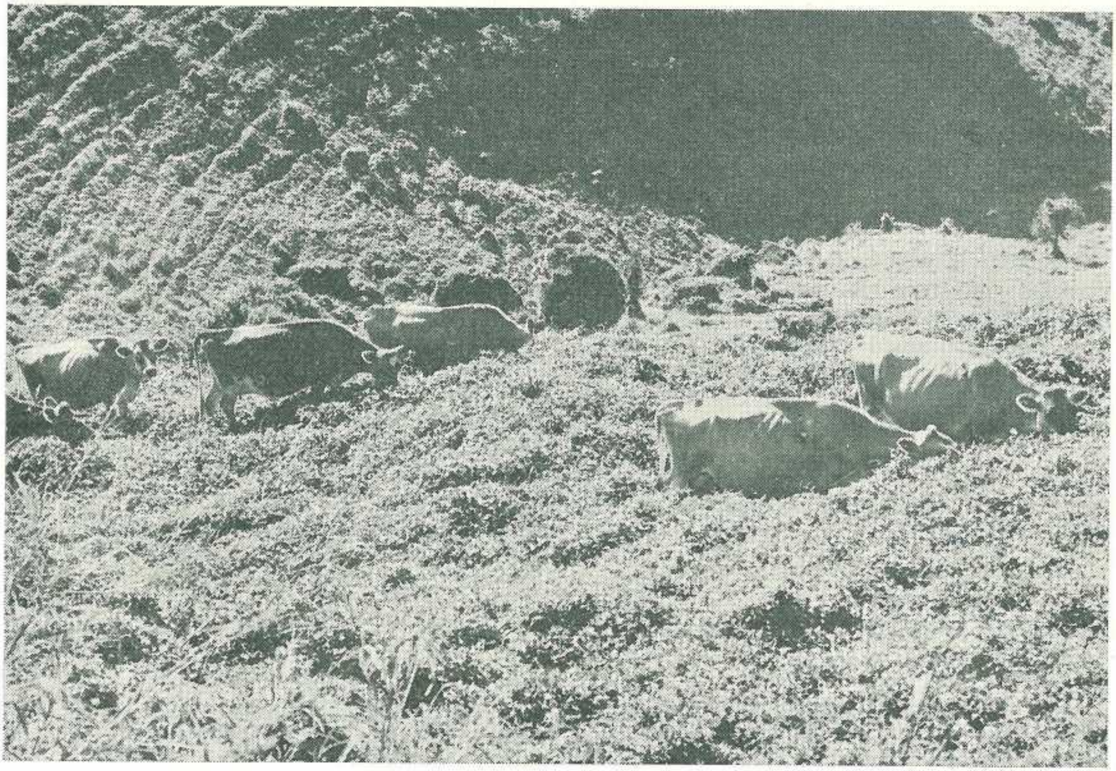
The main stem of the plant is erect and the trailing stems have no tendency to root down. This growth habit renders it susceptible to heavy grazing. Palatability is frequently questioned, but the plant is readily accepted once cattle become accustomed to the taste.

It is not demanding in rhizobial requirements, but inoculation with 'cowpea' strain guarantees effective nodulation.

Desmodium *(Desmodium intortum* cv. Greenleaf, *Desmodium uncinatum* cv. Silverleaf)

Both cultivars are hairy, pink to lilac flowered perennials. Silverleaf has a distinct silver blaze on each leaflet, while Greenleaf often has a brown to purple fleck. Both can root down along the runners, forming new crowns at some of these points.

An annual rainfall in excess of 1 150 mm is necessary for good growth of both species. Greenleaf has a long growing season, commencing with the spring rains and continuing until flowering in mid May. With suitable moisture, Silverleaf starts growing earlier but also finishes earlier with flowering in mid April.



Dairy cows grazing standover Tinaroo glycine/green panic pasture near Gympie in late June.

Axillaris based pasture in a low key development at Neerdie.

Greenleaf is well suited to most soil types provided moisture is adequate. Its main place in the area is in combination with setaria on the better drained coastal soils. Silverleaf is not quite so adaptable and is better suited to scrub situations, particularly in the cooler, moister areas.

The specific *Desodium* inoculum is required to achieve good nodulation in both species.

Glycine *(Glycine wightii* cultivars Clarence Cooper, Tinaroo, Malawi)

All cultivars are white-flowered perennials with a strong taproot and trailing, climbing and twining stems. They differ in flowering time, growth patterns, adaptability to soil type, frost tolerance, ability to root down and ease of establishment.

Clarence commences growth earlier than the other lines, but active growth stops with flowering in mid April, compared with late April, late May and early June in Cooper, Malawi, and Tinaroo respectively. As a result, Tinaroo and Malawi rarely set seed in frosted areas. However, with late onset of frosts, Clarence and Cooper will set some seed. Clarence and Malawi are slightly more frost tolerant than the other cultivars.

Tinaroo is the least adaptable to soil type, preferring krasnozems and prairie soils. All cultivars prefer high fertility and good drainage, although Clarence and Malawi are more versatile. Rooting down requires moist conditions, and Tinaroo and Cooper are superior to the others in this respect.

A high level of drought tolerance and good response to moisture ensure a place in planting mixtures for the different cultivars in most parts of the district.

Cowpea inoculant is suitable for this species.

Lotononis (*Lotononis bainesii* cv. Miles)

Lotononis is a yellow-flowered, prostrate to ascendant, succulent perennial which may form either a dense, lawn-type sward under heavy grazing or a taller (up to 50 cm) canopy under lenient grazing.

Locally, it is best suited to prairie soils on andesite, yellow and lateritic podzolics, soloths and the coastal podzols. It is not well suited to the red podzolic, latosol or krasnozem areas because the competition from companion species is too great.

With its good tolerance to frost and waterlogging, lotononis is valuable in lower areas.

Lotononis is susceptible to leaf and stem diseases, the spread of which is favoured by moist conditions such as encountered in tall pastures. This often leads to a reduction in stand but with more favourable conditions the stand recovers. Lotononis is usually more persistent under heavy grazing.

This legume can be difficult to establish because of its very small seed. Best results are obtained by broadcasting on to a clean, fine, firm seedbed and rolling.

It is highly specific in its rhizobial requirement and a special culture must be used.

Lucerne (*Medicago sativa* cv. Hunter River)

Lucerne may be sown on its own for hay or grazing, or as the legume component of a mixed pasture. Its main assets are a long growth period and a fair degree of drought and frost tolerance. Lucerne grows the whole year with a peak in midspring to early summer and a trough in winter. Its main deficiencies are susceptibility to waterlogging and to continuous grazing. In pasture situations it normally disappears in 2 to 3 years.

In the Gympie district, lucerne grows well on soils with a pH of 6.0 or higher. However, if the seed is pelleted with lime to ensure nodulation, it will grow in soils with a pH down to 5.5. Its soil requirements are best met by river and creek alluviums, but regular flooding in some of these areas results in a short stand life.

Because of the potentially high weed competition, good initial stand densities are important; in irrigated situations, seeding rates around 15 kg per ha are recommended. A dense stand also gives rise to long, fine stems necessary in good hay. In dryland swards or mixed pastures, lower seeding rates are used. Lucerne inoculum must be used.

Phasey bean (*Macroptilium lathyroides* cv. Murray)

Phasey bean is a deep red-flowered, erect annual or short-lived perennial. It will grow in low and high rainfall areas and thrives in poorly drained situations. Destocking is necessary in summer if seed-set is desired. Otherwise it is only of value as a pioneer species. Its inoculum requirements are similar to those of Siratro.

Red clover (*Trifolium pratense* cv. Grasslands Turoa (formerly New Zealand Montgomery) and cv. Grasslands Hamua (formerly New Zealand Cow Grass))

Red clover is a hairy-leaved, tap-rooted, pink-flowered biennial. Its main value is to complement white clover in irrigated pastures; white clover is most productive in the cooler months while red clover makes most growth in summer.

Turoa is more likely to persist into the second year.

The principal soil requirements are good drainage and a pH greater than 5.8. These needs are well met on most irrigated alluviums. Hamua develops faster than Turoa, although both species reach an early peak of production. Clover inoculum is necessary for effective nodulation.

Siratro (*Macroptilium atropurpureum* cv. Siratro)

Siratro is a purple-flowered perennial with trailing, twining stems and a large, woody tap root. It grows best on more open and/or well structured soils with good drainage (for example, prairie soils, yellow podzolics and krasnozems). It is not uniformly well suited to the red podzolics on shales and is unsuited to the soloth soils near Gunalda.

Growth extends roughly from November to March with a marked January-February maximum. Cold snaps and dry periods induce leaf shedding but the fallen leaf is still eaten by stock. Siratro is intolerant of frost although crown mortality is rare. Rooting down of runners is rare under local conditions.

It is not specific in its inoculum requirements, but inoculation with cowpea strain ensures success.

Stylo (*Stylosanthes guianensis* cultivars Oxley, Schofield, Cook, Endeavour)

'Stylo' is the common name for all species of *Stylosanthes*. These range from low-growing annuals such as Townsville stylo to large, woody, erect perennials.

Although Oxley has early seeding and a tolerance of drought, frost and heavy grazing, it has been unproductive in the Gympie district. The other cultivars are late seeders and less tolerant of these factors, but are more suited in other ways to this environment.

The tolerance of stylos to low fertility and poor soil structure makes them particularly valuable on old cultivations as well as the soloth soils. All lines have a fairly long growing season, with Schofield and Endeavour showing a marked summer peak, and Cook having the advantage in autumn.

The main drawback with these three cultivars is their extreme frost susceptibility. With grass temperatures of $-3°C$, a mature stand of Cook was eradicated. At the same site, Schofield was also completely frosted but recovered fully. However, in such areas, Schofield (the latest of the three) rarely seeds.

With the exception of Oxley, which is highly specific in its rhizobial requirements, these commercial lines nodulate on the cowpea strain of inoculum.

Townsville stylo (*Stylosanthes humilis* cultivars Lawson, Gordon and Paterson)

Townsville stylo is a low-growing, yellow-flowered annual. It may be distinguished from *S. guianensis* by the presence of a hook on the seed pod. Another stylo, *Stylosanthes hamata* cv. Verano, which also has a hooked pod, has recently been released, but early testing suggests this species is not suited to the area.

Townsville stylo's main strengths are its ability to tolerate heavy stocking and low soil fertility. It does not tolerate competition from sown grass species, thus limiting its value to low key development of native pastures. In most situations other legumes are more productive.

It nodulates with the native cowpea-type rhizobia as well as the commercial inoculant.

White clover (*Trifolium repens* cultivars Grasslands Huia (formerly New Zealand), Ladino, Louisiana, Haifa)

White clover is a white to pinkish-flowered, hairless, stoloniferous perennial. Unless growing side by side, individual varieties are difficult to distinguish.

The main soil requirements for white clover persistence are reasonable moisture availability with fair drainage and adequate nutrient levels, particularly phosphate. Drainage and moisture requirements are suitably filled on southerly slopes, irrigated or dryland alluviums and some coastal lowland situations.

Another factor affecting white clover persistence is summer grass competition. It is not only important to maintain sufficient ground cover to reduce evaporation and soil temperature, but also to have it low enough to limit shading of the clover.

The basic growth pattern of all cultivars is low production in summer and winter, fair growth in autumn and a marked spring flush.

With adequate moisture, Ladino is the most summer productive, Louisiana the most winter productive and Haifa the most spring productive. During the spring flush, there can be a considerable problem with bloat. This may be readily overcome by treating the strip to be grazed with an anti-bloat compound. Alternative methods involve the feeding of tallow, drenching in the bails, or the inclusion of appropriate compounds in the drinking water.

White clover, Kenya *(Trifolium semipilosum* cv. Safari)

Kenya white clover is a new species which may have potential in the area. It is more productive in summer and less productive in spring than the European white clover cultivars. Like white clover, it tolerates heavy grazing but differs in being able to grow up through the grass in more leniently grazed areas. Safari is more frost susceptible than white clover.

All the ordinary white clover cultivars nodulate satisfactorily with commercial inoculant 'B', but Safari requires its own specific inoculum.

Grasses

Guinea grass *(Panicum maximum* cultivars Riversdale, Hamil, Coloniao, Makueni)

Guinea grass has several types ranging from a fine-stemmed, low-growing, stoloniferous type to tall, heavy-stemmed, erect clumps. The commercial varieties are all tussock types. Coloniao and Hamil are tall-growing and Riversdale and Makueni medium-growing types. The lower-growing, fine-stemmed cultivars Petrie (green panic) and Gatton, will be considered under 'panics'.

Guinea grass cultivars vary considerably in growth patterns and acceptability to stock. Riversdale, Hamil and Coloniao produce a similar bulk of feed to Makueni, but do so mainly in summer. Makueni, although producing a summer peak, grows actively until the first frosts. All are susceptible to frost.

Hamil and Coloniao are extremely palatable even when mature. This feature provides a place for the two tall varieties as winter standover roughage, to be fed in conjunction with succulent temperate species or urea/molasses supplements. Apart from this aspect, the guinea grasses have little to offer. They are not as tolerant of heavy grazing or poor drainage as the setarias and paspalums and have a shorter growth period than most of the other grasses used in the area.

Makueni is a recent release and its potential in the area has not yet been fully assessed.

Kikuyu grass *(Pennisetum clandestinum)*

Kikuyu is a stoloniferous perennial which until recently could only be propagated vegetatively. A seeding cultivar, Whittet, is now available. Whittet is slightly more robust than common kikuyu or the more recently released seeding cultivar, Breakwell. All lines have similar requirements.

Kikuyu requires at least fair drainage and high fertility, especially as regards nitrogen. Plantings should therefore be restricted to the krasnozems, latosols, river alluviums, or any of the other minor soil types originally carrying rain-forest or wet sclerophyll.

It has a long growing period, extending from October through to May but is very sensitive to moisture stress and growth declines rapidly with the onset of a dry period. However, it is extremely drought hardy. Mild frosts have little effect on the leaf, but heavy frosts are damaging.

