Queensland AGRICULTURAL JOURNAL

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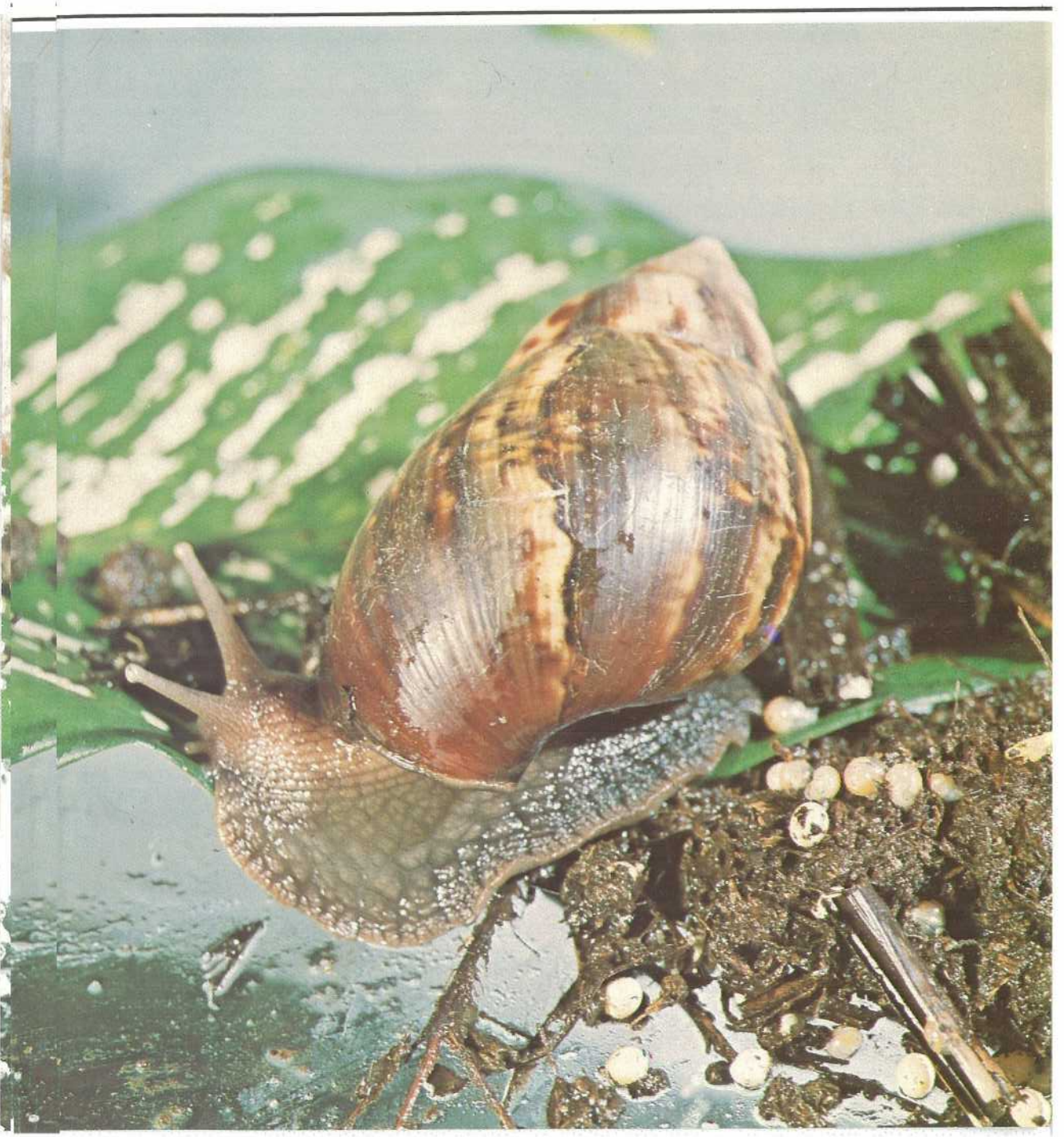

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COVER: The giant African snail (Achatina fulica *Bowditch) is an exotic pest that could cause untold damage to Queenslanders' crops, pastures and gardens.*

This snail can grow as large as 20 cm in length. However, its normal size is between 5 and 7 cm.

Photograph—Photography Section, Information and Extension Training Branch.

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Contents

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Pastures for the Gympie district

by B. G. Cook, Agriculture Branch

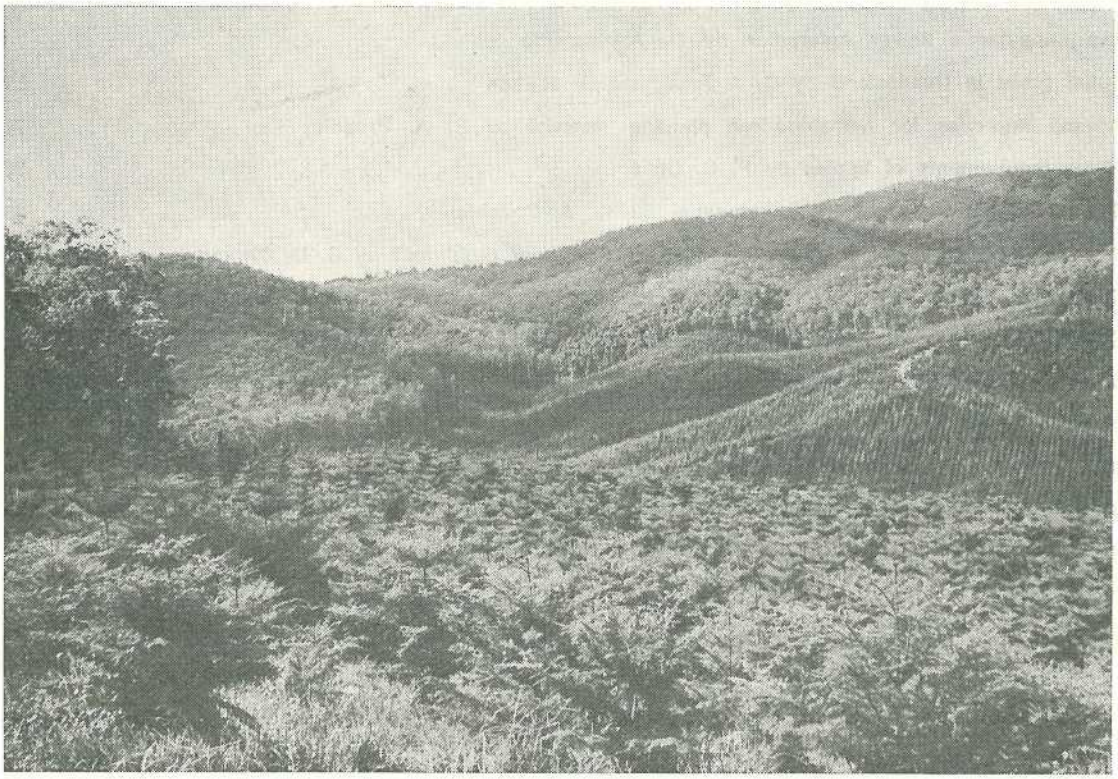
THE Gympie district comprises Widgee, Tiaro and the eastern portion of Kilkivan Shires.

The area may be divided into three basic topographical regions—the coastal lowlands, the central hilly area and the western ranges.

The coastal lowlands extend west to Tinana Creek, rarely rising higher than 75 m above sea level. The largest part is state forest which is devoted mainly to exotic pine plantations; beef production is of secondary importance. The main drainage systems are the Noosa River and Tinana Creek. Average annual rainfall is between 1 250 mm and 1 650 mm.

West of Tinana Creek, the coastal lowlands give way to an undulating hilly region mostly between 75 and 300 m above sea level. This area is predominantly shale and sandstone, interspersed with volcanic outcrops such as Mt. Mothar and Mt. Goomboorian. Rising 65 km south of Gympie, the Mary River meanders north being joined on the way by Obi Obi, Yabba, Six Mile, and Wide Bay Creeks. Alluvial soils suitable for irrigation occur along the river and creeks.

Flooding can be a problem although only the lowest of the three terraces is susceptible to regular flooding. Dairying is the main enterprise and is laregly confined to flat or undulating ground; beef production is important in the northern sector. The rainfall ranges from 1 000 mm in the west to about 1 250 mm in the east.



Hoop pine (Araucaria bidwillii) *plantation, Amamoor Range.*

. . . part 1

Further west, there is another increase in altitude to the Yabba, Jimna, Kandanga, Amamoor and Coast Ranges, which in places rise to more than 600 m above sea level. This rugged area of volcanic and sedimentary rocks is unsuitable for cultivation and is largely used for forestry. Beef production is important in the foothills around Kandanga, Amamoor, Widgee, Woolooga and Kilkivan. The rainfall ranges from less than 900 mm in the west to 1 000 mm in the east with some higher rainfall areas (above 1 250 mm) in the southern ranges.

Soils and vegetation

Coastal lowlands complex

Frequently referred to as 'The Wallum', this region has a number of major soil types:

- COASTAL SAND DUNES (sandy soils of minimal profile development).

These are inherently unsuitable for pasture development and fall mainly within state forest or national park boundaries.

- PODZOLS (leached sands with or without a compact pan-like layer below the bleached layer of the topsoil).

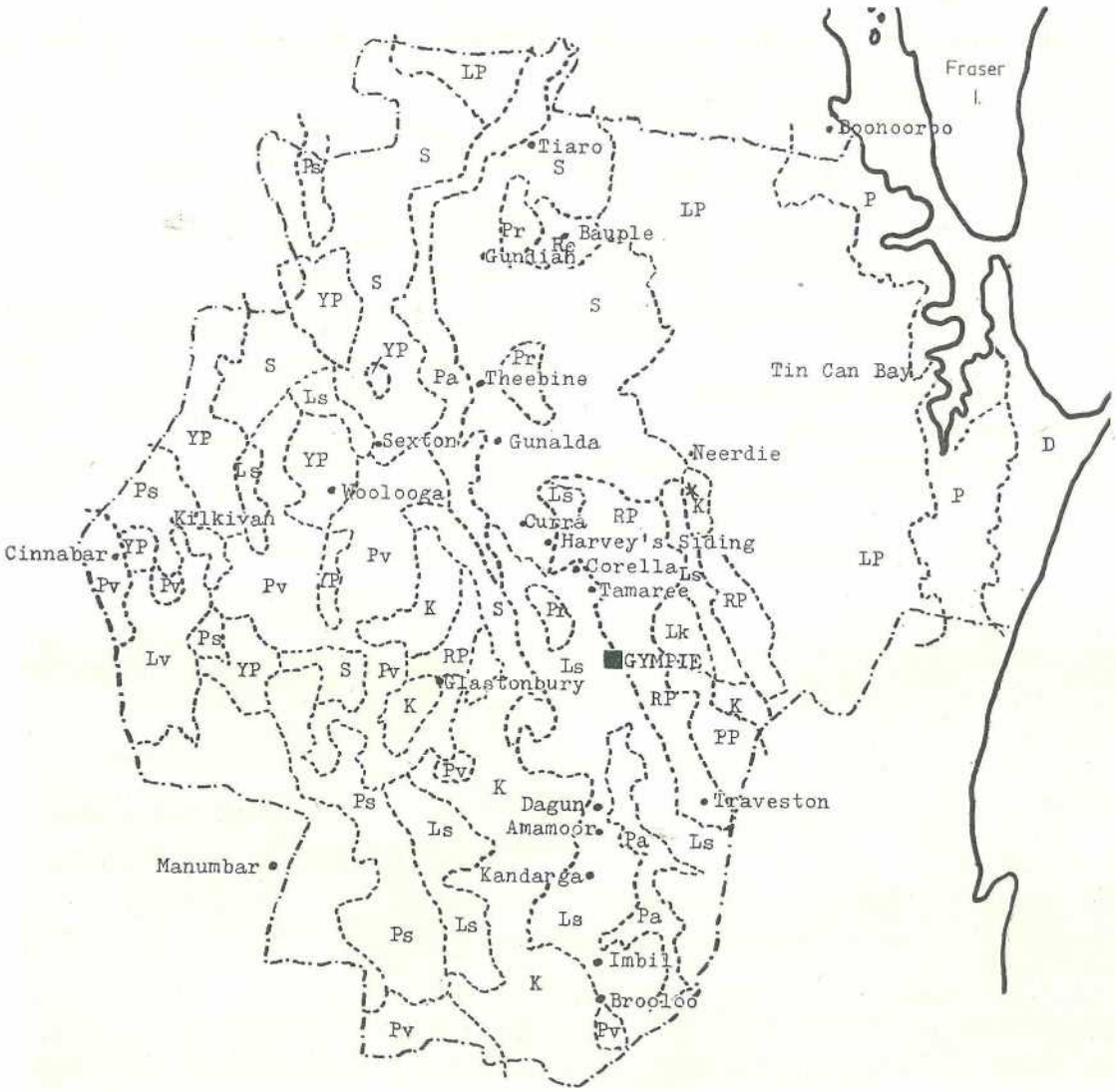
The podzols are found on flat to gently undulating country. Some variation in drainage occurs. The vegetation is usually dense, ranging from low shrubs and herbs up to trees with tall and low shrubs underneath.