With suitable growing conditions, kikuyu is extremely aggressive. Initially, legumes such as glycine, Greenleaf desmodium and clover will combine with the grass, but as the soil nitrogen level improves, kikuyu dominates the legume.

Its responsiveness to nitrogen, tolerance of heavy grazing, long growth period and slow decline in feeding value make it valuable for use when resting grass/legume pastures to permit legume recovery. Nitrogen applied at 100 kg N per ha in late winter and again in early autumn will provide a productive sward.

Kikuyu is best planted in spring or early autumn to avoid summer weed competition. Irrigation is preferable with spring plantings.

Once established, a nitrogen dressing of 50 to 100 kg per ha ensures rapid ground coverage. The use of the pre-emergence weedicide atrazine in establishment from seed is showing promise in initial experiments. At rates of 1·3 to 1·8 kg of 80% product per ha this weedicide has a depressing effect on a wide range of weeds, but little effect on kikuyu seedlings. Because of the susceptibility of the common grasses and legumes, atrazine can only be used where kikuyu is the only species to be established.

Molasses grass *(Melinis minutiflora)*

Molasses grass is a vigorous perennial with a characteristic odour. The large reddish-purple, plume-like inflorescence in late autumn to early winter is another distinctive feature.

The main soil requirement is good drainage. The grass develops rapidly from seed and is tolerant of low fertility, making it an ideal pioneer species. Although relatively drought-hardy, molasses grass should only be considered in areas with a rainfall in excess of 1 000 mm.

Susceptibility to frost, poor drainage, fire, heavy grazing, and competition from aggressive, established companion species make it a somewhat transient component of the pasture. It should therefore not be the sole grass sown.

Pangola grass *(Digitaria decumbens)*

Pangola looks like a giant couch grass. It is extremely adaptable, being tolerant of poor drainage as well as long, dry spells. Although tolerant of low nitrogen fertility, it is very responsive to added nitrogen.

It has four major weaknesses—a short growing season, an extreme frost tenderness, a failure to set viable seed and an aggressiveness that makes it difficult to obtain a grass/legume mixture.

In nitrogen-fertilized situations, the short growing season makes pangola an unattractive proposition compared to many other grass species in common use. It commences active growth about November and slows down in March.

To date, pangola grass has only found a real niche in coastal lowland low heath situations.

Panic *(Panicum maximum* var. *trichoglume* cv. Petrie and *P. maximum* cv. Gatton)

These are commonly known as green panic and Gatton panic respectively. They are finer-stemmed, lower-growing members of the species. Another variety, Sabi panic, has shown little promise in the district.

Their distribution is restricted by their requirement for near perfect drainage—this is only found on the krasnozems, the prairie soils, and perhaps the latosols and better drained podzolics. Although drought hardy, they are responsive to good moisture conditions.

The panics have a long growing season, coming away early with the first spring rains. Leaf production in green panic dwindles with the onset of flowering in early summer, which then continues through to late autumn. Although Gatton commences flowering at about the same time, it reaches its peak later, thus remaining leafy into the autumn.

Glycine and siratro are good companion legumes in most situations.

Para grass *(Brachiaria mutica)*

Para grass is a hairy-leafed, stoloniferous species whose main asset is a marked tolerance of waterlogging. When used for bank stabilization, it gradually extends into the free water. Unfortunately, this can provide a nucleus for undesirable silting of drainage channels.

This grass is best established from runners or sets with two or more nodes. It stands over well, and when grown in a swampy area provides a good drought reserve.

Para grass produces a bulk of fairly nutritious feed in the warm months. Although severely affected by frost, it persists well in frosted areas.

Paspalum *(Paspalum dilatatum)*

Paspalum is initially tufted but in time develops a mat of short rhizomes. It is an extremely adaptable species being tolerant of drought, temporary waterlogging and moderate frost. Previously, paspalum dominated large areas of the district but, with declining soil fertility, it has gradually given way to mat grass. An improvement in the nitrogen status of the soil can reverse this trend.

Although winter dormant, growth recommences early in spring but declines rapidly with the onset of flowering in summer. The flowers are almost invariably subject to attack by ergot, a fungus which can cause ergot poisoning in cattle and horses. The disease is no longer as common as it was when paspalum occupied much of the country. Due to this short growth period, setaria has replaced paspalum in most situations.

Paspalum, broadleaf *(Paspalum wettsteinii* cv. Warral)

This is a semi-prostrate, tufted perennial with wide adaptation to fertility, drainage and grazing abuse. Like paspalum, it is tolerant of both drought and waterlogging.

Although it has a similar growth pattern to the other two locally used commercial *Paspalum* species (*P. dilatatum* and *P. plicatulum*), it has the advantage of producing very early spring growth. In this respect, it is also superior to setaria and kikuyu. Seeding commences in early April, after which little vegetative growth occurs. The main disadvantage of this species is its susceptibility to frost. However, it is not killed.

Plicatulum *(Paspalum plicatulum* cultivars Bryan, Hartley, Rodds Bay)

Plicatulum is a tufted perennial which tolerates low fertility, poor drainage and dry spells. Early spring growth rates are slower than those of paspalum and broadleaf paspalum. Growth reaches a marked summer peak and declines with the onset of flowering in late March. The foliage is very frost tender but the crowns are not killed.

Plicatulum has its main value in the coastal lowlands around Maryborough, but its tolerance of low fertility and compatibility with legumes ensure a place for it in minor plantings throughout the region.

Hartley seed is no longer available. Bryan is more popular than Rodds Bay, mainly because of better palatability. However, both cultivars are less palatable than most other sown grasses.

Prairie grass *(Bromus unioloides* cv. Priebe)

Prairie grass is a low-growing (about 25 cm), tussock-forming biennial which is best suited to irrigated conditions. It displays a typical temperate species growth pattern, with a fair autumn flush, a winter depression and a strong flush in spring.

The prairie grass seedling is extremely vigorous, and with suitable moisture conditions will establish in a low sward of dormant summer species. If such annual regeneration is desired, stock exclusion in late spring and early summer is necessary for seeding.

Once established, it is reasonably drought tolerant, making it more atractive than rye grass in areas with restricted irrigation. It is generally more suited to sandier alluviums.

Rhodes grass *(Chloris gayana* cultivars Pioneer, Katambora, Callide)

Rhodes grass is a hardy, tufted perennial which spreads rapidly by runners. It is one of our most adaptable species, persisting well in virtually all situations, except where flooding or prolonged periods of waterlogging occur. It is tolerant of low fertility soils but responds well to added nitrogen. A valuable attribute is its tolerance of high salt levels in the soil.

Growth commences early in spring. As with most species, this dwindles with the onset of flowering. This leads to a reduction in feeding value. Pioneer is the worst in this respect; seeding throughout the growing season. Katambora and Callide are more restricted in their flowering period. Although growth terminates with the first frosts, Rhodes grass has a frost tolerance exceeded only by Narok setaria, paspalum and kikuyu among the coastal tropical grasses.

Callide is the most palatable cultivar and is eaten well even when mature. Pioneer and Katambora are eaten quite well when leafy, but are unpalatable when mature.

Katambora establishes and covers rapidly and persists well even at low fertility. This makes it ideally suited to soil conservation programmes.

Ryegrass, Italian *(Lolium multiflorum* cv. Grasslands Paroa), Tama *(L. multiflorum* cv. Grasslands Tama), Wimmera *(L. rigidum* cv. Wimmera), Kangaroo Valley *(L. perenne* cv. Kangaroo Valley), H1 or Short Rotation *(L. perenne x multiflorum* cv. Grasslands Manawa), Ariki *(L. (perenne x multiflorum) x perenne* cv. Grasslands Ariki)

The ryegrasses are cool season annual or perennial species, whose only value in this region is in correctly irrigated pastures. The abovementioned range, some annual and some perennial, covers the main cultivars used locally. Through speed of establishment in autumn, winter growth potential or extent of spring growth, each has its place in a grazing programme.

Kangaroo Valley, Manawa (H1) and Ariki are defined as perennial lines, but in this region after the second year, the stand is usually too sparse to warrant irrigation and nitrogen treatment. It is, however, possible to oversow ryegrass seed, either annual or perennial.

Of the perennial lines, Ariki has the longest growing season, producing a small quantity of feed in summer. This characteristic helps reduce the ingress of summer weeds responsible for the sward decline. Ariki has the disadvantage of slow establishment. Manawa establishes quickly and grows through to November when it seeds and becomes dormant.

Kangaroo Valley also establishes quickly, commences flowering in September, but continues growing through to October or November. Its main advantages are high productivity, a tolerance of hot conditions and stronger perenniality than Manawa.

The annual lines show good early development, and with adequate fertilizer and water can be grazed within 5 weeks from a March planting. Wimmera is the hardiest and has good winter production, but growth stops with flowering in September. Tama and Paroa both produce well through to November. Tama, recognizable by its exceedingly broad leaf, has a very high nutritive value but is prone to rust.

Ryegrasses are very demanding for fertility. The nitrogen source may be red clover or white clover, or bag nitrogen. Up to 500 kg per ha of N annually may be used economically.

Setaria *(Setaria anceps* cultivars Nandi, Narok, Kazungula)

All cultivars are erect, clump-forming perennials. When lodging occurs in taller stands, new plants form on those nodes touching the ground. The setarias are adaptable in terms of soil type, even where internal drainage is poor. Along with the paspalums they are the best adapted grasses to the coastal situation, being tolerant of short periods of inundation as well as the frequent short droughts. The three cultivars are sufficiently different to facilitate selection for a particular situation.

Narok and Kazungula establish more readily than Nandi. Narok and Nandi are not as competitive as Kazungula and form a better association with legumes. Even so, the legume component of most setaria-based pasture gradually declines, frequently leaving a dense sward of grass. Research has shown that setaria has a luxury uptake of potassium, competing more succesfully for this nutrient than the associated legume. In marginal potassium situations, this may well be the cause of legume decline.

Kazungula has a strong tendency to become stemmy and lose feed value. Flowering commences in late spring, with Nandi the earliest of the three cultivars. Flowering can be largely suppressed through high stocking pressures on a rotational basis.

The three cultivars have a long growing season, although the spring growth is not as good as in kikuyu and paspalum. Kazungula produces the most summer growth and Narok the most autumn and winter growth. Narok is the most frost tolerant of the three, withstanding temperatures down to about —3°C. Nandi is the most frost tender.

One disadvantage with setaria is the potentially toxic levels of oxalate found in flush growth. The symptoms of poisoning are similar to those of milk fever. In experiments, Kazungula has contained the highest level of oxalate, Nandi the lowest, and Narok an intermediate level. With cattle this is only a potential problem, adapted cattle rarely being affected. The problem can be quite serious with horses, giving rise to Big Head Disease. The best answer to this problem is to keep horses away from all cultivars of setaria.

Kazungula being the most robust line is recommended only in drier areas (down to about 750 mm), on shallow soils (for example, stony shale soils) and on the heavier soils. In most situations, Narok is the recommended cultivar. This is due to ease of management, frost tolerance, and good stock acceptance. Low seed yields of this cultivar with the consequent scarcity and high price of seed leave a place for Nandi in recommendations.

Signal grass *(Brachiaria decumbens* cv. Basilisk)

This is initially a tussock grass whose vertical stems gradually lodge and peg down, eventually producing a dense sward. Although traditionally considered a purely tropical plant, it grows well in this area in situations of at least fair drainage. It grows vigorously with moist conditions but is very drought tolerant.

Even under fairly low fertility conditions, signal grass is aggressive, precluding the possibility of a companion legume. It responds well to nitrogen fertilization, and may well be used in summer to allow spelling of legume grass pastures. It is essential to stock heavily to maintain the grass in a leafy, acceptable condition and to best utilize the fertilizer.

Signal grass has a fairly long growing season, producing active growth from spring to late autumn, but is very frost tender.

Although possessing many good points, its aggressiveness and weed potential make it a dubious prospect for a pasture programme.

Planting mixtures

Grass/legume pastures can be sown as simple or complex mixtures. The simple mixture comprises one grass and one legume species, and is the better one to use when species known to be compatible and suitable to the area are being planted. However, if there is doubt, a complex or shotgun mixture comprising several grass and several legume species can be advantageous.

The main problem here is the tendency for cattle to select one species over another. This can lead to dominance by the least palatable members of the shotgun mixture.

The planting recommendations table presents the species and fertilizer recommendations for the main soil types described earlier.

SEED AND FERTILIZER RECOMMENDATIONS

Soil/Vegetation Type	Grass	S.R.* (kg/ha)	Legume	S.R.* (kg/ha)	Fertilizer ‡	A.R.†
Coastal Lowlands Complex						
Podzol	Nandi setaria	2–3	Lotononis	0.5–1	Mo 12 Superphosphate ..	600 kg/ha
	Narok setaria	2–3	Greenleaf desmodium ..	2–3	Muriate of potash ..	120 kg/ha
	Plicatulum	2–4	White clover	2–4	Lime	600 kg/ha
	Pangola	cuttings			Zinc sulphate	8 kg/ha
	Broadleaf paspalum ..	2–3			Copper sulphate ..	8 kg/ha
Lateritic podzolic	Nandi setaria	2–3	Lotononis	0.5–1	as above	
	Narok setaria	2–3	Greenleaf desmodium ..	2–3		
	Gatton panic	2–3	Stylo (Cook, Endeavour, Schofield)	1–3		
	Pangola	cuttings				
Subcoastal Open Forest						
Lithosol on shale and phyllite	Nandi setaria	2–3	Greenleaf desmodium ..	2–3	Mo 12 superphosphate ..	600 kg/ha
	Narok setaria	2–3	Siratro	2–3		
	Kazungula setaria ..	1–2	Axillaris	2–4		
	Hamil grass or Coloniao guinea	1–2	Lotononis	0.5–1		
	Katambora Rhodes ..	2–3	Stylo (Cook, Endeavour, Schofield)	1–3		
	Molasses grass	1–2	Malawi glycine	2–3		
Soloth	Narok setaria	2–3	Lotononis	0.5–1	Mo 12 superphosphate ..	600 kg/ha
	Kazungula setaria ..	1–2	Stylo (Cook, Endeavour, Schofield)	1–3	Muriate of potash ..	100 kg/ha
	Plicatulum	2–4				
	Katambora or Callide Rhodes	2–3				
Red podzolic	Narok setaria	2–3	Greenleaf desmodium ..	2–3	Mo 12 superhosphate ..	600 kg/ha
	Nandi setaria	2–3	Siratro	2–3		
	Gatton panic	2–3	Axillaris	2–4		
	Makueni guinea	2–3	Stylo (Cook, Endeavour, Schofield)	1–3		
			Malawi glycine	2–3		
River alluvium						
(a) irrigation	Ryegrass	3 (30)**	White clover	4–8	Mo 12 superphosphate ..	500 kg/ha
	Prairie	6–10	Red clover	4–8		
	Kikuyu	2–3	Lucerne	4 (15)**		
(b) raingrown	Narok setaria	2–3	White clover	4–6	Mo 12 superphosphate ..	500 kg/ha
	Nandi setaria	2–3	Siratro	2–3		
	Kikuyu	2–3	Lucerne	4–6		
	Callide Rhodes	1–3				

Soil/Vegetation Type	Grass	S.R.* (kg/ha)	Legume	S.R.* (kg/ha)	Fertilizer ‡	A.R.†
Subcoastal Open Forest— *continued*						
Prairie on andesite	Gatton panic	2–3	Siratro	2–3	Mo 12 superphosphate ..	500 kg/ha
	Green panic	2–4	Lotononis	0.5–1		
	Callide Rhodes	1–3	Glycine	2–3		
	Narok setaria	2–3				
	Kazungula setaria ..	1–2				
Minimal prairie on serpentine	Green panic	2–4	Siratro	2–3	Mo 12 superphosphate ..	500 kg/ha
	Gatton panic	2–3	Axillaris	2–3	Muriate of potash ..	100 kg/ha
	Narok setaria	2–3	Stylo	2–3		
	Kazungula setaria ..	1–2				
Yellow podzolic	Green panic	2–4	Siratro	2–3	Mo 12 superphosphate ..	500 kg/ha
	Gatton panic	2–3	Lotononis	0.5–1		
Tall Open Forest/Wet Sclerophyll						
Red podzolic	Narok setaria	2–3	Greenleaf desmodium ..	2–3	Mo 12 superphosphate ..	600 kg/ha
	Nandi setaria	2–3	Malawi glycine	2–3		
	Gatton panic	2–3	Siratro	2–3		
	Kikuyu	2–3	White clover	4–6		
Closed Forest						
Krasnozem	Green panic	2–4	Tinaroo glycine	2–3	Not required initially	
	Gatton panic	2–3	White clover	4–6		
	Kikuyu	2–3	Silverleaf desmodium ..	3–4		
Prairie	Green panic	2–4	Tinaroo glycine	2–3	Mo 12 superphosphate ..	400 kg/ha
	Gatton panic	2–3	Siratro	2–3		
			Axillaris	2–3		
Latosol	Narok setaria	2–3				
	Nandi setaria	2–3	Malawi glycine	2–3	Mo 12 superphosphate ..	500 kg/ha
	Gatton panic	2–3	Greenleaf desmodium ..	1–2		
	Kikuyu	2–3	Siratro	2–3		

*S.R. Seeding rate of good seed of that species sown in single grass/single legume mixtures. If more than one grass or legume is used, these seeding rates should be adjusted accordingly.

**() Upper limit of seeding rate of that species in pure stands. Where this figure is not specified, a doubling of the S.R. is a good guide.

†A.R. Application rate of fertilizer to new ground. Where old pasture or cultivation areas are involved, soil analysis is the best indicator of fertilizer needs. In the Coastal Lowlands Complex or in rapidly prepared seedbeds, nitrogen at 20 to 30 kg per ha is beneficial to grass establishment.

‡ For glycine and Greenleaf desmodium, use Mo 24 superphosphate instead of Mo 12 superphosphate.

Caring for a house cow

by C. T. Gibbs, Dairy Field Services Branch.

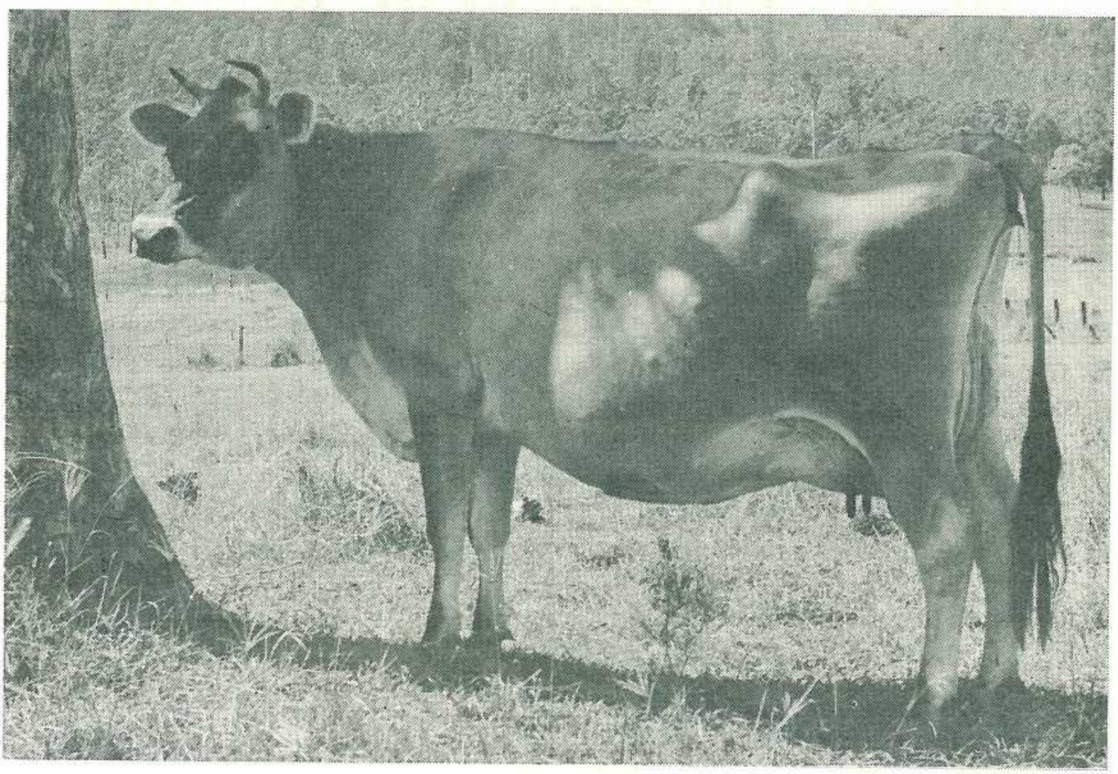
THERE are 32 000 house cows in Queensland, mainly in areas where there is no organized milk delivery.

Other people depend on a house cow if they want fresh milk rather than buying pasteurized milk.

Selecting a house cow

A dairy cow of any breed is suitable as a house cow, provided she has the following qualities.

- A QUIET TEMPERAMENT. She should be easily handled by any member of the family and preferably should have no horns.
- GOOD HEALTH AND CONDITION. Avoid a rough-looking cow. Udders should be soft and pliable—cows with hard or lumpy udders have probably had mastitis. Try milking the cow by hand and check the first few squirts for clots, which could mean mastitis. Have the cow checked by a veterinarian, particularly for brucellosis and tuberculosis. These diseases are transmittable to humans.



- EASY MILKER. If the cow is to be milked by hand, choose one with good-sized, even teats. Preferably she will have had some experience as a house cow. A young cow on her second or third calf is a good choice—she will have been broken-in but will not have many of the problems associated with older cows.

- GOOD PRODUCTION. Make sure she can produce enough milk for the family.

Feeding

Feeding is an important consideration that is often overlooked. Do not think mistakenly that because you have several hectares, there will be enough feed for the cow. In fact, the area of land is not important—it is the quality and quantity of feed growing on it that determines its suitability. As a rule of thumb, 1 to 2 hectares of good quality, fertilized pasture is enough for 1 house cow.

In Queensland in the dry months (April to September-October), paddock feed goes off in quality and amount. To keep the cow milking in this period, you may have to give her some supplements. Lucerne hay, crushed grain, or a dairy meal will generally be enough.

The cow should be in good condition at calving. She will naturally lose some condition after calving, but with good feeding she will soon improve.

Water and shade

Provide the cow with good, clean drinking water at all times. A mature cow needs between 65 and 160 litres of water a day, depending on daily temperature and humidity.

During summer, make sure adequate shade is available. Avoid tethering cows without shade during hot weather.

Milking time

Most house cows are milked by hand. For the sake of family health, pay strict attention to hygiene. Docile house cows can be milked in the paddock, but a covered area with a cement floor is recommended for good hygiene and protection from the weather.

The cow's udder and teats should be washed, cleaned and dried before milking, and the milker should have clean, dry hands. Dairy buckets must be kept clean and sterilized. After milking, rinse the buckets with cold or lukewarm water, then scrub with a warm detergent solution followed by a scalding with boiling water.

Do not leave any manure around the milking area—it is of more value on the garden.

How long can you milk a cow?

Ideally, a cow should be mated to calve once a year. You can expect her to milk for 10 months. She should be spelled then for 2 months before calving. To dry the cow off, just stop milking and stop feeding meal and grain concentrates.

Do not use the milk from freshly calved cows until about 10 days after calving.

Milk from cows with long lactations (more than 10 months) can become stale tasting, but it will be normal again after the next calving.

Mating the cow

A cow's gestation period is about 283 days. For your cow to calve once a year, you will need to remate her 60 to 90 days after calving.

Two methods of breeding are available: natural service and artificial breeding.

An artificial breeding service is available in many areas. This method gives you a choice of breeds and eliminates the necessity for keeping a bull. The cow also has no chance of contracting venereal disease.

Picking a cow in season ('on heat') can be hard, particularly if you only have one cow. Watch for excitement, bellowing and unusual behaviour. The heat period will last for 10 to 18 hours. If the cow does not conceive, heat periods will occur at 18 to 24 day intervals.

Routine treatment

- TICK CONTROL. In a tick-infected area, the cow will need to be dipped or sprayed regularly with a tickicide.

- DISEASE CONTROL. If you keep calves, have them vaccinated against all the common diseases, for example, blackleg, tetanus, leptospirosis and tick fever.

Any heifers that you keep for milking should be vaccinated with Strain 19 against brucellosis, between the ages of 3 and 6 months.

- IDENTIFICATION. Freeze and fire brands are the only legal method of identification of ownership. Brands must be registered. All cattle over 100 kg in weight must have a brand before they are sold.

Using the milk

A well cared for cow will give more milk than is needed by the average family. The surplus may be used in a number of ways:

- TO SUCKLE A CALF DURING THE DAY. Confine the calf at night and obtain the household milk in the morning, then let the calf run with the cow all day. This way, you will only have to milk once a day instead of the usual twice. Also, if you are away for a day or so, the calf will keep the cow milked out.
- TO MAKE YOGHURT OR HOME-MADE CHEESE.
- FOR CREAM. To use as fresh cream or for home-made butter.

Home pasteurizing

The reason for pasteurizing milk from a house cow is to eliminate any chance of human infection from disease organisms.

Place the container of milk inside another container which contains water (This stops the milk solids from sticking to the sides of the container).

Heat the milk to 63° to 66°C (145 to 150°F) and hold it at this temperature for 30 minutes. Do not boil it. Then cool it as quickly as possible.

Some legal aspects

- MILK LICENSING—Milk from house cows may only be consumed by people living on the property. To sell or even give away milk to other consumers would be a breach of the Milk Licensing Regulations under the Dairy Produce Acts.
- PERMISSION TO KEEP A COW. If you live in a metropolitan area, check the council laws relating to the keeping of livestock.
- MOVING LIVESTOCK—Check with the Department of Primary Industries if you wish to move stock as permits for transport are needed. Disease testing and spraying are compulsory in some cases.

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Frost and minimum temperature probabilities

FROST is one of the climatic hazards with which primary producers must contend.

Its potential as a damaging agency has been well demonstrated over the years.

Many crops and pasture plants have varying degrees of susceptibility to frost. As a consequence, it is usual practice to adjust the time of sowing to minimize the risk of frost occurring at a critical growth stage.

It takes years of experience at any one location to become familiar with the pattern of frost occurrences and their variation from year to year. However, by looking at temperature data for the past 70 to 80 years, it is possible to obtain a good picture of frost occurrence patterns.

This article presents tables of probabilities associated with frost occurrence. This provides a basis for the planning for frost avoidance. Probabilities associated with minimum temperatures throughout the year are also tabulated. Minimum temperature is often important in relation to establishment, subsequent growth and flowering of crops.

The probabilities discussed have been derived from long-term temperature data which have been collated within the Department of Primary Industries. The locations for which these data are available to date are Charleville, Dalby, Emerald, Goondiwindi and Roma.

Computer programmes have been written to analyse these data and produce the tables presented in this article.

by G. L. Hammer, Agriculture Branch and K. M. Rosenthal, Development Planning Branch.

Relation of minimum temperature to frost

The minimum daily temperature measured in a standard screen at 1·25 m above the ground has been used as the indicator of frost. A minimum temperature of 2°C in the screen will generally correspond to a light frost, whereas 0°C in the screen implies a heavy frost. However, caution must be taken here as the stability of the atmosphere is also important in determining whether or not a frost will occur. Hence, the specification based solely on minimum temperature can only be regarded as a rule of thumb.