Wild may (*Leptospermum flavescens*), tea-tree (*L. stellatum*), dwarf banksia (*Banksia oblongifolia*) and stunted specimens of paperbark tea-tree (*Melaleuca quinquenervia*) and swamp mahogany (*Tristania suaveolens*) are the major species in the heath, while yellow stringybark (*Eucalyptus acmenoides*), needlebush (*Hakea gibbosa*) and wallum banksia (*Banksia aemula*) dominate in the tree-and-shrub areas. These soils also carry areas of layered forest, vine-forest and thicket.

Alluvial flats of the Mary River.

GYMPIE DISTRICT

Major Soil Groupings



LEGEND

D	:	Coastal sand dunes
P	:	Podzol
LP	:	Lateritic podzolic
Ls	:	Lithosol on shale and phyllite
S	:	Soloth
RP	:	Red Podzolic
YP	:	Yellow podzolic
PP	:	Podzolics and podzols on granite and porphyry
Pa	:	Prairie on river alluvium
Ps	:	Prairie on serpentine
Pv	:	Prairie on andesite, other volcanic rocks and boulder beds
Pr	:	Prairie carrying rain-forest vegetation
Lk	:	Latosol
K	:	Krasnozem
Re	:	Red earths
Lv	:	Lithosols on volcanic rocks

- LATERITIC PODZOLICS (loamy sand to sandy loam grading down to a yellow clay subsoil).

These soils occur mostly in undulating and hilly areas. The main vegetation groups are layered and grassy forests, dry sclerophyll forest and layered woodland. Bloodwood (*Eucalyptus intermedia*), blackbutt (*E. pilularis*), grey ironbark (*E. drepanophylla*) yellow stringybark and paperbark tea-tree are the major tree species. Blady grass (*Imperata cylindrica*), kangaroo grass (*Themeda australis*), dwarf banksia and grass-tree (*Xanthorrhoea* sp.) dominate the ground flora.

The fertility of all these soils is low, particularly in regard to nitrogen, phosphorous, potassium and calcium. Trace element deficiencies are also widespread.

Subcoastal open forests

The open forest areas occur on a range of soil types between Tinana Creek and the western ranges and are the most important grazing areas in the district. Several soil vegetation types are present.

- LITHOSOLS ON SHALE AND PHYLLITE (shallow gravelly loams). These are found largely on hill crests and steep slopes in two strips of country from Anderleigh and North Deep Creek in the north to Ormesby and Skyring Creek in the south. In more stable situations within these areas, they grade into red podzolics.

The dominant tree species is spotted gum (*E. maculata*), which grows in association with grey ironbark, broad-leaved ironbark (*E. siderophloia*) and brush box (*Tristania conferta*). The shrub layer comprises predominantly Brisbane golden wattle (*Acacia fimbriata*) and black wattle (*A. cunninghamii*). The main grasses are blady grass and kangaroo grass. With continued use and overgrazing, blady grass has become prominent and bracken fern (*Pteridium esculentum*) has also spread. Mat grass (*Axonopus affinis*) has colonized the seepages and deeper soil areas.

The natural fertility of these soils is low, particularly as regards nitrogen and phosphorous, and to a lesser extent calcium. The potassium level is generally adequate for pasture growth except in those rare situations with a long history of cultivation. Molybdenum deficiency occurs in responsive legumes such as Greenleaf desmodium and glycine but other trace element responses are rare. Pasture growth is restricted by the poor moisture storage capacity of the shallow topsoil.

- SOLOTHS (hard-setting loams and sandy loams over yellow clay subsoil). Formed on sandstone and shale, these soils occupy a large area from north of Tiaro to south of Gunalda. Another strip extends from Pie Creek to Bells Bridge.

Again, spotted gum dominates, associated with Moreton Bay ash (*E. tessellaris*), gum-topped box (*E. moluccana*), grey ironbark and brush box. Each of these forms pure communities in places. Rusty gum (*Angophora costata*) is also common. The understorey is very similar to that on the lithosols. Blady grass and kangaroo grass are common, often with wire grass (*Aristida* sp.). In lower rainfall areas, black speargrass (*Heteropogon contortus*) appears after clearing, while in the higher rainfall areas, mat grass and blady grass dominate.

This group of soils is extremely infertile with deficiencies of nitrogen, phosphorus, potassium, calcium and molybdenum.

- RED PODZOLICS (hard-setting loamy soils over red clay subsoils). These soils are found in parallel strips east of the area of lithosols and are also formed on phyllites and shales. Another small area occurs in the Glastonbury area west of Gympie.

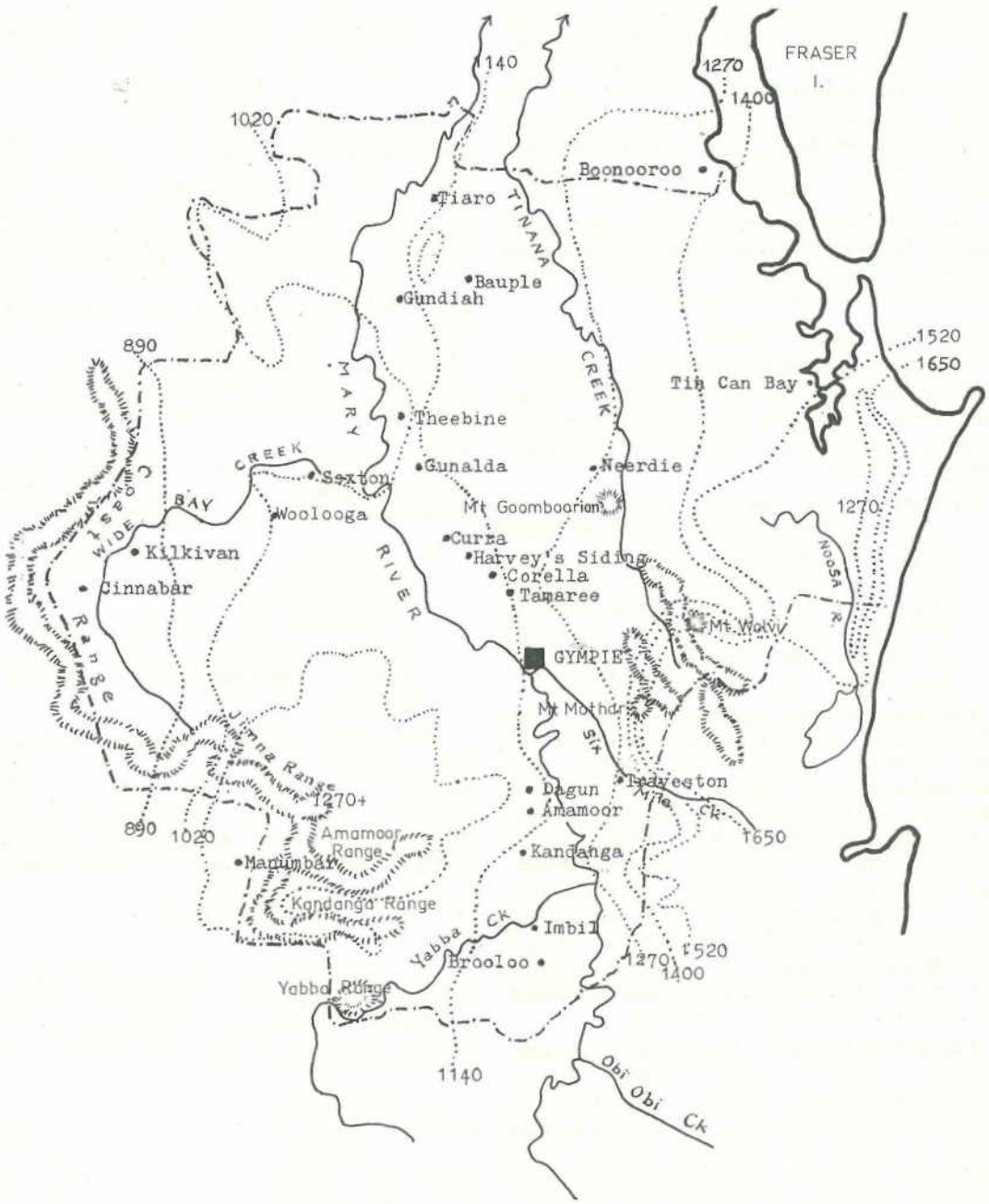
They carry vegetation ranging from open forest through to the occasional area of rainforest, the particular type being determined largely by soil depth. Spotted gum becomes less dominant on the deeper soils, giving way to grey ironbark, grey gum (*E. propinqua* and *E. punctata*), pink bloodwood (*E. intermedia*) and brush box. The natural grasses are blady grass and kangaroo grass.

After clearing, kangaroo grass predominated but was often replaced by paspalum (*Paspalum dilatatum*). Subsequent degeneration has largely produced a mat grass/blady grass/bracken fern association.

The fertility status is similar to that of the lithosols, being deficient in nitrogen, phosphorus, calcium and molybdenum, but adequately supplied with potassium. The deeper soil provides better moisture storage.

GYMPIE DISTRICT

Average Annual Rainfall (mm)



- PRAIRIE SOILS (dark friable loams to clays with brown to yellow-grey subsoils). There are four different types:

(i) *River alluvium.* The Mary River has at different times produced several distinct terraces. The soils forming these terraces are distinguishable, but are all classified as prairie soils.

Blue gum (*E. tereticornis*) and broad-leaved apple (*Angophora subvelutina*) are still to be found on the upper terraces, although the fringing forest of the low terrace has been largely cleared. This fringing forest contained weeping myrtle (*Eugenia ventenatii*), Morton Bay chestnut (*Castanospermum australe*), silky oak (*Grevillea robusta*) and Moreton Bay fig (*Ficus macrophylla*).

Kangaroo grass was originally the main grass on the blue gum flats. With clearing and development, paspalum and kikuyu (*Pennisetum clandestinum*) have become naturalized, although in some areas fertility decline has encouraged mat grass invasion. Green couch (*Cynodon dactylon*) forms dense swards on the regularly flooded low terraces.

Since the river country was among the first developed in the area, the natural fertility is unknown, but years of grazing, lucerne and maize cropping have left the soil deficient in phosphorus and, in places, potassium.

(ii) *Prairie soils formed on andesite.* These form a narrow band from Glastonbury-Warrawee, through Widgee to the Wonga area.

Narrow-leaved ironbark (*E. crebra*) and silverleaf ironbark (*E. melanophloia*) are the dominant trees on the ridges while blue gum is dominant on the flats. The natural ground flora comprises kangaroo grass, black spear grass and several native legumes including *Rhynchosia australis*. Large sections of the flats have been invaded by paspalum.

The fertility of these soils is fair, although phosphorus, sulphur and molybdenum levels must be raised for sown pasture production. Sufficient sulphur is added by using recommended rates of single superphosphate. Calcium levels are high.

(iii) *Prairie soils formed on volcanic rocks and boulder beds.* The hard-setting topsoil distinguishes these soils from others in the group but the vegetation is very similar to that on the andesitic prairie soil. Little is known regarding their fertility status. They occur in a fairly small area west of Kilkivan.

(iv) *Prairie and minimal prairie soils on serpentine.* This mixture of soils of differing texture is formed on a band of serpentine rock extending from Upper Kandanga in the south to Kilkivan in the north.

The main tree species are narrow-leaved ironbark and pink bloodwood (*E. intermedia*), frequently found with grass-tree and, in the higher rainfall Upper Kandanga area, with banksia or honeysuckle oak (*Banksia integrifolia*) and blue gum. The main grass was originally kangaroo grass which has given way to paspalum on the flatter areas.

The general fertility is poor, with high magnesium, low calcium and phosphorus, and a potassium status varying from very low to high. Pastures can be successfully established on the deeper ridge soils but the heavy nature of the flats makes cultivation difficult.

- YELLOW PODZOLICS (hard-setting and non-hard-setting sandy loam topsoil overlying yellow clay subsoil). These are the granite soils of the western portion of the district, being found north of Kilkivan and in the Woolooga and Lower Wonga areas.

Silverleaf and narrow-leaved ironbarks predominate in association with blue gum and Moreton Bay ash. Spotted gum tends to dominate on the shallow ridge tops. Black spear grass and blue grasses (species of *Dichanthium* and *Bothriochloa*) form the ground flora although paspalum has invaded the flats.

Analyses of soil samples taken from unimproved areas suggest that phosphorus levels are low and potassium levels low to fair.

Tall open forest/wet sclerophyll forest

These are two closely related vegetation types found on deeper red podzolics on phyllite in a belt east of Gympie in association with (ordinary) open forest. The open forest occurs largely on the ridge tops while the tall open forest and wet sclerophyll occupy the lower slopes, gullies and flats.

The main timbers of the tall open forest are pink bloodwood, grey ironbark, yellow stringybark (*E. acmenoides*), grey gum and brush box, with tallowwood (*E. microcorys*) and Gympie messmate (*E. cloeziana*) in restricted areas. In the wet sclerophyll, red stringybark (*E. resinifera*), turpentine (*Syncarpia glomulifera*), brush box, Gympie messmate and rose or flooded gum (*E. grandis*) dominate. In this latter association, the trees are entangled with creepers and in limited areas merge into rainforest.

The tree canopy is so dense as to limit grass to a scattering of blady grass and kangaroo grass. This country has been largely cleared and was initially sown to paspalum and clover, but a decline to mat grass, blady grass and bracken fern has taken place.

Although parent rock, soil type and natural fertility are similar to that of the open forest, the country is more attractive for pasture development because of greater depth of soil.

Closed forest or rain-forest

Rain-forest was originally widely distributed, usually in the more mountainous areas but with pockets on the coastal lowlands. Large areas have been cleared for forestry, small crops and pastures, but some virgin rain-forest still exists. There are three major soil types although the native vegetation on all was similar. Some species such as crow's ash (*Flindersia australis*) and hoop pine (*Araucaria cunninghamii*) were common to all. Others such as yellowwood (*F. xanthoxyla*) and bunya pine (*A. bidwillii*) were more restricted in their distribution. Because of the dense shade, grass growth was virtually non-existent.

The fertility and development of the three soil types varies considerably, as does their distribution:

- KRASNOZEMS (deep, red, friable clay soils). Formed largely on volcanic rock, krasnozems are found in the Dagun, Amamoor, Mooloo and Langshaw areas. Isolated pockets are also found at Goomboorian, Wolvi Mountain and Mothar Mountain.

In the virgin state, fertility is high with total phosphorus values up to 3 000 p.p.m. and available phosphorus values up to 90 p.p.m. in the surface 15 cm. The initial nitrogen level was also high, but continued cultivation has reduced it drastically.

Low frost incidence and good drainage make pineapple and small crop culture the most popular land use but some areas are devoted to pasture. Rhodes and paspalum were the most important grasses initially but kikuyu and green panic have largely replaced them.

- PRAIRIE SOILS. These soils occur mostly in the Chatsworth, Glenwood and Bauple areas and are often associated with pockets of krasnozem.

Green panic is the main grass on cleared country. The fertility is similar to that of the krasnozems.

- LATOSOLS (loamy topsoil grading down to a deep, well structured, red clay subsoil). Similar in appearance to krasnozems, these soils are found in association with the red podzolics in the phyllite country east and south-east of Gympie. They occur in undulating areas and on the lower slopes of the ranges.

Their natural fertility was better than that of the red podzolics. Although this has declined, the physical condition of the soil is still good in uneroded areas. With appropriate treatment, the existing mat grass/blady grass/bracken fern areas can be converted to a stable improved pasture.

Flies

(order Diptera)

THE flies form one of the larger insect orders and, despite a considerable diversity of form, almost all are characterized by the presence of only one pair of wings and mouth parts adapted for piercing and sucking.

The hind wings are reduced to small, knobbed structures called halteres which function as balancing organs to keep the fly steady in flight.

Flies have made inroads into almost every avenue of human endeavour. They are proven and important pests of a wide variety of horticultural and field crops, domestic animals and even man himself. From the maggots in our fruit, to attacks on our livestock, and the transmission of such human blood diseases as malaria, dengue fever and Murray Valley encephalitis, flies continually intrude upon our lives.

However, there are numerous exceptions to the old adage that 'the only good fly is a dead one'. Many flies play a beneficial role as pollinators of flowers while others greatly accelerate the decomposition of decaying organic matter.

The types of habitats frequented by flies are almost as diverse as the flies themselves. While many are aquatic in their larval stage others are to be found in living plant tissue or decomposing animal matter.

The normal restrictions of climate have also been overcome by many flies and it is recorded that explorers in the Artic region frequently suffered from the persecutions of hordes of mosquitoes. In short, it may be said that flies have adapted to a remarkable range of habitats and climates.

by B. K. Cantrell, Entomology Branch.

TOP. The dengue mosquito (Aedes aegypti). *Illustration provided by the Queensland Institute of Medical Research*

BOTTOM. A typical moth fly. Illustration reproduced with the permission of the C.S.I.R.O. Division of Entomology and Melbourne University Press.

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Part of the success of this adaption is due to their development of different types of mouthparts. In the mosquito, we have a typical example of mouthparts adapted for piercing and sucking. Here, the mouthparts resemble long, sharp needles which are ideal for piercing the skin of a host. Each needle has been hollowed out on one side so that when a pair of needles are brought together they form a tube through which a liquid meal can be taken from the host to the mouth of the mosquito.

Sandflies and marchflies use a slightly different action. Here, the mouthparts are short, sharp blades which lacerate the skin of the host rather than pierce it. It is because of this lacerating action that the bite of a sandfly is frequently more irritating than that of a mosquito.

The blowflies and housefly have adapted to utilize a liquid or very soft food and their mouthparts have no sharp blades at all. In their place we find a pair of soft, spongy lobes traversed by numerous, fine, open channels. Liquids flow into these channels in much the same way as water is soaked up by a sponge. Between these fleshy lobes are a number of sharp spines which can mascerate softer foods so they may be soaked up as a very fine suspension.

Within the many diverse forms of flies we can recognise two major groups. These are the Nematocera which includes the mosquitoes, sandflies and their allies and the Brachycera which encompasses the majority of species including houseflies, hover flies, fruit flies and blowflies.

Nematocera

Mosquitoes (family culicidae)

Mosquitoes are slender insects with long antennae and an elongate, slender proboscis containing the sharp, piercing stylets used in feeding. While females of most species require blood to provide protein to mature their eggs, the males live entirely on plant nectar. Mosquito eggs are laid in water either singly or in masses known as 'egg rafts'. The larvae which hatch from these eggs are accomplished swimmers and are commonly called 'wrigglers'. Unlike most insect pupae which are quiescent, mosquito pupae are very active and are propelled through the water by a flicking action of the abdomen.

Mosquitoes are very catholic in their choice of breeding places. Still pools, running streams, polluted water, salt water and even shallow pools left after rain provide ideal breeding sites. The adults may also exhibit diverse behaviour in their periods of activity. A number of species will feed only at night while others are limited to the daylight hours. Some mosquitoes are also restricted to feeding outdoors while several readily enter dwellings to find a blood meal.

Well-known species in Queensland include the malaria mosquito (*Anopheles farauti*) which, as its name suggests, is a vector of malaria. This species occurs only in north Queensland. One of the principal pest species of coastal Queensland is the salt marsh mosquito (*Aedes vigilax*) which breeds in tidal pools, while the mosquito most closely associated with man is the brown house mosquito (*Culex fatigans*). It breeds in polluted water close to human habitation in a great variety of sites—drains, sumps, tins, tyres, tree-holes etc. and readily enters houses to bite at night.

The dengue mosquito (*Aedes aegypti*) is also found close to human habitation where it breeds in water containing decaying vegetation in tree holes and in artificial containers such as tins, tyres etc. It bites indoors by day.

Sandflies (families Simuliidae and Ceratopogonidae)

In Queensland, the collective term 'sandfly' is used to describe small, biting flies of the families Simuliidae and Ceratopogonidae, although the latter are better termed 'biting midges'.

Simuliids are generally not well known except perhaps for the Dawson River sandfly (*Austrosimulium pestilens*) which is a pest in inland areas west of the Great Dividing Range in the area extending from about the level of Longreach south to the New South Wales border. East of the Dividing Range, it is a pest in the Dawson Valley.

The sandfly breeds only in running water, and immature stages are only found when rivers and creeks are in flood, when larvae and pupae can be found clinging in dense masses to submerged logs and tree roots. The adults appear about 10 days after the flood waters have receded and the fly infestation may last for

about 2 weeks. Once the rivers return to their normal level or, as some do, even dry-up to form a chain of ponds, the flies cannot be found. Obviously then the sandfly has a resistant stage in its life cycle to carry it through the months of adverse conditions until the next flood. The stage is not known for certain, but is probably the egg.

The bite of these insects is severe, causing intense irritation and subsequent inflammation. The fly attacks cattle, horses, sheep, dogs, kangaroos, wallabies and man.

Irritated stock will frequently gather in mobs and young animals may be trampled and separated from their mothers. Only limited feeding occurs during this time and general loss of condition may become obvious.

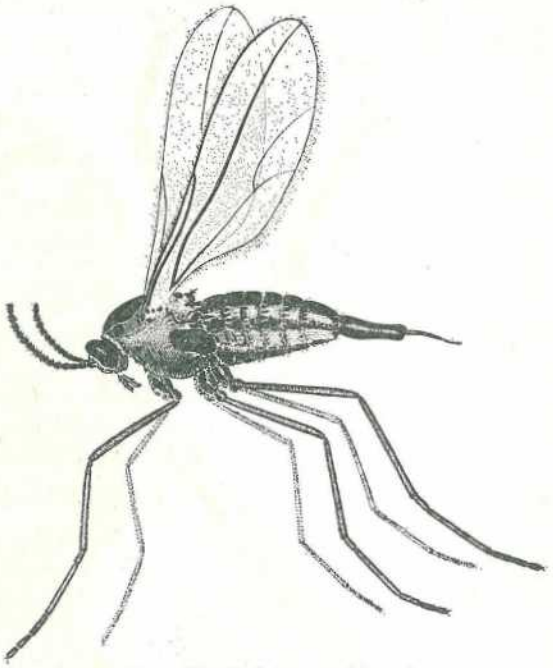
Biting midges are mostly insects of the coastal areas where the larvae live in mud in the intertidal region, often associated with mangrove forests. The adults have a painful bite and are an annoyance to fishermen and residents of coastal resorts. Many pest species belong to the genus *Culicoides*. They bite mainly in late afternoon and at night and generally do not move far from their breeding places, although they may be blown considerable distances by wind.

Moth flies (family Psychodidae)

Moth Flies are small, very hairy flies with sharply pointed wings. They do not bite and are quite harmless. The larvae of *Psychoda alternata* feed on organic matter and are sometimes found in immense numbers in sewage treatment plants. Adults may occasionally be found in domestic toilets and bathrooms.

Sorghum midge (family Cecidomyiidae)

The adults of the Sorghum Midge (*Contarinia sorghicola*) are tiny, delicate flies with a bright orange abdomen and transparent wings. The females lay their eggs on the flower heads of sorghum and other grasses and the larvae feed on the developing seeds. With heavy attacks, the amount of mature seed may be greatly reduced. The life cycle can be completed in about 3 weeks in summer and the midge can be a serious pest to sorghum producers. The midge survives the winter as a full grown larva in trash in sorghum fields and seed heads of wild hosts.