The effect of local topography must also be considered. It is a well-known fact that frosts are more severe in the bottom of a valley or depression ('frost pockets') than on a slope. If a site is in a slight depression in relation to the meteorological recording station then it is likely that a 2°C minimum screen temperature will correspond with a heavy frost at the site. Conversely, a site on a slight rise in relation to the recording site may only receive a light frost when the minimum screen temperature is 0°C.

Local knowledge in conjunction with a few temperature measurements taken over a period of time at a particular site enable the correspondence between the site and the official recording site to be established. The most accurate use of the information presented in this article could then be made.

Explanation of tables

Three distinct types of tables have been produced for each station:

(i) First and last frost occurrence (tables in Appendix 1).

The body of each table gives the date of the first (or last) occurrence of a particular minimum screen temperature for a given risk. For convenience, the year has been divided at July 15 (approximately the coldest time of year). A first occurrence is that day prior to July 15 when the minimum temperature first goes below the specified temperature. A last occurrence is that day after July 15 when the minimum temperature last goes below the specified temperature.

The dates of the earliest and latest recorded first (last) occurrences of a particular temperature are also given. The probability at the base of the table is the chance of receiving the particular minimum temperature at all before (after) July 15.

For example, consider the table for Dalby (table 2). There is a 71% chance of receiving a minimum temperature of —2°C or less before July 15 (that is, in 29% of years the minimum temperature did not go below —2°C before July 15) and there is a 30% chance that such a temperature will occur before June 16. The earliest first occurrence on record for this minimum temperature is May 8 and the latest first occurrence recorded is July 14.

(ii) Minimum temperature probabilities (tables in Appendix 2).

The tables give the weekly mean minimum for a particular risk for each week of the year. The lowest and highest weekly mean minimum temperatures recorded to date are also given.

For example, at Charleville (table 6) there is a 30% chance (or risk) that in the week beginning October 8 the weekly mean minimum temperature will be 12·4°C or lower. The lowest and highest weekly mean minimum temperatures observed to date for that week are 7·1° C and 19·7° respectively.

(iii) Frost occurrence and duration percentage probabilities (tables in Appendix 3).

The tables give the probabilities for the relevant weeks in the year which have at least 1 day, 2 consecutive days or 3 consecutive days with minimum temperatures less than or equal to that specified. Thus, they detail the chances related to the severity of frost throughout the season.

For example, at Emerald (table 13) there is a 13% chance of getting 2 consecutive days with minimum temperatures at or below 0° C in the week beginning July 2.

Use of tables

These tables present information that enables the risk, with respect to frost and minimum temperature, associated with a particular management decision to be accurately specified.

For example, with a winter crop such as wheat there is always the chance of getting a damaging frost at flowering if planting is early. Consider a property near Emerald where it is known that a minimum temperature of 0° C is critical. Looking at table 3 it is seen that there is a 30% risk of the last minimum temperature of 0° C or less for the year occurring after August 6. Table 13 shows the probabilities week by week and for 0° C they fall away from the beginning of August. Hence the grower may decide (depending on his attitude to risk) that planning for flowering in early August is reasonable and so will adjust his most desirable planting time for particular varieties accordingly.

Another example is with cotton where minimum soil temperature is an important consideration in crop establishment and frost before boll maturity is an important factor in the probability of a flower developing to a mature boll. The tables in Appendix 2 can be related to minimum soil temperatures so that the probability of this requirement being met by a particular date can be found. The tables in Appendix 1 and Appendix 3 enable the determination of the frost risk associated with time of flowering.

There are numerous situations where minimum temperature is a critical factor. Although the relationship between minimum temperature and frost occurrence is not exact, the specification of risks associated with minimum temperatures should prove useful as an aid to farmers in making management decisions. It should also help researchers develop and evaluate management strategies.

Appendix 1

Tables of the probability of the date of first and last frost occurrence for the year for specified minimum temperatures.

TABLE 1 CHARLEVILLE

Date of First Frost for Year (i.e. before July 15)

Temperature °C		3	2	1	0	−1	−2
Earliest		Apr 16	Apr 22	Apr 24	May 8	May 9	May 9
% Risk	10	Apr 26	May 3	May 10	May 19	May 29	June 6
	30	May 7	May 14	May 22	June 1	June 13	June 21
	50	May 15	May 22	May 30	June 10	June 24	July 8
	70	May 23	May 30	June 7	June 21	July 9	..
	90	June 4	June 11	June 19	July 12	..	..
Latest		June 29	June 29	July 7	July 12	July 12	July 14
Probability (%)		100	99	99	90	76	60

Date of Last Frost for Year (i.e. after July 15)

Temperature °C		−2	−1	0	1	2	3
Earliest		July 17	July 18	July 17	July 21	July 31	Aug 14
% Risk	90	..	..	July 21	Aug 2	Aug 13	Aug 25
	70	..	July 25	Aug 4	Aug 14	Aug 26	Sept 5
	50	July 20	Aug 5	Aug 13	Aug 23	Sept 3	Sept 13
	30	Aug 4	Aug 14	Aug 21	Sept 1	Sept 12	Sept 21
	10	Aug 18	Aug 26	Sept 2	Sept 13	Sept 25	Oct 3
Latest		Sept 8	Sept 8	Sept 23	Oct 3	Oct 3	Oct 12
Probability (%)		59	83	94	99	100	100

TABLE 2 DALBY

Date of First Frost for Year (i.e. before July 15)

Temperature °C		3	2	1	0	−1	−2
Earliest		Apr 14	Apr 14	Apr 17	May 5	May 8	May 8
% Risk	10	Apr 20	Apr 25	May 2	May 12	May 24	June 1
	30	May 2	May 8	May 16	May 25	June 5	June 16
	50	May 10	May 17	May 25	June 4	June 15	June 27
	70	May 18	May 26	June 4	June 14	June 27	July 13
	90	May 29	June 8	June 18	July 2	. .	. .
Latest		June 21	June 25	July 11	July 14	July 14	July 14
Probability (%)		100	100	100	96	84	71

Date of Last Frost for Year (i.e. after July 15)

Temperature °C		−2	−1	0	1	2	3
Earliest		July 18	July 18	July 18	July 17	Aug 12	Aug 17
% Risk	90	. .	. .	July 28	Aug 14	Aug 24	Sept 2
	70	July 19	July 31	Aug 12	Aug 25	Sept 4	Sept 13
	50	Aug 1	Aug 10	Aug 21	Sept 2	Sept 12	Sept 20
	30	Aug 11	Aug 19	Aug 30	Sept 10	Sept 19	Sept 28
	10	Aug 23	Aug 31	Sept 11	Sept 21	Sept 30	Oct 8
Latest		Oct 6	Oct 6	Oct 18	Oct 18	Oct 30	Oct 30
Probability (%)		72	85	96	100	100	100

TABLE 3 EMERALD

Date of First Frost for Year (i.e. before July 15)

Temperature °C		3	2	1	0	−1	−2
Earliest		Apr 22	Apr 23	Apr 23	Apr 29	May 25	June 12
% Risk	10	May 7	May 17	May 27	June 5	June 17	*
	30	May 21	May 31	June 12	June 22	July 13	*
	50	May 31	June 10	June 22	July 8	. .	*
	70	June 10	June 21	July 8	. .	. .	*
	90	June 24	July 11	. .	. .	. .	*
Latest		July 9	July 11	July 12	July 14	July 14	July 14
Probability (%)		99	90	77	61	35	16

Date of Last Frost for Year (i.e. after July 15)

Temperature °C		−2	−1	0	1	2	3
Earliest		July 17	July 17	July 17	July 18	July 18	July 19
% Risk	90	*	. .	. .	. .	July 22	Aug 3
	70	*	. .	. .	July 25	Aug 7	Aug 17
	50	*	. .	July 26	Aug 6	Aug 17	Aug 26
	30	*	July 25	Aug 6	Aug 16	Aug 26	Sept 4
	10	*	Aug 12	Aug 18	Aug 28	Sept 7	Sept 17
Latest		Sept 8	Sept 8	Sept 9	Sept 18	Nov 4	Nov 4
Probability (%)		30	42	63	80	94	100

* Insufficient occurrences for complete probability analysis

Table 4 Goondiwindi

Date of First Frost for Year (i.e. before July 15)							
Temperature °C		3	2	1	0	−1	−2
Earliest		Apr 5	Apr 17	May 8	May 8	May 9	May 17
% Risk	10	Apr 29	May 6	May 14	May 25	June 3	June 14
	30	May 10	May 18	May 28	June 9	June 18	June 28
	50	May 18	May 26	June 8	June 20	July 1	..
	70	May 26	June 3	June 18	July 4	..	..
	90	June 9	June 19	July 11	..	..	..
Latest		July 5	July 3	July 14	July 11	July 12	July 12
Probability (%)		99	97	92	81	66	48

Date of Last Frost for Year (i.e. after July 15)							
Temperature °C		−2	−1	0	1	2	3
Earliest		July 17	July 17	July 17	July 17	July 29	Aug 14
% Risk	90	..	..	..	July 28	Aug 10	Aug 23
	70	..	..	July 30	Aug 12	Aug 23	Sept 4
	50	..	July 22	Aug 10	Aug 22	Sept 2	Sept 12
	30	July 19	Aug 7	Aug 20	Sept 1	Sept 11	Sept 20
	10	Aug 12	Aug 22	Sept 3	Sept 16	Sept 25	Oct 2
Latest		Sept 7	Sept 7	Sept 27	Oct 16	Oct 16	Oct 16
Probability (%)		39	61	84	99	100	100

Table 5 Roma

Date of First Frost for Year (i.e. before July 15)							
Temperature °C		3	2	1	0	−1	−2
Earliest		Mar 29	Apr 14	Apr 18	May 2	May 2	May 8
% Risk	10	Apr 18	Apr 24	May 3	May 14	May 22	May 30
	30	Apr 30	May 8	May 17	May 28	June 5	June 13
	50	May 8	May 17	May 27	June 7	June 15	June 25
	70	May 16	May 26	June 6	June 18	June 27	July 12
	90	May 27	June 9	June 23	July 8	..	..
Latest		June 19	June 28	July 11	July 15	July 14	July 14
Probability (%)		100	99	97	94	86	72

Date of Last Frost for Year (i.e. after July 15)							
Temperature °C		−2	−1	0	1	2	3
Earliest		July 18	July 20	July 20	July 20	July 20	July 28
% Risk	90	..	July 20	July 29	Aug 10	Aug 22	Aug 31
	70	July 18	Aug 2	Aug 12	Aug 24	Sept 4	Sept 11
	50	Aug 1	Aug 12	Aug 20	Sept 2	Sept 12	Sept 19
	30	Aug 12	Aug 21	Aug 29	Sept 11	Sept 21	Sept 27
	10	Aug 26	Sept 1	Sept 10	Sept 25	Oct 4	Oct 9
Latest		Sept 13	Sept 14	Sept 26	Oct 2	Oct 25	Nov 2
Probability (%)		71	90	97	100	100	100

Appendix 2

Tables of weekly mean minimum temperature for a given risk.

TABLE 6 CHARLEVILLE

WEEKLY MEAN MINIMUM TEMPERATURE (°C) FOR A GIVEN RISK

Week Beginning	Lowest Observed	Percentage Risk					Highest Observed
		10	30	50	70	90	
January 1	15·6	18·3	20·0	21·2	22·4	24·1	26·8
January 8	16·4	18·6	20·2	21·4	22·5	24·2	25·9
January 15	16·6	18·7	20·3	21·4	22·5	24·2	27·2
January 22	16·5	18·7	20·4	21·5	22·6	24·2	27·2
January 29	17·3	18·9	20·4	21·5	22·5	24·1	27·5
February 5	16·7	18·7	20·3	21·3	22·4	23·9	26·6
February 12	16·6	18·4	20·0	21·0	22·1	23·7	25·8
February 19	15·7	18·0	19·5	20·6	21·6	23·2	25·1
February 26	15·6	17·5	19·0	20·1	21·1	22·6	23·8
March 5	13·5	16·6	18·2	19·3	20·4	22·1	25·0
March 12	13·2	15·8	17·4	18·6	19·7	21·3	23·6
March 19	13·3	14·9	16·6	17·7	18·8	20·5	22·3
March 26	11·5	13·8	15·5	16·7	17·8	19·5	21·8
April 2	10·3	12·6	14·3	15·5	16·7	18·4	19·9
April 9	7·3	11·0	12·9	14·2	15·5	17·4	19·4
April 16	5·7	9·3	11·3	12·7	14·1	16·1	18·6
April 23	4·3	7·7	9·9	11·3	12·8	15·0	17·5
April 30	4·2	6·6	8·8	10·3	11·7	13·9	16·6
May 7	2·2	5·3	7·5	9·1	10·6	12·8	15·6
May 14	0·6	4·2	6·5	8·1	9·6	11·9	14·1
May 21	0·3	3·3	5·6	7·2	8·8	11·1	15·1
May 28	0·8	2·7	5·0	6·5	8·1	10·4	14·2
June 4	0·3	2·2	4·5	6·1	7·7	10·0	13·6
June 11	0·4	1·6	4·0	5·7	7·4	9·8	13·2
June 18	−1·8	0·9	3·4	5·1	6·8	9·3	12·7
June 25	−2·4	0·5	2·9	4·5	6·2	8·6	12·9