Sorghum midge (Contarinia sorghicola).

Brachycera

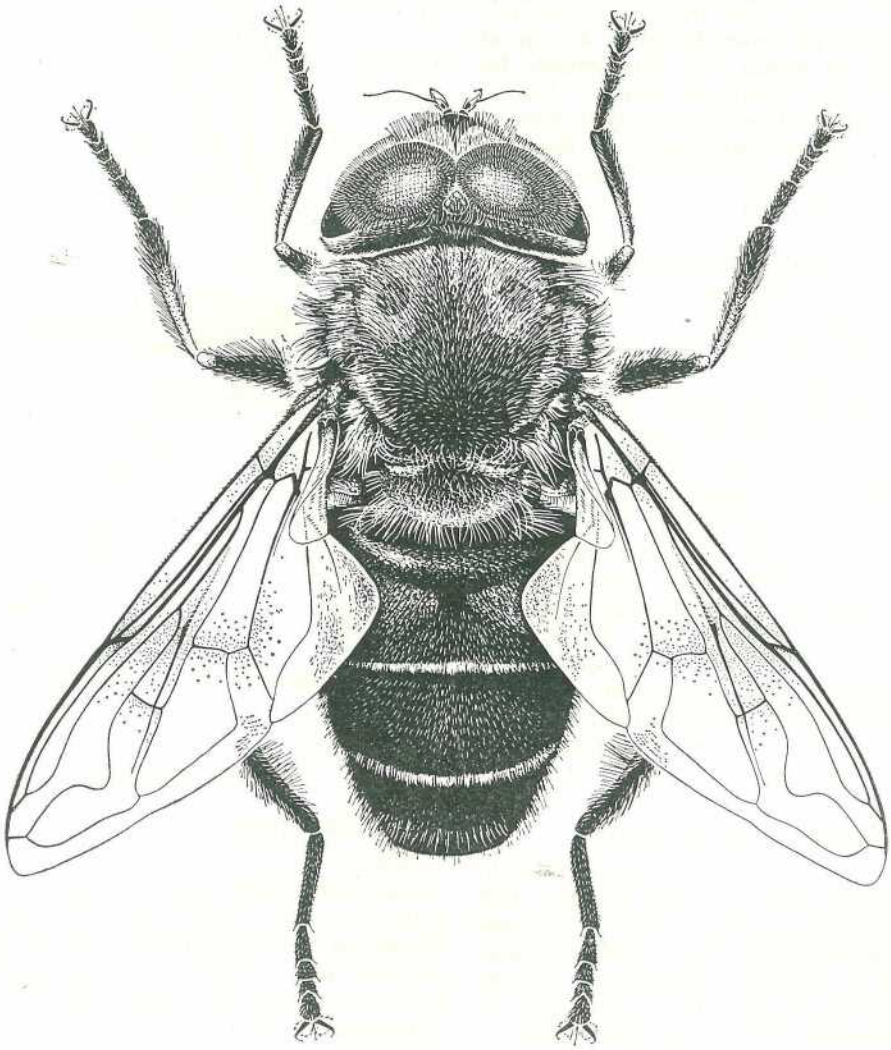
March flies (family Tabanidae)

March flies or horse flies are swift-flying, robust insects with large eyes and a horny beak with which they feed. Only the females suck blood and are usually most active on hot, sunny summer days. Apart from their painful bite to humans they may cause irritation to stock if present in large numbers. They are more common in the moist coastal areas.

Hover flies (family Syrphidae)

The brightly marked hover fly is a common sight in most gardens on a hot summer's day. They are frequently encountered hovering almost motionless above blossoms and when disturbed move away with a quick, darting action. While many hover flies are characterized by bright yellow markings on the body, a number are mimics of other insects and may closely resemble bees, wasps or other flies.

Many species of hover fly play an important role in the pollination of plants while the larval stage of others preys upon aphids.



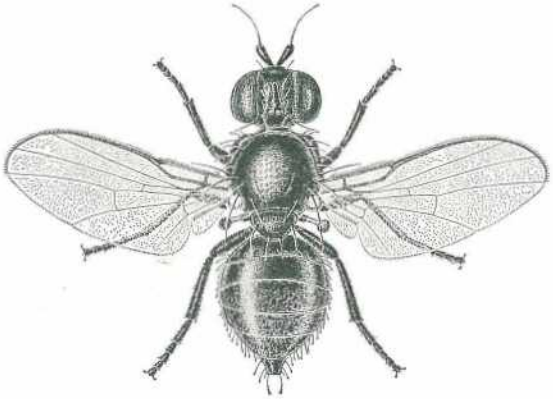
The drone fly (Eristalis tenax). *Illustration reproduced with the permission of the C.S.I.R.O. Division of Entomology and Melbourne University Press.*

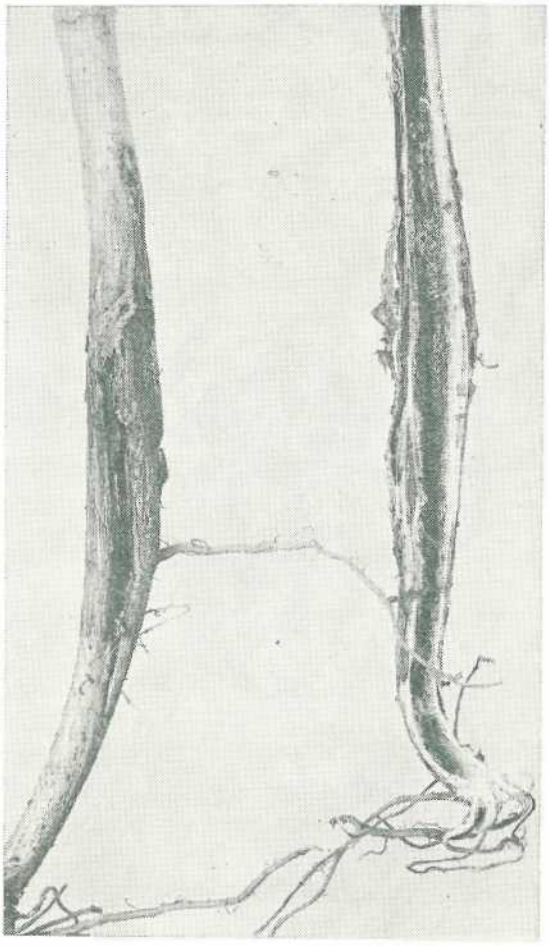
One well known species of hover fly is the drone fly (*Eristalis tenax*) which closely resembles a bee. Its larvae are the 'rat-tailed maggots' often found in dirty drains.

Bean fly (family Agromyzidae)

The Agromyzidae are a group of small, black flies, the larvae of which are usually leaf miners or stem borers. The Bean fly (*Melanagromyza phaseoli*) often makes the growing of beans in coastal areas during the summer months quite difficult. Plants growing under ideal conditions are all too often found to be far from flourishing. The plants may be wilted or stunted, and may eventually blow over in the wind and die.

The wilting of the plants is caused by the bean fly larvae feeding within the stem, which if examined will be seen to be abnormally swollen in parts, and often split open where the swellings occur. When mature, the larvae pupate within the stem to form brownish puparia from which the adults later emerge. Other species attack celery and various legumes in a similar manner.





TOP. Bean fly (Melanagromyza phaseoli). *BOTTOM. Bean fly damage to bean plants. RIGHT. Queensland fruit fly* (Dacus tryoni). *Drawing by W. Manley.*

Ferment flies (family Drosophilidae)

Most of the Ferment Flies are grouped together in the genus *Drosophila.* They are small, reddish-brown flies usually with bright red eyes, and are often attracted in large numbers to the juices of over-ripe fruit, where they feed and lay their eggs. Since they do not attack green fruit, they have no economic importance, but do have a role in the breakdown of waste.

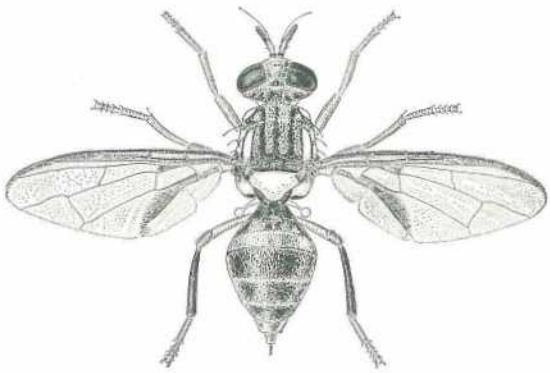
The group has achieved fame as a tool in genetic research because of their rapid life cycle and ability to produce mutants.

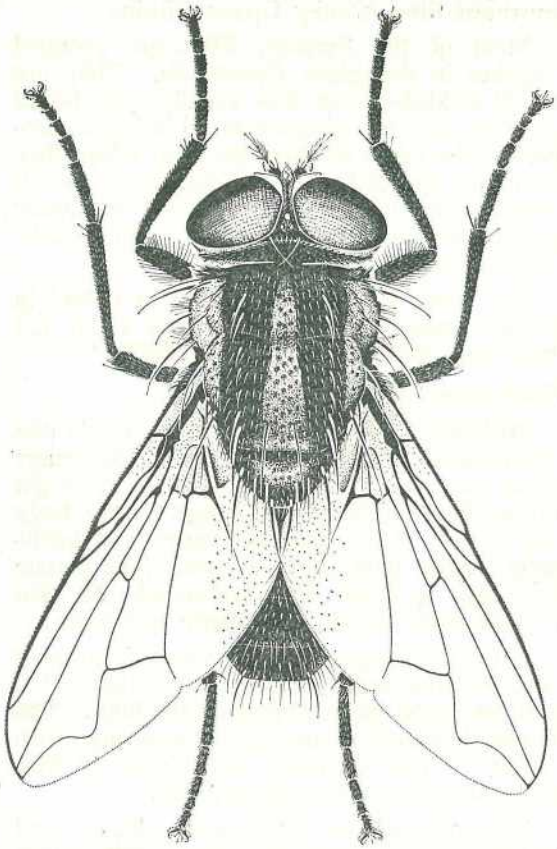
Fruit flies (family Tephritidae)

Probably the best known fruit fly is the Queensland fruit fly (*Dacus tryoni*). Like many other members of this family it is a bright yellow fly with brown markings on the body and wings. They resemble wasps and habitually waggle their wings at rest. The female lays eggs in small batches beneath the skin of fruit with the aid of a sharp ovipositor.

If the fruit is green, the eggs remain dormant until the fruit begins to ripen, when they hatch and the larvae begin to feed on the flesh. The feeding is usually accompanied by rotting which makes the fruit inedible. Some types of fruit when 'stung' may drop prematurely.

The range of fruit attacked is extensive and includes most commercial fruit as well as that of many rain-forest trees. The Queensland fruit fly is by far the most destructive species in Queensland but others worth mentioning include the banana fruit fly and the cucumber fly which attack bananas and cucurbits respectively. The banana fruit fly only occurs in the northern areas of the State.





The bush fly (Musca vetustissima). *Illustration reproduced with the permission of the C.S.I.R.O. Division of Entomology and Melbourne University Press.*

Family Muscidae

This family is a large and variable group of flies with many species of economic and medical importance.

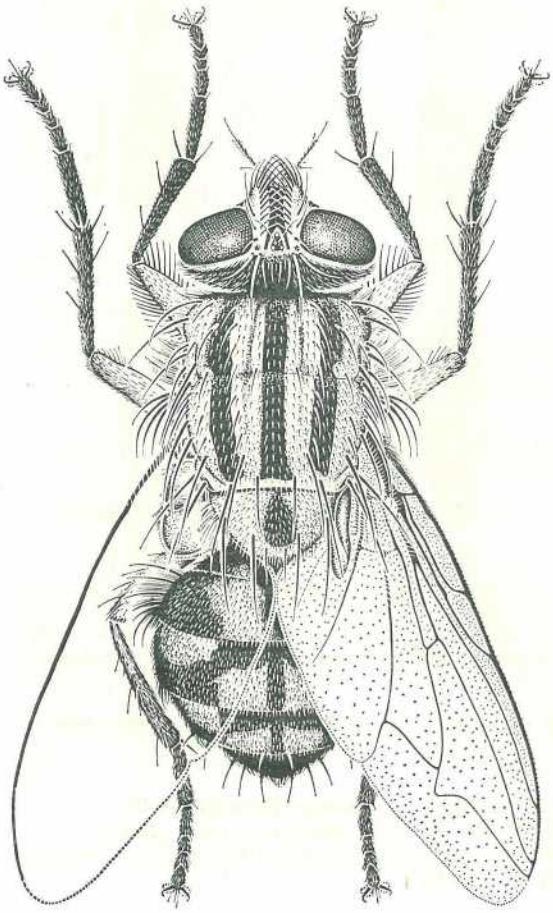
HOUSE FLY. The house fly (*Musca domestica*) probably needs no introduction. It is a cosmopolitan species and common in Australia where it frequents dwellings and animal houses, and is seldom seen far from habitation. The eggs are laid in batches of 120 to 150 usually in decaying organic matter. In warm weather, the life cycle can be completed in 8 to 14 days.

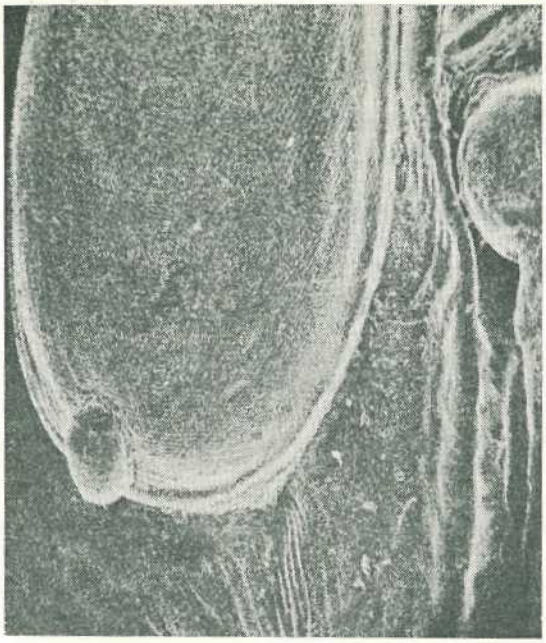
While the house fly has never been proven to transmit human diseases such as typhoid and gastroenteritis it would seem ideally suited to do so, considering its habit of regurgitating fluid from the crop before feeding. Also the many hairs on the feet and legs of the fly would enable mechanical transmission of infective organisms.

BUSH FLY. Picnickers will be equally familiar with the bush fly (*Musca vetustissima*). Very similar to the house fly in appearance, the bush fly normally is confined to the outdoors, where it breeds mainly in cattle dung.

The bush fly is a common cause of annoyance to stock and man. Its habit of feeding on the secretions of the mouth, eyes, ears and nose, often in countless numbers, make it an extremely irritating pest. Superficial wounds are also particularly attractive to this fly. The bush fly has the habit of resting on the backs and hats of human beings, and may be carried many miles in this manner. It is suspected that they may transmit trachoma in man.

A typical flesh fly. Illustration reproduced with the permission of the C.S.I.R.O. Division of Entomology and Melbourne University Press.



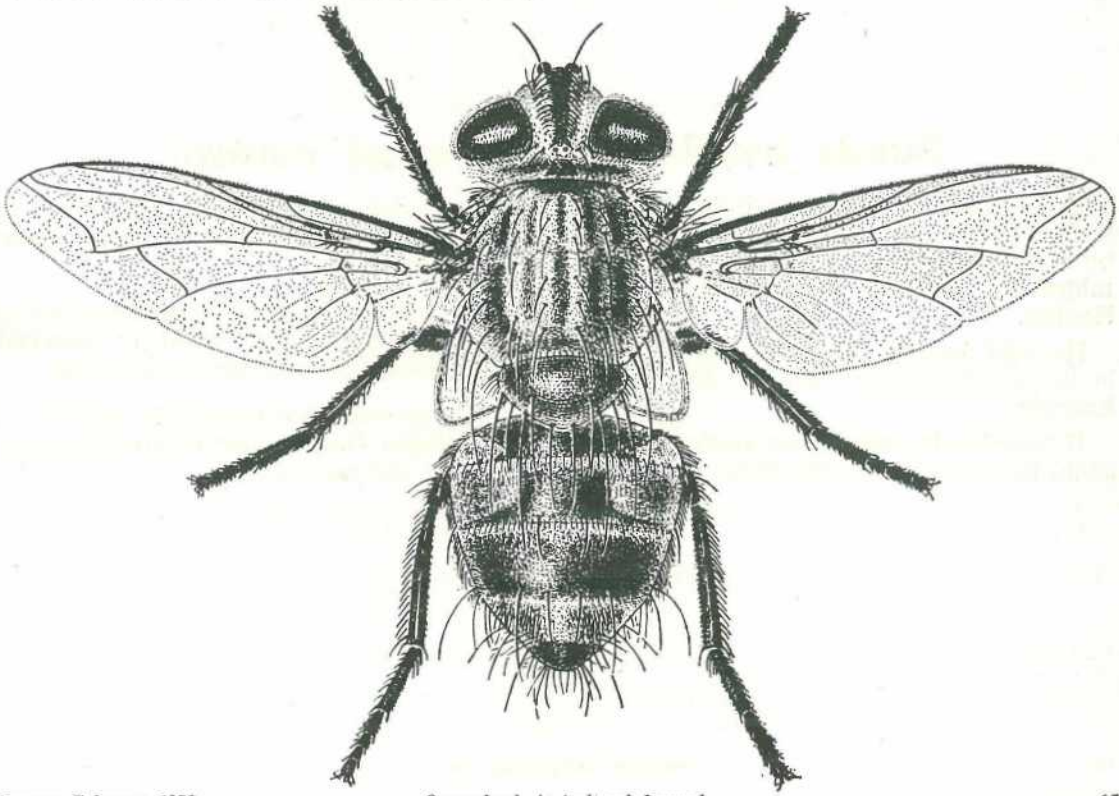


ABOVE. Egg of Blaesoxipha *sp. attached to the eye of a locust.*

The flies often reach huge populations in summer in western Queensland from where they may be blown by north-west winds to New South Wales and Victoria. Research by C.S.I.R.O. indicates that with strong winds the flies can make the journey to Canberra in less than 24 hours! In the south, the fly populations are decimated by the cold winters, but after receiving a fresh influx from the north can breed freely until the onset of the next winter.

STABLE FLY. The stable fly (*Stomoxys calcitrans*) is a cosmopolitan pest, and like the house fly is common in Australia, mainly in summer. The flies resemble house flies but can be recognized by the horny beak below the head, through which they suck blood. They attack stock and man and their bites are quite painful and annoying. The larvae breed in decaying vegetable matter such as humus heaps, but develop more slowly than house flies, the life cycle occupying 3 to 4 weeks in warm weather.

BELOW. A typical tachinid. Drawing by W. Manley.



Flesh flies (family Sarcophagidae)

Flesh flies are much larger than muscids and are easily recognized by the grey thorax with its three dark stripes and the chequered pattern of the abdomen. Many species develop in carrion and other decomposing organic matter.

The genus *Blaesoxipha* however, is a parasite of grasshoppers in the larval stage, and was an ally to farmers during the locust plagues of recent years. The females 'glue' their eggs on the heads of locusts, and the larvae penetrate the host and feed on the flight muscles and abdominal organs so that it cannot fly properly and is prevented from breeding. The mature larva leaves the host and pupates in the soil.

Sheep blowfly (family Calliphoridae)

Though frequently a problem in dwellings, the introduced Australian sheep blowfly (*Lucilia cuprina*) is principally a pest of sheep where it accounts for up to 80% of primary strikes. The sheep blowfly which is larger and more stout than a house fly is a distinctive metallic green in colour with red eyes and silvery-white cheeks and face.

Tachinids (family Tachinidae)

In Australia, we have a very large and diverse tachinid fauna. This group is of particular interest as the larvae of almost all species are internal parasites of other insects including many pests of agricultural importance. At times, tachinid parasites can account for a very marked reduction in pest numbers.

Though most tachinids are bristly-grey indivduals, the genus *Rutilia* contains a number of large, broad-bodied flies of bright metallic colouration. Most members of this genus are thought to be parasites of beetle larvae.

Flies have bothered man for centuries and scientists are continually investigating new ways to control them. The flies however always appear to be one step ahead and are in no danger of extinction. Like taxes, the flies will always be with us.

Funds available for locust control

THE Minister for Primary Industries, Mr V. B. Sullivan, announced that funds would be made available to control the spread of migratory locusts in the Capricornia Region.

He said hopper bands had been located in the Gindie-Fernlees area to the south of Emerald.

If these bands, presently on grazing country, could be sprayed now, the threat to crops in the area would diminish and there would be every chance of preventing the development of a plague.

The Central Highlands Plague Grasshopper Destruction Committee, based at Emerald, would direct the campaign in that area.

Departmental officers would be available to assist Plague Grasshopper Destruction Committees in the region.

Leaf and soil analysis . . . a guide to fertilizing citrus

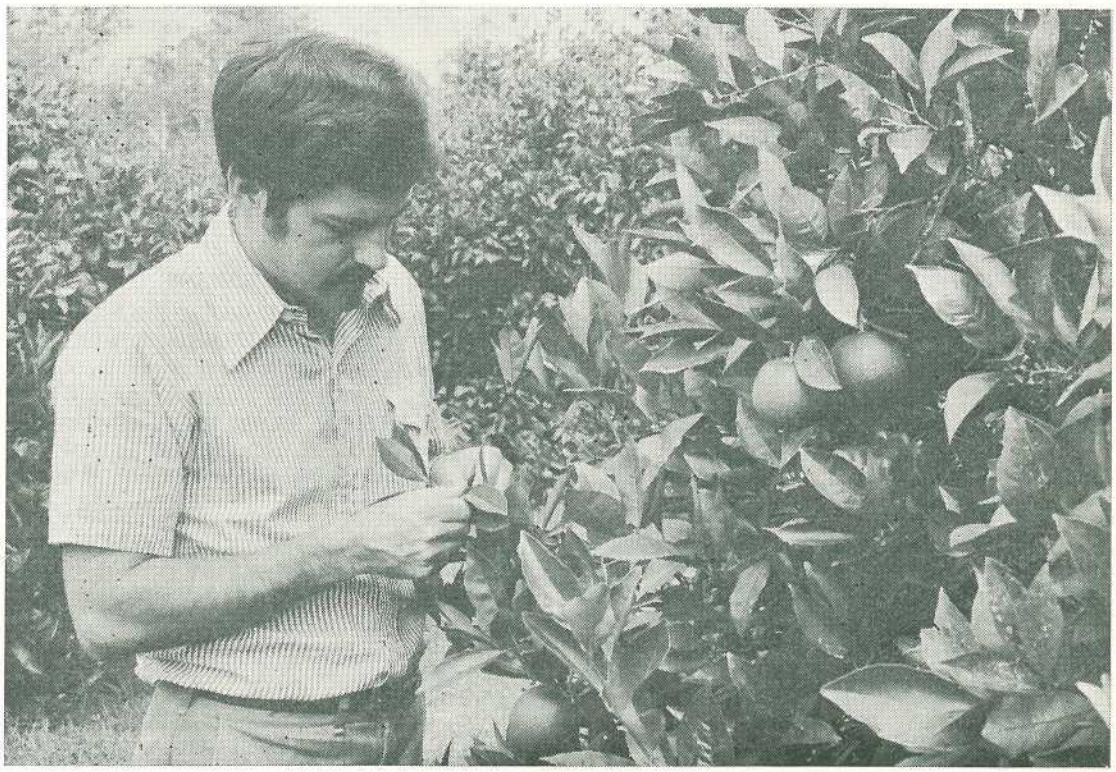
by K. R. JORGENSEN, Horticulture Branch.

HOW does an orchardist know how much fertilizer to put on his citrus trees?

Should he apply the same as last year, the same as his neighbour uses, or the same as the general recommendation for Queensland citrus?

Unfortunately, no two blocks of citrus are the same. They differ in such things as fruit variety, tree age, soil type and accumulated fertilizer nutrients. Each block therefore needs to be assessed separately to decide its particular fertilizer requirements. This individual assessment can be made most accurately by using the technique of leaf and soil analysis.