TABLE 6 CHARLEVILLE—*continued*

WEEKLY MEAN MINIMUM TEMPERATURE (°C) FOR A GIVEN RISK

Week Beginning	Lowest Observed	Percentage Risk					Highest Observed
		10	30	50	70	90	
July 2	−1·4	0·4	2·7	4·3	5·9	8·2	11·6
July 9	−2·0	0·1	2·5	4·1	5·7	8·1	11·4
July 16	−1·9	0·1	2·4	3·9	5·4	7·6	12·2
July 23	−1·3	0·5	2·6	4·0	5·4	7·5	9·1
July 30	−1·7	1·0	3·0	4·4	5·8	7·8	10·7
August 6	−1·4	1·6	3·6	5·0	6·4	8·4	14·8
August 13	0·6	2·2	4·2	5·6	7·0	9·1	12·8
August 20	−0·2	3·0	5·1	6·5	7·9	9·9	12·0
August 27	2·0	4·0	6·0	7·4	8·8	10·8	13·3
September 3	3·0	5·0	7·0	8·4	9·8	11·8	14·3
September 10	3·5	6·0	8·0	9·3	10·7	12·7	14·8
September 17	4·8	6·8	8·8	10·1	11·5	13·5	15·7
September 24	3·5	7·8	9·8	11·2	12·6	14·6	15·4
October 1	5·8	9·2	11·2	12·6	13·9	15·9	19·2
October 8	7·1	10·6	12·4	13·7	14·9	16·7	19·7
October 15	8·8	11·7	13·4	14·5	15·6	17·3	18·5
October 22	10·0	12·6	14·3	15·4	16·5	18·2	21·2
October 29	9·1	13·4	15·2	16·3	17·5	19·3	23·0
November 5	12·2	14·0	15·8	17·1	18·3	20·1	24·3
November 12	11·4	14·8	16·6	17·9	19·1	21·0	24·0
November 19	13·7	15·4	17·2	18·4	19·6	21·4	23·9
November 26	14·5	16·0	17·8	19·0	20·2	22·0	24·1
December 3	11·0	16·3	18·1	19·3	20·6	22·4	24·2
December 10	12·9	17·0	18·7	19·9	21·1	22·8	25·7
December 17	15·7	17·5	19·2	20·4	21·6	23·3	25·1
December 24	14·1	17·8	19·6	20·8	22·1	23·8	26·9

TABLE 7 DALBY

WEEKLY MEAN MINIMUM TEMPERATURE (°C) FOR A GIVEN RISK

Week Beginning	Lowest Observed	Percentage Risk					Highest Observed
		10	30	50	70	90	
January 1	14·9	16·1	17·3	18·2	19·1	20·4	23·2
January 8	14·0	16·0	17·4	18·3	19·2	20·5	22·4
January 15	13·2	16·1	17·4	18·3	19·2	20·5	22·9
January 22	13·6	16·1	17·4	18·3	19·2	20·5	21·5
January 29	14·8	16·1	17·3	18·2	19·1	20·3	22·5
February 5	14·2	15·9	17·2	18·1	19·0	20·3	22·0
February 12	14·0	15·8	17·1	18·0	18·9	20·2	21·4
February 19	14·2	15·6	15·9	17·8	18·7	20·0	21·9
February 26	13·4	15·2	16·5	17·4	18·2	19·5	20·5
March 5	12·5	14·6	16·0	16·9	17·8	19·2	21·2
March 12	12·7	14·2	15·5	16·3	17·2	18·5	20·5
March 19	11·5	13·4	14·8	15·7	16·6	18·0	19·9
March 26	10·2	12·2	13·7	14·8	15·8	17·3	19·4
April 2	7·8	11·1	12·7	13·8	14·9	16·5	18·3
April 9	6·9	9·7	11·5	12·7	13·8	15·6	17·7
April 16	5·3	8·5	10·3	11·5	12·7	14·5	16·5
April 23	4·4	7·3	9·2	10·4	11·6	13·5	15·8
April 30	4·2	6·3	8·2	9·5	10·8	12·7	16·9
May 7	1·8	5·1	7·1	8·5	9·8	11·9	15·6
May 14	2·0	4·1	6·2	7·6	9·0	11·1	13·2
May 21	0·6	3·3	5·4	6·9	8·4	10·5	15·5
May 28	0·7	2·7	4·8	6·3	7·8	9·9	13·1
June 4	−0·7	2·3	4·4	5·9	7·4	9·6	13·9
June 11	0·3	1·7	4·0	5·6	7·1	9·4	12·1
June 18	−2·3	0·9	3·2	4·9	6·5	8·9	11·5
June 25	−3·8	0·2	2·6	4·3	5·9	8·3	12·7

TABLE 7 DALBY—*continued*

WEEKLY MEAN MINIMUM TEMPERATURE (°C) FOR A GIVEN RISK

Week Beginning	Lowest Observed	Percentage Risk					Highest Observed
		10	30	50	70	90	
July 2	−2·8	0·0	2·4	4·0	5·7	8·1	11·1
July 9	−2·4	−0·1	2·3	3·9	5·5	7·9	12·6
July 16	−2·5	−0·1	2·2	3·8	5·4	7·7	11·0
July 23	−1·8	0·3	2·5	3·9	5·4	7·6	10·9
July 30	−2·8	0·9	2·9	4·3	5·6	7·6	9·8
August 6	−1·7	1·5	3·4	4·7	6·0	7·8	10·1
August 13	−0·1	2·0	3·8	5·1	6·4	8·2	11·1
August 20	−0·4	2·7	4·5	5·7	6·9	8·7	11·6
August 27	−0·1	3·6	5·3	6·5	7·6	9·3	11·5
September 3	−0·9	4·4	6·1	7·3	8·5	10·2	12·2
September 10	2·6	5·3	7·1	8·3	9·4	11·2	12·5
September 17	2·0	6·1	7·8	9·0	10·2	12·0	14·6
September 24	0·2	7·0	8·8	10·0	11·2	12·9	14·3
October 1	−1·0	8·1	9·9	11·1	12·3	14·1	16·1
October 8	4·8	9·3	11·0	12·1	13·2	14·9	17·9
October 15	5·4	10·1	11·7	12·8	13·9	15·4	16·6
October 22	6·5	10·9	12·4	13·5	14·5	16·0	17·0
October 29	9·8	11·7	13·2	14·2	15·2	16·7	18·6
November 5	10·6	12·3	13·8	14·8	15·9	17·4	20·8
November 12	9·8	13·0	14·5	15·5	16·5	17·9	19·8
November 19	11·2	13·7	15·1	16·0	16·9	18·3	21·2
November 26	11·5	14·3	15·6	16·4	17·3	18·6	20·3
December 3	11·4	14·7	16·0	16·9	17·8	19·1	20·2
December 10	12·8	15·2	16·5	17·3	18·2	19·5	22·1
December 17	14·1	15·5	16·8	17·7	18·5	19·8	21·7
December 24	14·2	15·7	17·0	17·9	18·8	20·1	22·3

TABLE 8 EMERALD

Weekly Mean Minimum Temperature (°C) for a Given Risk

Week Beginning	Lowest Observed	Percentage Risk					Highest Observed
		10	30	50	70	90	
January 1	14·1	19·2	20·3	21·1	21·9	23·1	25·7
January 8	11·0	19·2	20·4	21·2	22·1	23·3	24·9
January 15	11·9	19·2	20·4	21·2	22·1	23·3	25·5
January 22	11·0	18·9	20·2	21·1	22·0	23·3	25·4
January 29	10·8	18·8	20·1	21·0	22·0	23·3	25·5
February 5	10·8	18·5	19·9	20·9	21·8	23·2	24·5
February 12	13·3	18·4	19·8	20·8	21·8	23·2	23·8
February 19	11·3	18·3	19·7	20·7	21·7	23·1	24·4
February 26	11·4	17·8	19·3	20·3	21·3	22·8	24·2
March 5	8·8	17·1	18·7	19·8	20·9	22·5	24·3
March 12	8·4	16·5	18·1	19·2	20·4	22·0	23·1
March 19	9·6	15·8	17·4	18·6	19·7	21·4	22·5
March 26	11·4	14·9	16·6	17·8	19·0	20·7	21·8
April 2	9·8	14·2	15·9	17·0	18·1	19·8	20·8
April 9	7·7	12·9	14·7	15·9	17·2	19·0	21·1
April 16	6·8	11·6	13·5	14·8	16·1	17·9	20·8
April 23	5·4	10·4	12·4	13·7	15·0	17·0	19·0
April 30	2·0	9·2	11·3	12·7	14·2	16·3	17·8
May 7	4·5	8·0	10·2	11·7	13·2	15·4	16·9
May 14	2·3	6·9	9·2	10·8	12·3	14·6	18·1
May 21	3·1	6·1	8·4	10·0	11·6	13·9	16·3
May 28	3·5	5·5	7·8	9·4	10·9	13·3	15·2
June 4	2·0	4·9	7·3	8·9	10·5	12·8	16·8
June 11	1·2	4·4	6·8	8·4	10·0	12·4	16·1
June 18	1·6	3·7	6·2	7·9	9·6	12·0	13·5
June 25	−1·5	3·0	5·6	7·4	9·2	11·7	15·8

TABLE 8 EMERALD—*continued*

WEEKLY MEAN MINIMUM TEMPERATURE (°C) FOR A GIVEN RISK

Week Beginning	Lowest Observed	Percentage Risk					Highest Observed
		10	30	50	70	90	
July 2	−0·4	2·9	5·4	7·2	8·9	11·5	13·4
July 9	−1·1	2·5	5·2	7·0	8·8	11·4	14·1
July 16	0·1	2·4	4·9	6·5	8·2	10·7	9·5
July 23	−0·9	2·3	4·7	6·3	8·0	10·3	13·9
July 30	−0·1	2·8	5·1	6·7	8·3	10·6	13·0
August 6	1·3	3·5	5·7	7·3	8·8	11·1	16·1
August 13	0·8	4·3	6·4	7·9	9·4	11·6	14·5
August 20	2·6	5·2	7·3	8·7	10·0	12·2	14·6
August 27	2·1	6·1	8·2	9·6	11·0	13·0	15·6
September 3	5·6	7·2	9·2	10·5	11·8	13·7	15·1
September 10	6·5	8·4	10·2	11·5	12·7	14·6	15·7
September 17	6·0	9·3	11·1	12·3	13·6	15·4	18·9
September 24	8·7	10·3	12·1	13·3	14·6	16·4	19·6
October 1	9·2	11·5	13·2	14·4	15·6	17·4	18·9
October 8	8·8	12·7	14·3	15·5	16·6	18·3	19·7
October 15	11·4	13·6	15·1	16·2	17·3	18·9	20·0
October 22	12·0	14·4	15·9	16·9	18·0	19·5	20·2
October 29	10·3	15·1	16·6	17·6	18·6	20·1	21·9
November 5	12·9	15·8	17·2	18·2	19·1	20·6	22·5
November 12	13·1	16·6	17·9	18·8	19·7	21·0	22·5
November 19	15·7	17·3	18·4	19·3	20·1	21·3	22·3
November 26	15·7	17·7	18·9	19·7	20·5	21·6	22·1
December 3	14·6	18·0	19·2	20·1	21·0	22·2	24·1
December 10	15·2	18·5	19·7	20·5	21·3	22·5	23·4
December 17	12·8	18·7	19·9	20·7	21·5	22·7	24·1
December 24	13·1	18·9	20·0	20·9	21·7	22·8	24·3

TABLE 9 GOONDIWINDI

WEEKLY MEAN MINIMUM TEMPERATURE (°C) FOR A GIVEN RISK

Week Beginning	Lowest Observed	Percentage Risk					Highest Observed
		10	30	50	70	90	
January 1	15·6	17·1	18·6	19·6	20·6	22·1	25·5
January 8	15·5	17·1	18·6	19·7	20·7	22·2	24·9
January 15	14·7	17·2	18·7	19·7	20·7	22·1	25·6
January 22	16·0	17·3	18·7	19·7	20·7	22·1	24·2
January 29	12·1	17·2	18·6	19·5	20·5	21·9	24·0
February 5	14·3	17·1	18·5	19·5	20·4	21·8	24·3
February 12	12·1	16·8	18·3	19·3	20·3	21·8	23·2
February 19	12·0	16·4	17·9	18·9	20·0	21·5	23·3
February 26	11·9	16·1	17·5	18·5	19·4	20·8	21·8
March 5	11·3	15·3	16·9	17·9	18·9	20·4	22·8
March 12	11·1	14·7	16·2	17·3	18·3	19·8	23·0
March 19	7·9	14·1	15·5	16·6	17·6	19·0	21·3
March 26	10·1	13·0	14·6	15·6	16·7	18·2	20·3
April 2	8·7	12·0	13·6	14·6	15·7	17·2	20·1
April 9	8·4	10·8	12·4	13·5	14·5	16·1	17·8
April 16	7·1	9·6	11·2	12·3	13·3	14·9	17·8
April 23	5·4	8·2	9·9	11·1	12·3	14·0	15·8
April 30	4·9	7·2	9·0	10·2	11·4	13·2	15·0
May 7	4·2	5·9	7·9	9·2	10·5	12·4	14·5
May 14	3·0	4·9	6·9	8·3	9·7	11·7	14·5
May 21	1·4	4·0	6·1	7·6	9·0	11·1	15·3
May 28	−1·5	3·4	5·5	6·9	8·3	10·3	11·9
June 4	−1·7	3·0	5·0	6·5	7·9	10·0	13·8
June 11	−0·5	2·6	4·7	6·2	7·6	9·7	12·4
June 18	−0·6	1·9	4·1	5·6	7·1	9·3	11·8
June 25	−4·5	1·4	3·6	5·1	6·6	8·7	11·8