A sample of leaves is taken in a particular way, and at a particular time, and analysed for all the important nutrients required by citrus trees. The analysis for each nutrient is then compared with a table of standard levels to decide whether the trees are high, low or optimum in their content of each element when compared with the levels in healthy, productive citrus of the same variety.



Collecting a leaf sample for analysis. This is the first step in determining the fertilizer needs of a block of citrus.

If the block of trees is low in a given nutrient when compared with the standard, then more nutrient needs to be applied, or else the uptake from the soil needs to be improved. If the block is high in the element, then future applications need to be reduced. If it is optimum, then application rates need to be maintained, or even reduced if the soil analysis shows that the soil level is high.

In each case the level of nutrients in the soil, as well as that in the leaf, is measured to determine what the future fertilizer programme should be. The soil is also tested for its pH or relative acidity to determine whether this is interfering with nutrient uptake and tree health.

The object of the whole exercise is to determine exactly what nutrients a particular block of trees requires, and in what quantities. This allows the fertilizer programme to be tailor-made to the trees, avoiding wasteful over-fertilizing and dangerous under-fertilizing which produces nutrient deficiencies.

Does it work?

Almost all citrus growers who have obtained leaf and soil analyses of their orchards have found that their old fertilizer programme was over-supplying some elements and under-supplying others. This occurs because general fertilizer recommendations are made to cover average conditions and no orchard is just average.

One common situation revealed is an accumulation in the soil of phosphorus and potassium from previous fertilizer dressings. In this case, application of these elements can be reduced for several years until this reserve is used up. In several cases, nitrogen applications have been found to be excessively high and wasteful of both fertilizer and money.

The nutrient most commonly under-supplied is calcium. Many citrus soils are found to have low pH and low calcium levels. When these are improved by spending money on liming materials instead of on the over-supplied phosphorus and potassium, tree growth improves because the trees are receiving what they actually need, not just the same ration as last year.

One grower whose orchard was in this situation has been able to halve his fertilizer bill while increasing his production by 50%.

Leaf and soil analysis also tests for harmful chloride. When these tests are low, the grower knows that he can safely use potassium chloride (muriate of potash) instead of potassium sulphate, thus saving himself money.

Who analyses the samples?

Leaf and soil samples are analysed by commercial laboratories for a fee. The major laboratory in Queensland is operated by Consolidated Fertilizer Sales Pty. Ltd. which also provides an interpretation of the results and a fertilizer recommendation.

This company sells to the grower a do-it-yourself sampling kit for leaf and soil sampling. This provides instructions for sampling, the materials for sampling and for despatch of the samples, and an information sheet on which to record the data needed for the fertilizer recommendation. The cost of the analysis is included in the price of the kit.

The Department of Primary Industries provides the information on which the leaf analyses are interpreted. This includes a table of leaf analysis standards and data on tree responses to fertilizer applications obtained from nutrition trials with citrus in Queensland.

When to sample

Leaf samples are collected at the time when the leaves have reached maturity and their nutrient levels have stabilized. In Queensland, this is in the months of February and March. Leaves collected at other times of the year have higher or lower nutrient levels, and cannot be compared with the table of standard levels.

This is also a suitable time to collect soil samples, as the summer rains will by then have stabilized the effect of the winter/spring fertilizer applications.

February and March are also convenient months to sample, as there is still sufficient time to have the leaf and soil samples analysed and a fertilizer recommendation prepared before ordering the winter fertilizer requirements.

Which blocks?

Growers who are using leaf and soil analysis for the first time often prefer to try it out on a few blocks first. The best blocks to use are orange and mandarin blocks of moderate to large size with healthy trees in the 10 to 20 years age group. These trees are best able to benefit from the improved nutrition which leaf and soil analysis makes possible.

Leaf sampling

Selecting the leaves

Leaf samples have to be collected in the same way as the samples used to determine the table of leaf analysis standards, otherwise they cannot be compared with the standards. The leaf sample used in Queensland and in most citrus areas of the world is the middle leaf from 5 to 6 month-old spring flush non-fruiting terminals.

Terminals or shoots which emerged in the normal spring flush in September are the right age for sampling in February and March. The middle leaf along their length is the one to sample.

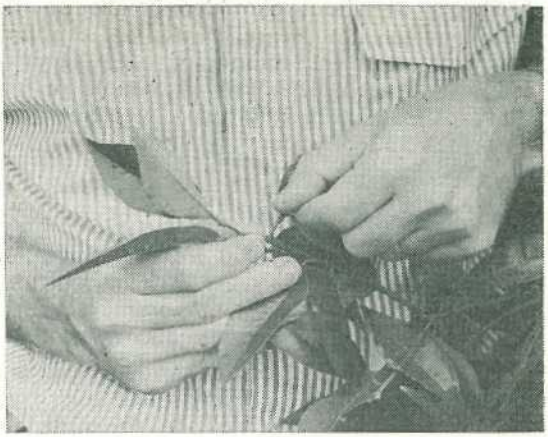
Most citrus trees will flush several times in summer as well as the main flush in spring, and it is important that leaves are not sampled from these younger flushes instead of from the spring flushes.

The best way to identify the correct spring flush shoots for sampling is to mark non-fruiting shoots in spring with a spot of plastic paint. These can then be located in February and used to identify other spring shoots by comparison of their leaf and bark colour.

Another way to identify the correct non-fruiting shoots is to look first at fruiting shoots. These will have emerged in spring, so must be the right age. Some fruit are borne in the axils of leaves on old shoots, so care is needed to ensure that the leaves behind fruit which are inspected are of the right age.

The appearance of leaves on the correct spring flush fruiting shoots is a guide to the appearance of the non-fruiting shoots from which the leaf sample is collected.

All spring flush leaves will be carrying residues of the petal-fall copper spray while younger leaves will look much cleaner.



Correct sampling procedure—collecting the middle leaf from a non-fruiting spring flush shoot.

A non-fruiting spring flush shoot and a fruiting spring flush shoot. The correct leaf to sample is the one pointing to the bottom left of the picture.

Where possible, the leaves should be taken from shoots which are still terminal and have not flushed again. In some very vigorous blocks, most spring flush shoots will have flushed again. In that case, leaves should still be collected from the spring flush and a noting made on the information sheet that the shoots had flushed again.

Shoots at about shoulder height on the outside of the canopy are selected for sampling. The leaf from the middle of each shoot is snapped off complete with its petiole or leaf stalk. Clean, non-damaged leaves free from blemishes and deficiency symptoms should be collected.

Collecting the sample

A sample of about 200 leaves is collected from each block of trees. When collecting these leaves, it is most important that the block is sampled in a systematic way.

If the trees in the block are wide-spaced and the collector can walk right around each tree, then the block is sampled on the diagonal. This involves starting at one corner of the block and walking across on the diagonal, sampling on the way.

In a rectangular block, it will be necessary to make several diagonal crosses in a zig-zag fashion before reaching the other end. It is then necessary to go back to the starting end and sample the opposite set of the diagonals.

If the trees are close-spaced, then it is necessary to walk along the inter-rows, sampling trees from each row alternately on the way.

Before the sampling of a block starts, the number of trees in its length and width should be counted. A sampling pattern is then drawn up so that the required 200 leaves will be collected from the whole block.

In a large block sampled on the diagonal, this may mean sampling only every second tree on the diagonals. In a small block, it may mean sampling two leaves per tree. The four sides of the trees should also be sampled in rotation, that is, first leaf from north side and second leaf from east side.

In a close-planted block, leaves are collected from at least every second row middle, but only every second, third or fourth tree is sampled as required to obtain the necessary 200 leaves.

Leaves are not collected from the trees in the outside row or in areas that are not typical of the block, for example, where drainage is different.

Soil sampling

A soil sample is required which is representative of the soil in the root zone of the citrus trees. It must also be representative of the whole block of trees. Many sub-samples are therefore collected which are mixed together to make the block sample.

The sample should be collected over the depth 0 to 30 cm. Samples are often collected over the 0 to 15 cm depth as a matter of convenience, but they are not as meaningful as the deeper sample. A second sample from 30 to 60 cm can also supply useful information.

The samples are best collected with a small auger or post hole digger. They can also be collected using a spade to dig a hole to spade depth, then slicing a thin section off the side of the hole to full spade depth.

Sub-samples from 20 to 30 such sites are collected from the whole block of trees in a systematic manner similar to that used for the leaf sample. Five to ten sub-samples may provide sufficient soil for a full sample, but are not sufficiently representative of the whole block.

The soil from the sub-samples is thoroughly mixed together, then halved or quartered to provide the 450 g sample required by the analytical laboratory.

After sampling

Information required

An information sheet is supplied with both leaf and soil analysis kits to record crop and site information. It is most important that these sheets be filled out as completely as possible, so that a good fertilizer recommendation can be made.

Last year's yield from the block is required, and the previous yield also, in the case of mandarins. When the yield is not known accurately, then an estimate is better than nothing at all.

The fertilizer history of the block is also important. If the programme has been changed in recent years, then the previous programme should also be given.

Despatching the sample

Leaf and soil samples are packaged in the bags provided in the sampling kit. They should be kept in a cool, dry place and posted to the laboratory as soon as possible. The best procedure is to sample and post the same day.

STANDARDS FOR CITRUS LEAF ANALYSIS IN QUEENSLAND

FOR USE WITH SAMPLES* COLLECTED IN FEBRUARY TO MARCH OF MIDDLE LEAVES FROM NON-FRUITING TERMINAL SPRING FLUSH SHOOTS

Element and Unit†	Deficient Range‡	Low Range	Optimum Range	High Range	Excess Range
N %	< 2·4		2·4 —2·6	2·6 —3·0	> 3·0
P %	< 0·10	0·10—0·14	0·14—0·16	0·16—0·25	> 0·25
K %	< 0·7	0·7 —0·9	0·9 —1·2	1·2 —1·7	> 1·7
Ca %	< 2·5	2·5 —3·0	3·0 —6·0	6·0 —7·0	> 7·0 (?)
Mg %	<0·16	0·16—0·25	0·25—0·6	0·6 —1·2	> 1·2 (?)
Na %			<0·16	0·16—0·25	> 0·25
Cl %			<0·3	0·3 —0·7	> 0·7
S %	< 0·14	0·14—0·2	0·2 —0·4	0·4 —0·5	> 0·5
Zn ppm	<16	16—25	25—100	100—300	>300
Mn ppm	<16	16.25	25—100	100—300	>300
Cu ppm	< 3·6	3·6 —5	5—10	10—15	> 15
Fe ppm	<36	36—60	60—120	120—200	>200

* This table of standards is for use with leaves which have not been sprayed with the element under consideration. Most commercial samples will have been sprayed with copper and many with sulphur, manganese and zinc. Most will also be contaminated with iron from dust and irrigation water.

† The element contents are expressed on a dry weight basis.

‡ The deficient and excess ranges are those in which economic returns are adversely affected, mainly through a reduction in yield. The low and high ranges are those in which element levels are away from the optimum, but are not necessarily having an adverse economic effect.

Cattle slaughter subsidy scheme

THE on-property slaughter subsidy scheme for drought-affected cattle began in December.

Commenting on the scheme, the Minister for Primary Industries (Mr V. B. Sullivan, M.L.A.) said: 'The slaughter subsidy should not be confused with the Commonwealth administered Beef Industry Incentive Payments Scheme under which payments are made for recognized disease control and husbandry procedures such as spaying, dipping and vaccinating'.

'It should be understood it is not allowable to make a claim under both schemes for the same animal'.

He said the slaughter subsidy scheme would operate, within declared drought areas, until 30 June this year.

The subsidy payable to stockowners would be $10 a head.

Mr Sullivan said that, to be eligible, cattle would have to be drought-affected; over 5 months of age; in the present ownership for a minimum of the preceding 3 months before slaughter and be virtually unsaleable. No restriction applied on the number of stock slaughtered.

'An essential condition is that owners give prior notification of intention to slaughter to designated officers of my Department', Mr Sullivan said. They are required to certify subsidy claims.

'Officers from the Veterinary Services, Beef Cattle Husbandry and Dairy Field Services Branches are considered to be designated officers for the purpose of this scheme'.

Mr Sullivan said that owners slaughtering stock which met the specified eligibility conditions were required to retain full tails as verification until claims had been paid.

He added that claim forms could be obtained from D.P.I. offices located in declared drought areas.

Cotton varietal testing

TO obtain high returns per hectare is the aim of any farmer.

To do this, he must improve the yield of his crop and the quality of his product at minimum extra cost. With cotton, this can be done at virtually no extra cost by using high yielding, high quality varieties.

Since 1962, the Queensland Department of Primary Industries has grown variety trials throughout the State to determine the most suitable varieties to grow under irrigation. When the series commenced, the varieties being grown in Queensland were introductions from the United States of America. These were Empire, and selections from U.S.A. varieties such as Miller 43-9-0.

Spinners required cotton fibre of middling grade with staple lengths of 25 to 27 mm. The Miller varieties rarely produced fibres as long as this but their lint was easy to clean so that middling grades and better were common. Empire, while having adequate fibre length, was difficult to clean because of its densely hairy leaves and so middling grade fibre was rarely produced.

A cotton variety trial at St. George.

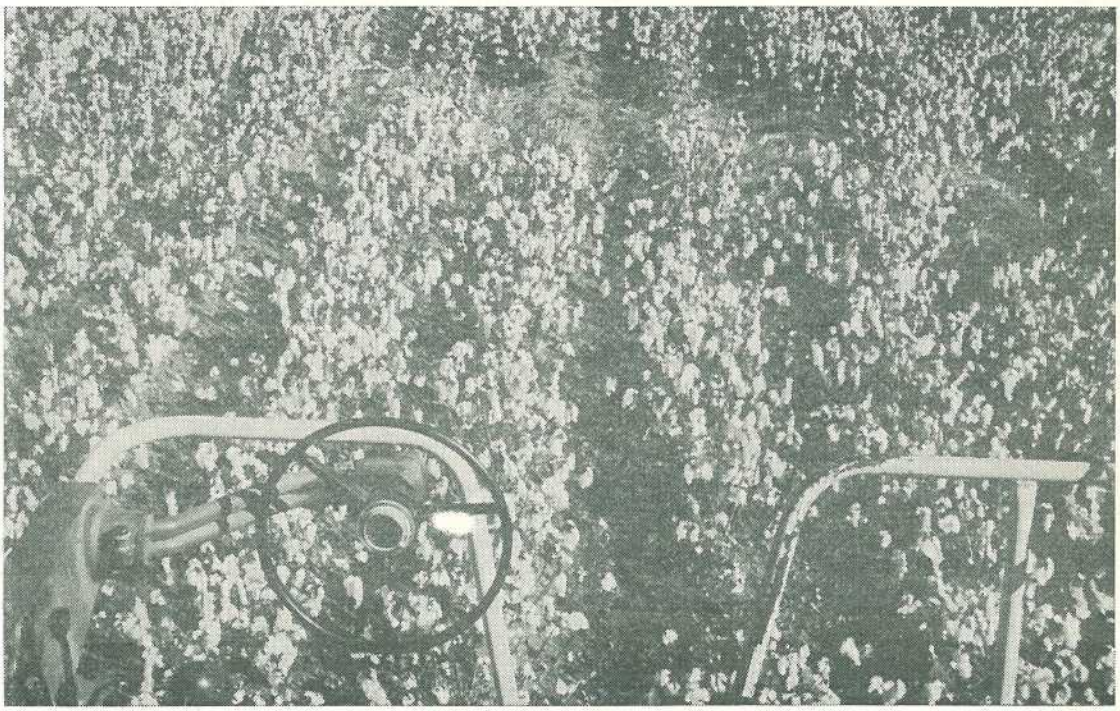
in Queensland

by G. T. McINTYRE and V. E. MUNGOMERY, Agriculture Branch and C. A. S. ELLIS, formerly of Agriculture Branch.

Later, Deltapine Smoothleaf was introduced from the U.S.A. This variety successfully combined these characters of length and grade. It was included in trials at Biloela Research Station for the first time in 1961. Results of variety trials over the period 1962–3 to 1966–7 clearly demonstrated the superiority of Deltapine Smoothleaf over all the varieties available at the time in both yield and grade. It was released for commercial production in 1964 and immediately became the predominant variety in all Queensland cotton growing areas.

The Deltapine Smoothleaf grown at that time was in fact a mixture of several similar strains. Intensive selection in the mid 1960s from this and closely related varieties was carried out at the Biloela Research Station. This selection produced several strains, 16 of which were then tested in strain trials at sites in all Queensland cotton growing areas.

Deltapine Selection 13 produced the most consistent yields in these trials and, on average, exceeded the yield of the commercial Deltapine Smoothleaf variety. It produced cotton of similar quality.



Cotton variety trial plot.

Consequently, it was released and has become the Queensland strain of Deltapine Smoothleaf. It is used mainly in central Queensland areas. South Queensland growers have been using acid-delinted Deltapine Smoothleaf seed from New South Wales. This variety has since been replaced by the closely related Deltapine 16 variety.

The only other varieties of any signfiicance grown in Queensland are Hopicala and, more recently, Namcala.

Variety testing 1968 to 1974

In the period 1968 to 1974, an Advanced Strains Testing Programme was conducted to obtain a critical evaluation of the breeding ability and fibre properties of advanced breeding lines and newly introduced varieties. Trials were conducted each season at sites in all of the major Queensland cotton growing areas—Brookstead (Darling Downs), Biloela, Lockyer and St. George.

In this period, 55 different strains and varieties were grown in the trials. Sources of these strains included U.S.A., Africa and the breeding programmes of the Queensland Department of Primary Industries, the New South Wales Department of Agriculture and the C.S.I.R.O.

The method of testing involved the co-operation of cotton growers in each area, who made land available within their crops for these variety trials to be established. The trials were treated as parts of the commercial crops and as such received precisely the same treatment as the commercial crops. All trials were handled in this way except for those at Biloela where they were grown on Biloela Research Station under optimum conditions of irrigation, fertilization and weed and insect control.

Each plot consisted of four rows, 10 metres in length and each variety was replicated at least three times. Yield was measured by machine harvest of the middle two rows. Ginning was carried out on a small eight saw gin using 20-boll samples of seed cotton from each plot.

Factors which were measured at each site included yield, lint percentage, lint index, weight of seed cotton/boll, seed weight, fibre fineness, fibre length, fibre strength and elongation. Fibre fineness was measured on a micronaire instrument and strength and elongation on a stelometer.

Trial results 1972-73 to 1973-74

In these, the last two seasons of the series, 25 varieties were grown each year. This report presents the results for 12 of these (table 1). Riverina Poplar and Riverina Gold were produced by the C.S.I.R.O. at Griffith, N.S.W. They were bred for a short season environment and for stripper harvesting from closely spaced rows. As a result, they were not expected to be particularly useful in Queensland conditions. They are included because of interest from growers in this State. The other ten varieties gave the best results in the trials and represent a range of breeding material. Table 2 shows a summary of fibre and yield characters for the varieties.

Since cotton is marketed on a weight basis, with premiums and discounts for quality, the total yield is of prime importance to the commercial grower. Consequently, yield is the major character considered in the evaluation of variety trial results.

Quality, while of obvious value because of the premium and discount system, is of secondary importance to yield and is far more complicated to assess. Quality is measured in terms of grade, fibre length, fibre fineness and fibre strength. It is unlikely that the modern varieties should differ much in grade, length or fineness except where breeding for a special purpose has occurred. In fact, few differences in these characters show up in these trial results. On the other hand, there is considerable variation in fibre strength. While this does not usually affect the price of cotton directly, it has a considerable effect on the grade of lint produced and on its length after passage through ginning equipment.

Throughout the six seasons of the trial series, the Deltapine strains consistently produced the best lint yields and this remained true in 1972-3 and 1973-4.

One important reason for this is the high lint percentage (ratio of lint to seed cotton) which these strains show. Within this group, Selection 13 has been marginally better than the others at all sites, but the difference is very slight. Deltapine 5540 which develops

TABLE 1

COTTON LINT YIELDS (kg/ha) AVERAGE OF 1972–73 AND 1973–74 TRAILS

Variety	Biloela	Brookstead	Lockyer	St. George	Variety Average
Deltapine Selection 13	1 068	636	1 325	1 547	1 144
Hancock	956	797	1 265	1 454	1 118
Deltapine 16	973	621	1 349	1 513	1 114
Deltapine Small leaf	990	662	1 227	1 523	1 100
Pee Dee 4381	908	641	1 170	1 456	1 044
H62–8	969	593	1 127	1 450	1 035
Deltapine 5540	905	556	1 163	1 395	1 005
Hopicala	870	625	1 010	1 437	985
Acala 1517BRII	769	646	1 005	1 288	927
Riverina Gold	698	680	983	1 219	895
Acala SJ–1	797	491	990	1 297	894
Riverina Poplar	595	494	753	1 108	737
Site Mean Yield*	867	631	1 080	1 366	

* Site Mean Yield is the average of all varieties in the trial at each site.

TABLE 2

SUMMARY OF YIELD AND QUAILTY MEASUREMENTS

Variety	Lint (%)	Weight Seed Cotton/Boll	Fineness Micronaire	Strength (gm/tex*)	Elongation units	Staple Lenths (inches)
Deltapine Selection 13 ..	40·0	5·8	4·7	17·53	3·0	$1\frac{1}{32}$–$1\frac{1}{16}$
Deltapine Smalleaf	38·9	5·8	4·8	17·80	3·5	$1\frac{1}{32}$–$1\frac{1}{16}$
Deltapine 16	39·3	6·2	4·7	17·39	3·1	$1\frac{1}{32}$–$1\frac{1}{16}$
Deltapine 5540	39·1	6·3	4·4	18·61	2·2	$1\frac{1}{32}$
Pee Dee 4381	37·4	6·1	4·4	19·49	2·0	$1\frac{1}{16}$–$1\frac{3}{32}$
Acala 1517BRII	37·1	6·8	4·6	20·29	2·0	$1\frac{3}{32}$
Acala SJ–1	37·4	6·6	4·5	20·49	2·0	$1\frac{1}{16}$–$1\frac{3}{32}$
Hopicala	39·1	6·7	4·6	20·76	2·0	$1\frac{1}{16}$
H62–8	35·1	5·4	4·6	18·99	3·0	$1\frac{3}{32}$
Hancock	39·4	6·4	4·7	17·83	2·0	$1\frac{1}{32}$–$1\frac{1}{16}$
Riverina Gold	35·7	6·0	4·8	17·73	2·2	1
Riverina Poplar	35·9	6·0	4·7	18·45	1·9	1

* gm/tex x 4 approximates Pressley strength ('000 lb/sq. inch).

stronger and therefore higher quality fibre produced consistently lower yields than the other Deltapine strains at all sites.

As a group, the Deltapine strains produce fibre which is marginal in strength. It is, however, acceptable to the spinning industry. This is probably because of their high elongation ability. This elasticity allows a good yarn strength to be obtained from comparatively weak fibre.

Because of this deficiency in the otherwise excellent quality of Deltapine cotton, the Queensland Department of Primary Industries embarked on a programme of breeding and selection for strains with higher fibre strength. H62-8 is a product of this programme.

It is recognized, however, that high strength cottons do not yield as well. It is clear in these trials that the three Acala strains and Pee Dee 4381 have all yielded consistently below the Deltapine strains but have considerably stronger fibre.

H62-8 and Hancock both performed quite well. They represent a kind of compromise between yield and fibre strength, and have been included in the new series of trials.

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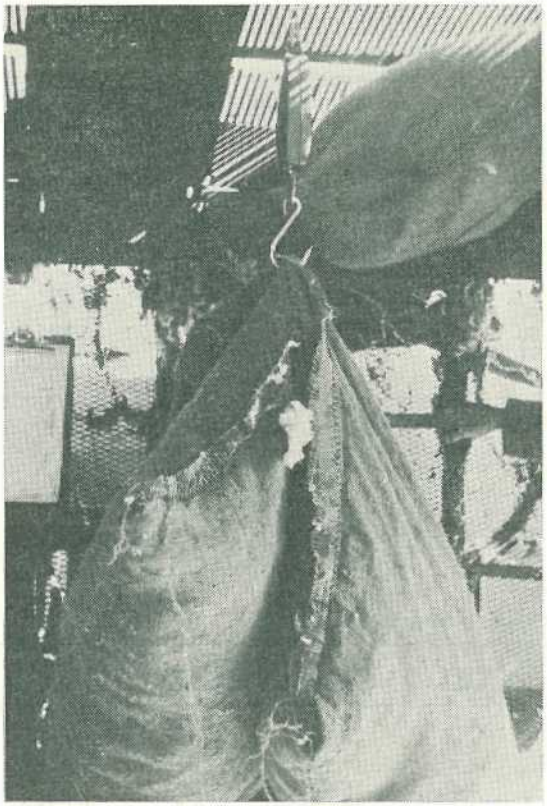


Plot yield measurement in cotton picker basket.