TABLE 9 GOONDIWINDI—*continued*

WEEKLY MEAN MINIMUM TEMPERATURE (°C) FOR A GIVEN RISK

Week Beginning	Lowest Observed	Percentage Risk					Highest Observed
		10	30	50	70	90	
July 2	−2·7	1·3	3·4	4·9	6·3	8·5	11·8
July 9	−2·1	1·2	3·2	4·6	6·0	8·1	12·3
July 16	−0·9	1·2	3·1	4·4	5·7	7·7	13·8
July 23	−1·1	1·5	3·4	4·7	5·9	7·8	10·6
July 30	−1·2	2·0	3·8	5·0	6·2	8·0	9·8
August 6	1·2	2·7	4·3	5·5	6·7	8·4	9·7
August 13	1·3	3·0	4·7	5·9	7·1	8·8	10·7
August 20	1·2	3·7	5·4	6·6	7·7	9·4	11·2
August 27	2·8	4·5	6·1	7·2	8·3	9·9	12·9
September 3	4·3	5·3	6·9	8·0	9·1	10·8	13·7
September 10	2·7	6·1	7·8	9·0	10·2	11·8	13·7
September 17	3·8	6·8	8·5	9·7	10·9	12·7	14·3
September 24	4·1	7·7	9·5	10·7	11·9	13·7	15·1
October 1	6·4	8·9	10·6	11·9	13·1	14·8	18·2
October 8	7·3	10·1	11·7	12·8	13·9	15·6	18·0
October 15	9·6	11·0	12·5	13·5	14·6	16·1	18·0
October 22	10·6	11·7	13·2	14·3	15·3	16·9	18·4
October 29	8·8	12·4	14·0	15·1	16·2	17·8	19·8
November 5	10·6	13·1	14·7	15·8	16·9	18·6	21·8
November 12	10·0	13·9	15·5	16·6	17·6	19·2	21·1
November 19	12·7	14·5	16·0	17·1	18·1	19·7	23·1
November 26	13·1	15·1	16·6	17·6	18·6	20·1	22·2
December 3	13·4	15·5	17·0	18·0	19·1	20·5	21·5
December 10	12·4	16·1	17·6	18·6	19·6	21·0	23·1
December 17	15·1	16·5	18·0	19·1	20·0	21·5	23·1
December 24	15·5	16·8	18·3	19·3	20·4	21·9	25·5

TABLE 10 ROMA

WEEKLY MEAN MINIMUM TEMPERATURE (°C) FOR A GIVEN RISK

Week Beginning	Lowest Observed	Percentage Risk					Highest Observed
		10	30	50	70	90	
January 1	15·0	17·4	19·0	20·1	21·1	22·7	25·6
January 8	15·8	17·5	19·1	20·1	21·2	22·7	25·2
January 15	15·3	17·6	19·1	20·1	21·2	22·7	24·6
January 22	15·4	17·6	19·1	20·1	21·1	22·6	23·9
January 29	14·4	17·5	19·0	20·0	21·0	22·5	24·4
February 5	14·2	17·3	18·8	19·9	20·9	22·4	24·6
February 12	15·7	17·2	18·7	19·7	20·7	22·3	23·3
February 19	13·3	16·6	18·2	19·3	20·5	22·1	24·5
February 26	12·2	16·2	17·8	18·8	19·9	21·5	22·2
March 5	11·7	15·3	17·0	18·2	19·3	21·0	22·9
March 12	10·8	14·7	16·3	17·5	18·7	20·3	23·3
March 19	12·1	14·0	15·6	16·8	17·9	19·6	21·2
March 26	9·9	12·9	14·6	15·8	17·0	18·8	22·3
April 2	6·9	11·8	13·6	14·8	16·0	17·8	23·9
April 9	6·6	10·2	12·1	13·5	14·8	16·8	22·2
April 16	4·9	8·5	10·6	12·1	13·5	15·7	19·7
April 23	4·6	6·9	9·2	10·8	12·4	14·7	17·3
April 30	3·2	5·8	8·2	9·8	11·5	13·9	18·3
May 7	2·3	5·0	7·3	8·8	10·4	12·7	17·9
May 14	0·7	4·3	6·5	8·0	9·4	11·7	13·9
May 21	0·9	3·2	5·4	6·9	8·5	10·7	13·5
May 28	−0·7	1·9	4·2	5·8	7·4	9·8	12·8
June 4	−1·2	1·4	3·8	5·5	7·1	9·5	14·0
June 11	−0·5	1·1	3·5	5·2	6·9	9·4	13·2
June 18	−1·1	0·4	3·0	4·7	6·5	9·0	12·6
June 25	−4·8	−0·1	2·5	4·2	6·0	8·6	12·4

TABLE 10 ROMA—*continued*

WEEKLY MEAN MINIMUM TEMPERATURE (°C) FOR A GIVEN RISK

Week Beginning	Lowest Observed	Percentage Risk					Highest Observed
		10	30	50	70	90	
July 2	−2·6	−0·1	2·4	4·1	5·7	8·2	11·1
July 9	−3·0	−0·2	2·2	3·8	5·4	7·8	9·6
July 16	−4·3	−0·3	2·0	3·6	5·2	7·5	14·0
July 23	−2·8	0·2	2·3	3·8	5·3	7·5	11·4
July 30	−1·4	0·6	2·8	4·3	5·7	7·9	10·4
August 6	−3·2	1·1	3·3	4·7	6·2	8·4	14·5
August 13	−1·7	1·6	3·8	5·3	6·8	9·0	11·2
August 20	0·3	2·5	4·6	6·1	7·5	9·7	11·5
August 27	−0·9	3·1	5·4	6·9	8·4	10·6	14·2
September 3	1·4	4·2	6·3	7·8	9·3	11·5	14·2
September 10	2·4	5·3	7·4	8·8	10·3	12·3	15·0
September 17	3·1	6·2	8·2	9·7	11·1	13·2	14·0
September 24	2·6	7·2	9·3	10·8	12·2	14·3	15·9
October 1	6·0	8·5	10·6	12·0	13·4	15·5	19·1
October 8	5·2	9·9	11·8	13·1	14·4	16·3	19·1
October 15	8·2	10·9	12·7	13·9	15·1	16·8	17·7
October 22	8·1	11·8	13·5	14·7	15·9	17·6	19·6
October 29	7·6	12·5	14·3	15·5	16·8	18·6	22·4
November 5	8·3	13·1	14·9	16·2	17·4	19·2	21·9
November 12	10·7	14·0	15·7	16·9	18·1	19·7	21·7
November 19	13·0	14·7	16·4	17·5	18·6	20·3	21·2
November 26	13·1	15·3	17·0	18·1	19·2	20·8	22·7
December 3	11·9	15·6	17·3	18·5	19·6	21·3	26·6
December 10	13·9	16·2	17·8	19·0	20·1	21·7	28·4
December 17	12·3	16·5	18·2	19·4	20·5	22·2	26·1
December 24	13·6	16·8	15·2	19·7	20·9	22·6	26·3

Appendix 3

Tables of the probability of at least 1 day, 2 consecutive days or 3 consecutive days in a given week at or below the given temperature.

TABLE 11. CHARLEVILLE—FROST OCCURRENCE AND DURATION PROBABILITIES (%)

Temperature °C	3			2			1			0			−1			−2		
Week Beginning	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days
March 26 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 16	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 23	8	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
April 30	10	4	1	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0
May 7	25	10	5	19	6	3	6	3	1	5	1	0	1	0	0	0	0	0
May 14	42	22	10	25	9	1	5	3	1	4	1	1	1	1	0	1	0	0
May 21	44	27	19	28	20	14	19	14	5	15	9	1	4	3	0	3	0	0
May 28	57	44	23	39	24	13	30	15	4	23	8	1	11	4	0	5	3	0
June 4	62	38	27	43	25	16	27	15	8	18	10	5	8	4	0	1	1	0
June 11	70	52	35	57	39	22	41	19	10	25	11	5	8	1	0	4	0	0
June 18	71	53	34	59	44	25	52	32	15	39	27	13	28	11	6	13	6	3
June 25	78	62	42	70	52	34	58	43	22	46	28	13	30	14	5	16	8	1
July 2	86	73	54	78	59	34	65	48	23	54	35	18	41	19	10	19	9	4
July 9	86	71	54	76	56	42	65	43	29	56	33	23	38	22	11	22	11	5
July 16	89	77	61	82	70	44	68	54	27	63	43	14	41	24	13	22	15	8
July 23	86	71	57	81	58	43	70	41	30	54	28	20	34	22	9	16	9	3
July 30	87	68	51	77	59	37	63	38	24	47	27	14	28	14	6	8	5	1

TABLE 11. CHARLEVILLE—FROST OCCURRENCE AND DURATION PROBABILITIES (%)—*continued*

Temperature °C	3			2			1			0			−1			−2		
Week Beginning	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days
August 6 ..	86	66	32	71	46	20	53	25	9	43	19	6	23	8	4	8	4	0
August 13 ..	80	58	37	65	38	25	38	23	13	25	15	8	18	6	1	6	3	1
August 20 ..	70	39	25	47	25	16	32	18	8	22	10	5	15	4	3	1	0	0
August 27 ..	65	41	19	42	20	8	18	6	0	10	3	0	4	3	0	0	0	0
September 3 ..	43	22	9	20	6	1	6	3	0	4	1	0	3	0	0	0	0	0
September 10 ..	22	8	3	13	3	1	3	0	0	1	0	0	0	0	0	0	0	0
September 17 ..	18	4	0	8	0	0	4	0	0	1	0	0	0	0	0	0	0	0
September 24 ..	13	1	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 1 ..	8	4	1	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0
October 8 ..	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 15 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 22 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 29 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November 5 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 12. DALBY—FROST OCCURRENCE AND DURATION PROBABILITIES (%)

Temperature °C	3			2			1			0			−1			−2		
Week Beginning	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days
March 26 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 9	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 16	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 23	14	6	2	7	4	1	2	0	0	0	0	0	0	0	0	0	0	0
April 30	20	4	1	11	1	0	5	0	0	1	0	0	0	0	0	0	0	0
May 7	30	17	5	23	11	1	13	4	0	7	4	0	2	1	0	1	1	0
May 14	46	24	10	35	14	6	20	6	1	14	0	0	1	0	0	1	0	0
May 21	44	29	23	27	23	19	25	14	6	18	11	1	6	1	0	1	0	0
May 28	67	40	21	45	30	14	32	18	7	24	13	4	13	6	1	6	4	0
June 4	67	44	24	54	35	13	42	20	8	31	15	7	25	8	0	10	1	0
June 11	64	45	29	55	37	21	43	25	11	37	21	10	20	13	7	12	4	1
June 18	69	57	40	62	46	26	55	35	19	44	25	11	33	17	1	25	6	1
June 25	82	61	42	75	54	32	62	40	21	54	35	20	44	21	11	30	11	2
July 2	90	71	54	86	64	42	76	51	29	70	40	23	55	19	11	36	8	4
July 9	82	62	50	74	54	42	67	50	31	61	39	21	43	23	12	29	11	6
July 16	87	76	60	81	68	48	70	57	27	65	42	19	50	29	11	33	14	6
July 23	83	64	52	77	57	39	63	49	24	58	38	18	48	26	11	33	14	7
July 30	88	65	49	74	57	39	64	46	27	60	35	18	39	15	6	19	4	2
August 6 ..	86	64	27	74	45	19	65	30	6	58	21	5	31	7	2	12	1	1
August 13 ..	86	61	35	69	51	24	56	37	14	44	26	10	26	12	1	8	1	0
August 20 ..	69	48	27	60	39	15	43	20	8	30	11	7	18	5	1	6	0	0

TABLE 12. DALBY—FROST OCCURRENCE AND DURATION PROBABILITIES (%)—*continued*

Temperature °C	3			2			1			0			−1			−2		
Week Beginning	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days
August 27 ..	69	32	23	49	24	11	30	8	4	20	6	2	6	4	1	5	0	0
September 3 ..	56	24	7	40	10	5	26	5	2	13	2	1	4	1	0	1	1	0
September 10 ..	32	6	5	18	2	2	8	2	1	5	1	0	2	0	0	1	0	0
September 17 ..	33	14	2	19	5	1	6	1	0	4	1	0	0	0	0	0	0	0
September 24 ..	17	7	1	11	2	1	6	2	1	4	2	1	2	1	1	1	1	1
October 1 ..	13	5	1	7	2	1	4	1	1	2	1	1	1	1	1	1	1	1
October 8 ..	4	2	1	2	1	0	1	0	0	1	0	0	0	0	0	0	0	0
October 15 ..	2	1	0	1	1	0	1	1	0	1	1	0	0	0	0	0	0	0
October 22 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 29 ..	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November 5 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 13. EMERALD—FROST OCCURRENCE AND DURATION PROBABILITIES (%)

Temperature °C	3			2			1			0			−1			−2		
Week Beginning	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days
March 26 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 23	3	1	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0
April 30	5	1	1	3	1	0	1	0	0	1	0	0	0	0	0	0	0	0
May 7	5	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May 14	9	5	1	5	3	1	1	1	0	0	0	0	0	0	0	0	0	0
May 21	18	8	4	10	3	1	4	0	0	4	0	0	1	0	0	0	0	0
May 28	23	8	0	10	3	0	5	1	0	4	0	0	1	0	0	0	0	0
June 4	38	20	5	20	9	1	14	4	1	11	4	0	5	0	0	0	0	0
June 11	35	23	13	29	14	6	13	5	4	6	4	3	3	3	0	3	0	0
June 18	52	28	13	32	18	6	17	10	1	13	6	0	6	3	0	3	0	0
June 25	54	30	20	38	20	13	27	15	6	20	8	5	9	5	5	4	1	1
July 2	58	37	20	39	28	14	24	18	8	20	13	5	14	9	3	8	3	1
July 9	61	41	23	47	27	18	35	14	10	27	9	4	14	3	1	3	0	0
July 16	59	42	29	48	34	19	43	23	11	33	16	8	19	13	3	9	4	0
July 23	66	47	32	57	34	19	42	19	8	33	11	6	16	6	3	4	1	0
July 30	66	43	29	44	29	16	33	15	8	25	8	4	13	3	3	4	1	0
August 6 ..	54	29	15	41	19	10	24	8	1	13	5	0	8	1	0	1	0	0
August 13 ..	41	22	14	27	14	5	15	8	3	11	5	3	6	3	3	3	3	1
August 20 ..	30	11	3	22	5	0	6	0	0	5	0	0	3	0	0	0	0	0

TABLE 13. EMERALD—FROST OCCURRENCE AND DURATION PROBABILITIES (%)—*continued*

Temperature °C	3			2			1			0			−1			−2		
Week Beginning	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days
August 27 ..	15	8	3	9	5	3	4	3	0	4	1	0	1	0	0	1	0	0
September 3 ..	9	3	0	3	1	0	1	1	0	1	1	0	1	0	0	0	0	0
September 10 ..	9	1	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
September 17 ..	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
September 24 ..	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 1 ..	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 8 ..	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 15 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 22 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 29 ..	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November 5 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 14. GOONDIWINDI—FROST OCCURRENCE AND DURATION PROBABILITIES (%)

Temperature °C	3			2			1			0			−1			−2		
Week Beginning	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days
March 26 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 23	5	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 30	6	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
May 7	19	6	1	9	3	1	1	1	0	1	1	0	1	0	0	0	0	0
May 14	35	14	1	18	1	0	9	0	0	4	0	0	1	0	0	0	0	0
May 21	44	20	9	25	11	4	11	5	1	8	0	0	4	0	0	0	0	0
May 28	49	29	13	37	10	3	18	6	1	11	4	1	4	1	1	3	1	1
June 4	58	33	24	39	18	11	24	8	3	20	5	3	13	3	1	1	1	1
June 11	61	37	22	49	19	11	28	13	4	20	9	4	9	4	0	4	1	0
June 18	59	46	29	48	32	16	38	19	5	30	9	4	22	3	0	9	0	0
June 25	75	47	28	61	33	16	41	22	8	38	18	4	24	6	1	9	3	1
July 2	80	62	42	68	51	29	57	34	22	52	23	14	33	11	4	13	4	3
July 9	75	51	37	66	42	27	47	22	16	38	18	14	22	13	8	11	3	1
July 16	90	76	51	76	51	28	57	33	13	49	22	11	29	9	1	9	4	0
July 23	85	65	42	68	44	23	48	29	8	37	19	4	22	10	1	11	3	0
July 30	80	57	42	68	43	20	48	16	5	43	11	4	16	3	1	4	0	0
August 6 ..	81	41	19	65	32	11	42	13	4	39	11	4	13	1	0	3	0	0
August 13 ..	73	49	28	56	28	15	37	10	0	32	5	0	16	0	0	1	0	0
August 20 ..	53	25	13	34	17	8	19	8	3	14	3	0	5	0	0	1	0	0

TABLE 14. GOONDIWINDI—FROST OCCURRENCE AND DURATION PROBABILITIES (%)—*continued*

Temperature °C	3			2			1			0			−1			−2		
Week Beginning	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days
August 27 ..	49	27	14	30	6	3	11	1	0	8	1	0	3	0	0	0	0	0
September 3 ..	35	8	4	13	3	1	4	3	1	4	1	1	3	0	0	1	0	0
September 10 ..	24	4	3	9	1	0	5	0	0	3	0	0	0	0	0	0	0	0
September 17 ..	11	0	0	4	0	0	3	0	0	3	0	0	0	0	0	0	0	0
September 24 ..	14	4	0	8	3	0	5	0	0	1	0	0	0	0	0	0	0	0
October 1 ..	5	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
October 8 ..	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 15 ..	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 22 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 29 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November 5 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 15. ROMA—Frost Occurrence and Duration Probabilities (%)

Temperature °C	3			2			1			0			−1			−2		
Week Beginning	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days
March 26 ..	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 9	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 16	4	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April 23	14	10	3	11	4	0	1	0	0	0	0	0	0	0	0	0	0	0
April 30	25	9	6	9	3	0	3	0	0	1	0	0	1	0	0	0	0	0
May 7	29	14	9	20	9	4	9	4	1	6	4	1	4	0	0	1	0	0
May 14	49	24	10	33	11	4	11	4	0	6	1	0	1	0	0	0	0	0
May 21	49	33	24	41	20	13	23	9	4	18	8	1	8	3	0	1	1	0
May 28	70	46	22	52	32	11	32	18	8	23	14	6	15	5	1	8	4	0
June 4	73	49	32	59	38	18	43	24	11	35	19	10	22	10	5	9	6	3
June 11	67	52	34	57	41	27	47	29	22	37	25	18	30	18	6	15	4	3
June 18	80	56	39	68	51	33	59	42	23	54	35	15	44	20	3	19	6	0
June 25	84	66	47	76	54	34	62	46	25	57	38	24	43	29	13	24	10	1
July 2	94	67	49	90	61	41	68	48	28	59	39	20	47	20	13	33	11	6
July 9	82	66	47	75	54	43	63	46	37	56	44	28	46	30	15	33	18	8
July 16	86	77	54	80	70	47	77	63	38	72	53	30	57	37	17	34	19	5
July 23	91	72	52	80	66	44	75	54	30	71	46	25	44	27	13	27	16	8
July 30	86	67	44	80	61	37	63	49	27	54	38	15	39	20	6	14	6	3
August 6 ..	84	65	39	72	52	19	61	43	16	51	27	11	33	14	5	14	4	1
August 13 ..	82	65	43	68	47	29	53	34	19	44	28	13	27	15	6	15	9	5
August 20 ..	68	43	22	53	28	16	43	16	8	34	13	6	18	9	3	6	0	0

TABLE 15. ROMA—FROST OCCURRENCE AND DURATION PROBABILITIES (%)—*continued*

Temperature °C	3			2			1			0			−1			−2		
Week Beginning	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days	At Least 1 Day	2 Consec. Days	3 Consec. Days
August 27 ..	70	35	25	54	30	14	43	16	8	28	11	3	14	5	1	5	3	1
September 3 ..	58	32	11	41	18	9	22	9	3	13	5	3	5	1	1	3	0	0
September 10 ..	41	14	6	24	9	4	10	3	1	5	3	1	1	1	1	1	0	0
September 17 ..	32	14	3	23	4	1	6	1	0	3	0	0	0	0	0	0	0	0
September 24 ..	22	11	4	11	4	4	4	3	1	3	0	0	0	0	0	0	0	0
October 1 ..	15	4	1	9	3	0	1	0	0	0	0	0	0	0	0	0	0	0
October 8 ..	3	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 15 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 22 ..	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October 29 ..	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November 5 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Wheat and barley planting guide—1978

THERE are five quick-maturing, one slow-maturing and three midseason wheat varieties recommended for sowing in 1978.

The recommendations are based on trial results, field performance and susceptibility to disease.

The quick-maturing varieties are Cook, Gatcher, Kite, Songlen and Timgalen. The midseason varieties are Oxley, Shortim and Timson and the slow-maturing variety is Hopps.

All these varieties except Oxley and Hopps have effective resistance to stem rust. A new race of stem rust was found in a few late crops of Oxley in 1976 and 1977, and it is anticipated that this race will become more widespread in the future, causing some yield loss in years favouring rust development.

The varieties differ in their susceptibility to leaf rust. Timson is fully resistant to all races, and Songlen to all but one new race which is not yet widespread in Queensland. Oxley has a useful level of field resistance to leaf rust. Of the other varieties, Kite is the most susceptible.

Cook, Gatcher, Oxley, Shortim, Songlen and Timgalen may be classified Prime Hard; Kite and Timson are restricted to the No. 1 Hard classification, and Hopps has been deleted by the State Wheat Board from varieties attracting any premium.

Gamut is not a recommended variety and has also been deleted by the State Wheat Board from Prime Hard, but is eligible for No. 1 Hard classification.

To reduce production risks arising from disease or adverse weather conditions, growers should plant at least three varieties.

Compiled by S. R. Walsh, Agriculture Branch.

Notes on the varieties

Quick-maturing varieties

Cook is a quick-maturing, awned variety released from the Queensland Wheat Research Institute by the Department of Primary Industries. It is resistant to stem rust and has some tolerance to crown rot.

Cook is slightly shorter in height than Timgalen (one of its parents) and the grain has Prime Hard quality, with high volume weight and excellent appearance. It appears less susceptible to grain bleaching than Timgalen and Gatcher.

The straw is very fine and somewhat susceptible to lodging.

Cook has combined disease resistance with high yield and high grain quality.

Gatcher is a quick-maturing, awned variety of medium height which produces good quality grain. It is a widely grown variety and has performed well in commercial production, particularly in the more marginal wheat growing areas. However, it appears more subject to nutritional disorders than other varieties and is not recommended for some soils of the plains area of the Darling Downs. Gatcher appears more susceptible to yellow spot than other recommended varieties.

Kite is a semi-dwarf, awnless variety released by the N.S.W. Department of Agriculture. It is highly resistant to stem rust but susceptible to leaf rust. It has yielded well in trials and commercial plantings. Kite is harder to thresh than Mendos, but is an alternative to this variety in the western areas if an awnless variety is required so that it can be grazed in the event of a crop failure. Kite has certain quality defects and is not accepted into the Prime Hard classification.

Songlen is a new, quick-maturing, semi-dwarf wheat released by the University of Sydney. It is an awned variety very similar in general appearance to Timgalen (one of its parents) but has improved resistance to both stem and leaf rust. To date, the yield performance has averaged a little better than Timgalen, but the variety is susceptible to frosting in the early growth stages. The quality of Songlen appears to be at least equal to that of Timgalen.

Timgalen is a medium-early, awned variety of medium height with strong tillering characteristics. The variety has good grain quality, and is renowned for its high protein content. It has some tolerance to crown rot.

Midseason and slow-maturing varieties

Midseason varieties are recommended on a more restricted basis than the quick-maturing varieties. They are intended for planting early when suitable rains occur. Except in very reliable districts, or under irrigation, their performance may be poor when sown late.

Hopps is a dual purpose variety, which has adult plant resistance to stem rust and is recommended for certain coastal and sub-coastal situations only.

Oxley is a semi-dwarf, awned variety of high potential. With mild conditions in the month after planting, Oxley will behave as a mid-season variety, but if cold conditions are experienced early in the crop growth, it may then act as a quick-maturing type with maturity similar to Timgalen.

Oxley is intended mainly for planting late May and June on the Darling Downs. It may be sown somewhat earlier in the more northern and inland areas, but is definitely not suitable for late sowing in these districts.

Oxley is now susceptible to stem rust and some modification of planting strategy may be necessary particularly on the Darling Downs. Growers should not plant a large proportion of their wheat area to Oxley. Some should be replaced with a stem rust resistant variety such as Cook or Kite.

Late planting of Oxley should be avoided in all districts.

Shortim was released in 1977 by the University of Sydney Plant Breeding Institute. It is a semi-dwarf, awned variety with a similar maturity to Oxley. It is resistant to all field races of stem rust at present in Queensland and has some tolerance to crown rot.

Shortim is shorter in height than Oxley. It is not recommended for the western districts except when it is grown under irrigation. Under rain-grown conditions it may also have a slightly lower yield than Oxley. The area to which it is best suited is the Darling Downs, for sowing in late May-June.

Supplies of seed for commercial sowing will be limited in the 1978 season.

Timson is a new, awned semi-dwarf wheat bred by the University of Sydney Plant Breeding Institute. Seed supply of this variety in 1978 will be limited. In Departmental tests, Timson has not yielded as well as Oxley or Shortim. On the other hand, it is resistant to all stem and leaf rust strains at present in Queensland. Timson has certain grain quality defects and therefore is not accepted into the Prime Hard classification.

Grain quality

Premiums for Prime Hard and No. 1 Hard classification for 1978–1979 will be paid by the State Wheat Board only on the following varieties:—

Prime Hard

- Cook
- Gatcher
- Mendos
- Oxley
- Shortim
- Songlen
- Spica
- Timgalen

No. 1 Hard

- Gamut
- Kite
- Timson

Recommendations

Varieties are listed in this table in order of preference for the particular regions.

Region	Planting Guide	
Capricornia	(Livingstone, Fitzroy, Broadsound, Calliope, Nebo, Emerald, Peak Downs, Belyando, Bauhinia, Banana, Duaringa Shires)	
	Mid April-May	Oxley, Timson
	May-June	Gatcher, Cook, Kite, Songlen, Timgalen
	Irrigated:	All varieties including Shortim: Planting time as for rain-grown.
Burnett	(Miriam Vale, Kolan, Gooburrum, Woongara, Isis, Perry, Biggenden, part Tiaro, Woocoo, Hervey Bay, Monto, Eidsvold, Gayndah, Mundubbera Shires)	
	Late April-May	Oxley, Timson
	May-June	Cook, Kite, Songlen, Timgalen, Gatcher
South Burnett	(Kingaroy, Nanango, Wondai, Murgon, Kilkivan, part Rosalie Shires)	
	Mid May-mid June	Shortim, Oxley, Timson
	Late May-July	Cook, Kite, Songlen, Timgalen, Gatcher
Near North Coast	(Widgee, Noosa, part Tiaro, Maroochy, Landsborough Shires)	
	April-May	Hopps (dual purpose)
	May-June	Cook, Kite, Songlen, Timgalen, Gatcher
East and West Moreton	(Caboolture, Pine Rivers, Redlands, Albert, Beaudesert, Moreton, Esk, Kilcoy, Boonah, Gatton, Laidley Shires)	
	April	Hopps (grazing)
	May	Shortim, Oxley, Timson
	Late May-June	Cook, Kite, Songlen, Timgalen, Gatcher, Shortim
	July	Cook, Gatcher
Darling Downs	(Wambo, Chinchilla Shires)	
	May-early June	Shortim, Oxley, Timson
	June-July	Cook, Kite, Songlen, Timgalen, Gatcher
	(Pittsworth, Millmerran, Jondaryan, Crows Nest, part Rosalie, Cambooya, Clifton, Allora, Glengallan, Rosenthal, Stanthorpe, Inglewood Shires)	
	Late May-June	Shortim, Oxley, Timson
	June-July	Cook, Kite, Songlen, Timgalen, Gatcher
	Note:	Shortim is NOT recommended for the Chinchilla and Inglewood Shires. Gatcher is NOT recommended for some soils on the plains.
	Irrigated:	All varieties including Shortim: Planting time as for rain-grown.

Region	Planting guide	
Near South-west	(Waggamba, Balonne, Murilla, Tara, Taroom, Bungil, Bendemere, Warroo Shires)	
	Late April-mid May	Oxley, Timson
	Mid May-June	Gatcher, Cook, Kite, Songlen, Timgalen
	Irrigated:	All varieties: Planting time as for rain-grown.

Planting rate and depth

The planting rate for wheat ranges from 25 to 50 kg per ha for rain-grown conditions but should be increased to 60 to 70 kg per ha when grown under irrigation. These rates should be adjusted to the region, soil type, available soil moisture, planting time and variety. The planting rate of a high tillering, small-seeded variety such as Timgalen or Cook could be reduced by 15%. The rate should be increased by 6 to 10 kg per ha for each month planting is delayed after the optimum planting time.

The planting rate is closely dependent on local conditions and your Shire Agricultural Extension Officer should be consulted.

It should be noted that the semi-dwarf characteristics of Cook, Kite, Oxley, Shortim and Songlen may result in poor plant emergence if deep planting is practised. The maximum planting depth for these varieties is 10 cm.

Fertilizer

The type and rate of fertilizer is related to soil type, available soil moisture, cropping history and planting time; consult your Shire Agricultural Extension Officer.

Planting strategy

Mr David Woodruff of the Queensland Wheat Research Institute has collated information on varietal performance as related to cropping history, soil type, soil moisture, soil fertility, planting time and planting rate. Using this data together with rainfall probabilities, crop performance can be reasonably predicted. Your Shire Agricultural Extension Officer can give guidance on how to make this prediction.

Barley

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

About 195 000 hectares were registered with the Barley Marketing Board in 1977 for a production of about 165 000 tonnes.

Clipper is the only barley variety that the Barley Marketing Board will accept for classification as Malt or Manufacturing. Other varieties such as Corvette, Prior, Maris Baldric, Zephyr, and Lara will only be accepted as feed classification. Corvette has also shown promise as a grazing variety.

When sown for grain, barley is planted in the May to July period in the main areas. The earlier planting will mature in the cooler temperatures and produce a better malt quality grain. Frost 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; the late planting in August will only provide a limited quantity of forage.

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

Be tempted with asparagus

WHEN the endless crunch of lettuce becomes a bore and your conscience tires of acting referee between the need to shed your waistline and a desire to raid the pantry, then take a suggestion from the ancient Greeks and Romans.

Treat yourself to something delicious, low in calories and with enough vitamins to justify a splurge—fresh, green asparagus. Once considered by these people to have health giving properties, asparagus is still regarded with esteem, not only by the calorie conscious, but also by gourmets throughout the world.

If you are dieting, try it with a little lemon dressing, a tub of cottage cheese and a wedge of tomato—it makes a great change from crackers.

And when you have reached your weight target and deserve a reward, or if you happen to be one of the lucky ones who can stay trim without dieting, then tempt yourself to a few of the combinations below, you will be delighted.

Dilled asparagus creamer

Standard 250 ml measuring cup and 20 ml tablespoon are used. All measurements are level.

1 x 310 g can asparagus tips

1 x 125 g packet Australian cream cheese

2 tablespoons chopped spring onions

½ cup sour cream

¼ teaspoon dill salt

1 teaspoon salt

¼ teaspoon ground black pepper

Recipes provided by the Dairy Foods Advisory Bureau.

Beefball orientale.

Combine all ingredients together in a vitamizer. Blend at high speed till well mixed. Pour into a serving bowl. Chill thoroughly. Accompany with a selection of dippers (crisp, salted crackers; celery or cucumber sticks; carrot rings or raddish slices). Makes 1½ cups.

Lemoned chicken pancakes

Standard 250 ml measuring cup and 20 ml tablespoon are used. All measurements are level.

8 x 15 cm pancakes
1½ cups chopped, cooked chicken
1 x 310 g can asparagus cuts, drained, liquid reserved

THE SAUCE

2 tablespoons butter

2 tablespoons flour

1 cup coarsely grated Australian matured cheddar cheese.

2 teaspoons finely grated lemon rind

Melt butter in a heavy-based saucepan. Stir in flour. Cook for 2 minutes without colouring. Whisk in the asparagus liquid, made up to 1 cup with cold water. Bring to boiling point while stirring constantly. Allow sauce to simmer for 3 minutes. Add grated Cheddar and lemon rind. Stir till cheese melts. Reserve ¼ cup sauce. Stir chicken and asparagus into remaining sauce. Divide chicken mixture evenly between pancakes. Roll pancakes loosely and arrange on a serving platter. Cover with aluminium foil and heat in the oven at 180°C for 15 minutes. Reheat reserved sauce and pour over pancakes to serve. Serve as an entree or light luncheon dish. Serves 4.

Beefball orientale

Standard 250 ml measuring cup and 20 ml tablespoon are used. All measurements are level.

THE MEATBALLS

125 g Australian Gouda cheese, cut into 1 cm cubes

Mix together in a large bowl:

500 g finely minced steak

1 egg, lightly beaten

1 cup fresh breadcrumbs

1 tablespoon prepared hot English mustard

1 teaspoon salt

freshly ground black pepper to taste

Roll meatball mixture into balls, approximately 3 cm diameter, enclosing a cube of cheese in the centre of each ball.

4 tablespoons butter

¾ cup spring onions, sliced into 2 cm lengths

1 small red pepper, cut into thin strips

1 cup beanshoots

1½ cups fresh asparagus, cut into 1 cm thick diagonal slices

1¾ cups stock, made with 2 chicken stock cubes

1 teaspoon soy sauce (or to taste)

1 tablespoon cornflour, mixed with

¼ cup water

Melt one tablespoon butter in a heavy based frypan. Add onion, pepper and beanshoots. Saute until vegetables are cooked but still slightly crisp. Remove with a slotted spoon and keep warm. Melt a further one tablespoon butter. Add asparagus. Cook till tender. Remove and add to other vegetables. Add remaining two tablespoons butter to pan. Cook meatballs till browned and cooked through. Shaking pan occasionally to prevent sticking. Add stock to pan. Heat till simmering. Stir in cornflour and water. Return vegetables to pan. Simmer 3-4 minutes or till heated through. Add soy sauce and additional seasonings to taste. Serves 4.

Asparagus 'n' cod supreme

Standard 250 ml measuring cup and 20 ml tablespoon are used. All measurements are level.

1 x 310 g can asparagus spears, drained, juice reserved

6 smoked cape cod fillets, approximately 125 g each

1 medium lemon, thickly sliced

1 small onion, thickly sliced

2 sprigs parsley

1 bay leaf

½ teaspoon coarsely ground black pepper

1 medium apple, ½ grated, remainder reserved for garnish

125 g Australian Swiss cheese, coarsely grated

1 tablespoon cornflour

salt and pepper to taste

Make up reserved asparagus liquid to 2 cups with water. Pour into a large, covered frypan or shallow saucepan. Add fish fillets, lemon, onion, parsley, bay leaf and pepper. Simmer approximately 5 minutes or till fish is tender and flakes easily. Remove fish to a heated serving platter. Arrange asparagus on top. Keep warm. Strain fish stock through a fine sieve. Return ¾ cup liquid to the pan. Add grated apple. Heat till simmering. Toss cheese and cornflour together. Add to simmering liquid a little at a time, stirring well after each addition. Season sauce to taste. Pour over fish fillets. Garnish with slices of reserved apple. Serves 6.

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Some Queensland butterflies

BUTTERFLIES belong to the insect order Lepidoptera, which also includes the moths.

These insects are characterized by having the body and wings covered with over-lapping scales. These scales are actually flattened hairs and are often brightly coloured and arranged in delicate patterns, making the lepidoptera some of the most attractive insects of all.

The butterflies shown here exhibit some of the beauty around us but which many never see.

• *Papilio ulysses*. There are 15 subspecies of this remarkable butterfly distributed throughout Queensland, New Guinea, the Solomon Islands and nearby areas. The Australian subspecies occurs from Cape York to the Mackay area.

The photograph is of a male, the female being duller and having smaller blue markings.

The ulysses butterfly is never found far from rainforest where its larval host plant grows, and the blue insect makes an impressive sight against the dark green forest. This insect has been added to the list of protected fauna in Queensland. It is an offence to collect specimens.

• *Ornithoptera priamus*. This specimen is also a male. The female of the Cairns birdwing is much larger and lacks the metallic green markings. In fact, the two sexes bear very little resemblance, the female being dull black with white and yellow markings on the wings. Its distribution is similar to the ulysses, although its southern limit in Australia is in the N.S.W.-Queensland border ranges.

This species is also protected under Queensland's fauna laws. An insect of the rainforests, the larvae feed on *Aristolochia* vines growing in the canopy. While the females may lay eggs on the introduced Dutchman's pipe (*A. elegans*) the larvae cannot develop on this species.

• *Papilio anactus* is also known as the dingy swallowtail, although citrus butterfly is more descriptive of its taste, for the larvae are commonly found feeding on cultivated citrus. The larvae are blue-black with short, fleshy spines and rows of bright yellow-orange spots along the body. They occasionally damage young plants but normally do not cause any real problems.

The butterfly is found only in Australia where it occurs in the eastern mainland States and parts of South Australia. In Queensland, it is active throughout the year, but it is only a summer insect in the south.

• *Danaus plexippus*. The wanderer butterfly is thought to have reached Australia about 1870, having gradually extended its range across the Pacific Ocean from North America where it is known as the Monarch. It now occurs in the three eastern States and South Australia.

It is a very mobile species, and research began some years ago at the Australian Museum in Sydney to study its movements. A tagging program commenced and results have shown that while the wanderer is present inland during the summer months it contracts to the warmer coastal regions during the winter.

• *Eurema hecabe*. The common grass yellow occurs throughout northern and eastern Australia from the Sydney area to northern Western Australia. A large and variable species, there are more than 30 subspecies spread from India through south-east Asia and Japan to the Solomons, Fiji and Tonga. It is an excellent example of the common name 'yellows' applied to the family Pieridae to which it belongs. The larvae are velvety green and feed on legumes.

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by B. K. CANTRELL,
Entomology Branch.

Some Queensland butterflies

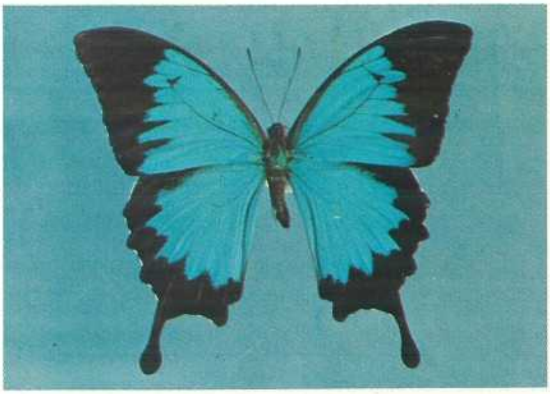
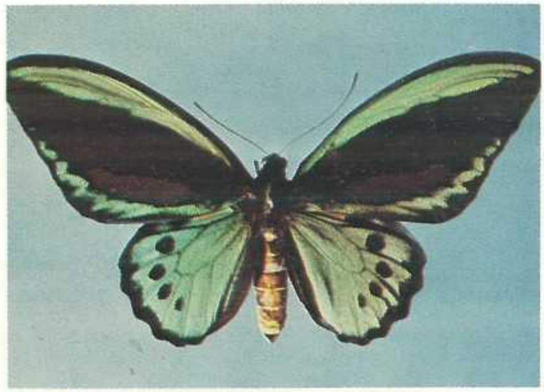


Plate 1.



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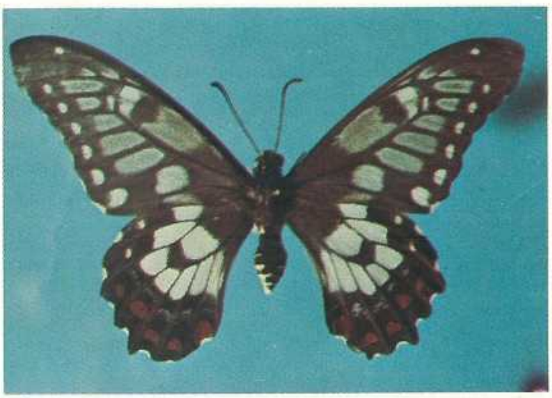

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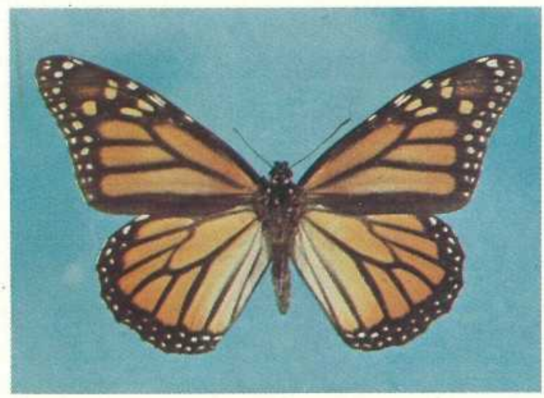

Plate 4.

Plate 1. Ulysses butterfly (Papilio ulysses)

Plate 2. Cairns birdwing (Ornithoptera priamus)

Plate 3. Citrus butterfly (Papilio anactus)

Plate 4. Wanderer (Danaus plexippus)

Plate 5. Common grass yellow (Eurema hecabe)

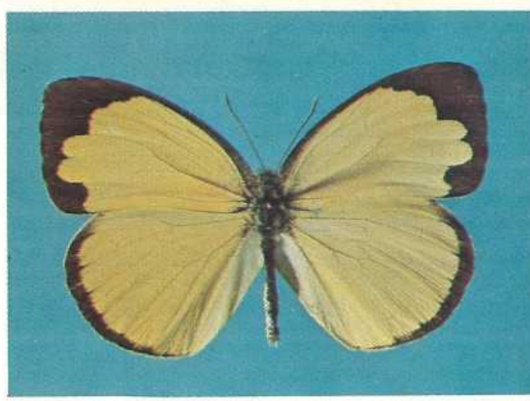

Plate 5.