As expected, the two Riverina varieties performed badly. Yields were low and their quality was no better than that of the Deltapine group. They appear to have no value in Queensland under our present growing system.

Hopicala (and the selection from it, Namcala) which is grown to a small extent in Queensland, produces longer fibre of good strength. It is a fairly hairy plant and there are many difficulties associated with cleaning its long fibre. Spinners are not interested in paying premiums for cotton of this length and strength unless it is very clean.

Trials continue

Variety trials have continued since 1973–4 but now have an interstate flavour. As Australian Cotton Cultivar Trials, they are run in close co-operation with breeders from C.S.I.R.O. and the New South Wales Department of Agriculture. Varieties in this series are entered by the individual organizations and the same varieties are then grown at all sites in both States. This increases the range of environments in which co-ordinated testing is possible.

Deltapines best

As a summary, it is clear that, in the absence of greater emphasis on high strength fibre by the spinners in the form of incentive premiums, the higher yielding Deltapine varieties must still be recommended for commercial use. Their fibre quality is at least acceptable. Differences among commercial strains of Deltapine are very slight.

Acknowledgements

The conduct of these trials over such a long period was (and still is) only possible through the kind co-operation of a number of growers. We would like to express our gratitude to Messrs. Allan Brimblecombe, Ian Thomas, Jonathon Blight, Mike and Peter Thomas and Ray French on whose properties these trials were established. We wish also to acknowledge the assistance of Mr. K. G. Trudgian who constributed very much to the conduct of the trials. Fibre testing was carried out by Mrs. Lyn Eagles and Miss Jenelle Hare to whom we express our thanks.

The day-feeding armyworm in north Queensland

by R. H. BROADLEY,
Entomology Branch.

MANY primary producers on the Atherton Tableland have become familiar with the day-feeding armyworm.

This pest, known scientifically as *Spodoptera exempta,* belongs to a well established insect group, some members of which are of worldwide agricultural importance. It has been described as the most damaging of several armyworm species in Africa, and is also distributed through southern Asia, the Phillipines, the Hawaiian Islands and Australia.

Householders often encounter the female moth which has the annoying habit of depositing eggs in the vicinity of light fittings, on ceilings and on other household objects such as curtains. Insect screens will prevent moths entering internal rooms, but it is virtually impossible to prevent egglaying by moths attracted to external lights.

A mature maize crop severely injured by the day-feeding armyworm. Only some of the upper leaves and midribs of the lower leaves were left undamaged.

Developmental cycle

The life cycle of the day-feeding armyworm commences when a mated female lays eggs. Eggs are deposited in clusters of variable size and subsequently covered with fine scales from the tip of the abdomen. Each female has the capacity to lay many hundreds of eggs.

Development of newly laid eggs proceeds rapidly in warm midsummer conditions, and emergence of tiny larvae normally occurs within 3 to 5 days. Because they hatch en masse from the egg cluster, young larvae are often initially found in loose aggregations. However, as feeding continues, larvae may become more dispersed.

Each larva passes through several growth stages, which are marked by a shedding or sloughing off of the skin. Providing food is available and other conditions are favourable, full larval development can be achieved in 2 weeks. Larger armyworm larvae measure up to 3 cm in length and have a pattern of distinctive, longtitudinal bands and stripes running the full length of the body.

Day-feeding armyworms exhibit what is termed 'phase polymorphism' which means there is a solitary and gregarious phase.

- The solitary phase occurs when larvae are reared in solitary conditions. Such larvae show a considerable range of colour variations and are not prone to excessive movement.
- The gregarious phase is normally found when larvae develop under crowded conditions. These have a distinctive blue-black colouration and are inclined to excessive movement. The movement of ill-defined or well-defined groups of larvae across a paddock, together with the habit of feeding during daylight hours, has resulted in the coining of the common name—day-feeding armyworm.

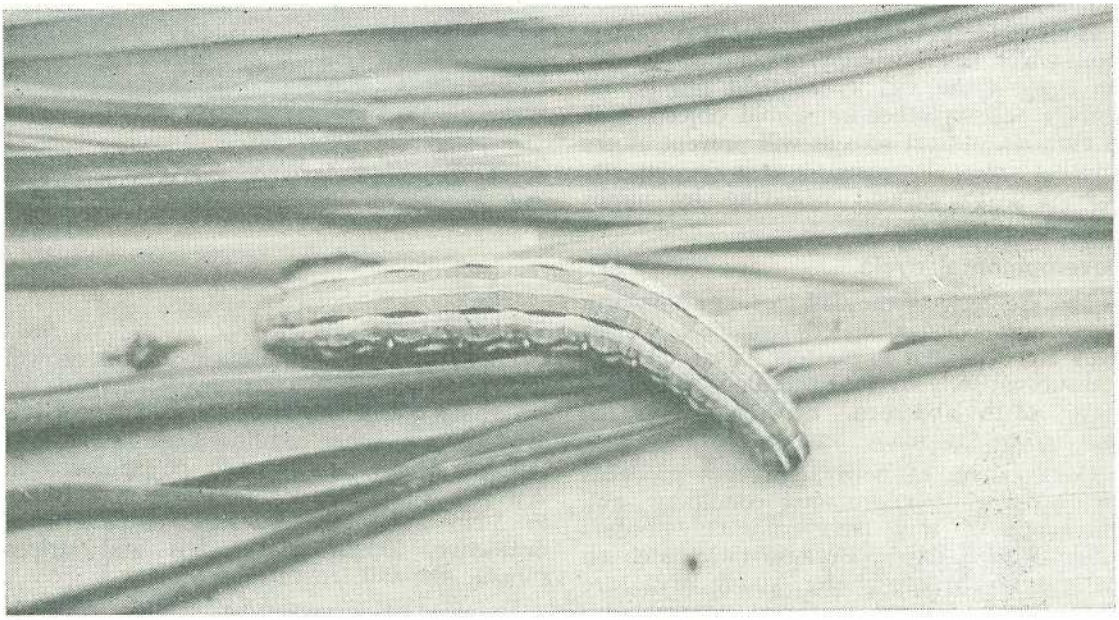
Groups of larvae can be quite large and on one occasion an army of larvae was recorded taking approximately 24 hours to pass a highway observation point. Aggregations of this size are more common in the wetter regions of the Atherton Tableland to Millaa Millaa than in the drier Mareeba-Dimbulah district.

Contrary to popular belief, movement by armyworms is not always a direct search for a new source of food—it is probably a response to crowded rearing conditions. It has been suggested that constant contact between larvae creates the gregarious phase. A similar process is related to swarming in certain grasshopper species.

When fully grown, larvae move down into the soil, construct a pupal chamber and transform into pupae. These may occasionally be found in sheltered sites on the soil surfaces, especially if the ground is quite hard. After an incubation period of several days, the drab-coloured adult moths emerge to mate, disperse and recommence the life cycle.

Plant damage and host species

The day-feeding armyworm feeds primarily on members of the grass family (Graminaceae). Important cultivated host crops include maize, sorghum and sugar-cane. Among other hosts in north Queensland are para, summer, molasses, guinea, love, red Natal, Rhodes and paspalum grasses. Various other plant families are attacked, but not relished, by armyworms. Preference for more competitive grasses, rather than newly germinated legumes, often allows legumes in a mixed pasture to become established more rapidly than usual.



Dorsal view of the lighter coloured 'solitary phase' of the day-feeding armyworm. The gregarious form found mostly in large aggregations of larvae has a dark blue or blackish colouration.

The feeding capacity of the last two larval growth stages is considerably greater than the earlier ones and, as a result, plant injury is much more severe. Furthermore, this damage is manifested over a short period (5 to 7 days) and many growers are shocked at the defoliation of an outwardly healthy crop that can occur between weekly inspections.

Armyworms select the softer plant tissues, and disregard the more unpalatable stems, leaf midribs, and seedheads. Several larvae commonly defoliate a single plant before being forced to move to a new feeding site. This type of damage can be quite spectacular when seen, for example, in a mature maize crop. Leaves (especially the lower leaves) are skeletonized and the surface of the ground beneath the plants becomes covered in a soft mulch of larval droppings (frass). The peripheries of such crops, adjacent to uncultivated grassy areas, are encountered first by moving groups of larvae and are normally the worst affected.

Seasonal incidence

In north Queensland, armyworms are most commonly found in the midsummer period between December and March. Although some localized damage occurs annually, it is only irregularly (once every 3 to 5 years) that armyworm populations reach levels where widespread problems occur. It has been noted that armyworm damage is more severe when the wet season is delayed.

A typical day-feeding armyworm problem occurred in early 1973 on the Atherton Tableland. This outbreak was correlated with an abnormal dry period lasting from October 1972 to the middle of January 1973. Armyworms, for reasons explained later, were able to breed and increase during this dry spell and so take advantage of grass growth resulting from rainfall in mid January. One month later, in February, a massive day-feeding armyworm outbreak developed and was followed by a smaller one in March. Thereafter, armyworm numbers declined rapidly. The sequence in which only one or two armyworm generations cause serious crop and plant injury appears to be characteristic of the species.

Natural causes of death

Natural mortality factors are probably responsible for the rapid disappearance of armyworm populations.

- Rainfall may have a twofold effect on the pests. Firstly, heavy falls can drown larvae, particularly smaller larvae, and can also kill pupae if the soil remains waterlogged for a prolonged period.

  Secondly, high humidity associated with wet weather, together with the presence of large numbers of larvae, promote the spread of fungal and virus diseases. An important fungal disease in north Queensland is *Nomuraea rileyi*, which forms a whitish or light green coating on the bodies of infected larvae. Epizootics of this disease can drastically reduce armyworm populations and may be the main reason why outbreaks last only one or two generations.

  Nomuraea rileyi is not as active during dry weather, and this could explain why outbreaks are most severe when the onset of the annual north Queensland 'wet season' is delayed.

- A number of parasitic wasps (families Braconidae and Ichneumonidae) and parasitic flies (family Tachinidae) can also be important. The wasp parasite *Apanteles* sp. can be recognized by the presence of small, fluffy, white pupal cocoons on the plants. On the other hand, fly parasites usually emerge from armyworm pupae formed beneath the soil surface and therefore are seldom seen by growers.

- Other armyworm predators include predatory bugs, cane toads and birds such as ibis.

Control

Control of day-feeding armyworms should only be attempted in the following circumstances:

A. When severe infestations in cultivated crops (for example, maize, sorghum) make heavy damage a distinct possibility. Growers should take the following factors into account before making an affirmative spray decision.

- Only parts of the crop may warrant remedial action, so a thorough survey of the distribution of larvae in a paddock before action is initiated is strongly recommended.

- More mature maize plants are less able to recover from armyworm damage than immature ones. Potential loss of yield, price of grain, and insecticide plus spray costs must be critically considered to determine whether control will be profitable.

- Large larvae can cause economic damage in a short period and therefore demand immediate control measures. Regular inspections of crops and pastures (for example, twice weekly) ensure the detection of smaller larvae which will have caused little damage. These inspections are necessary even during periods of wet weather.

B. When large numbers of larvae are recorded in an improved pasture suffering from a lack of water, economic losses are highly probable. However, growers should seriously consider whether or not spraying is necessary when adequate moisture is available for plant growth. Under such conditions, dry matter production often exceeds the demand for stock food and some armyworm damage can be tolerated.

C. When a grass species is being grown for seed production, prevailing market prices will determine the economics of spraying.

Should chemical control be warranted, growers are advised to spray with an insecticide listed in table 1.

TABLE 1

INSECTICIDES FOR ARMYWORM CONTROL

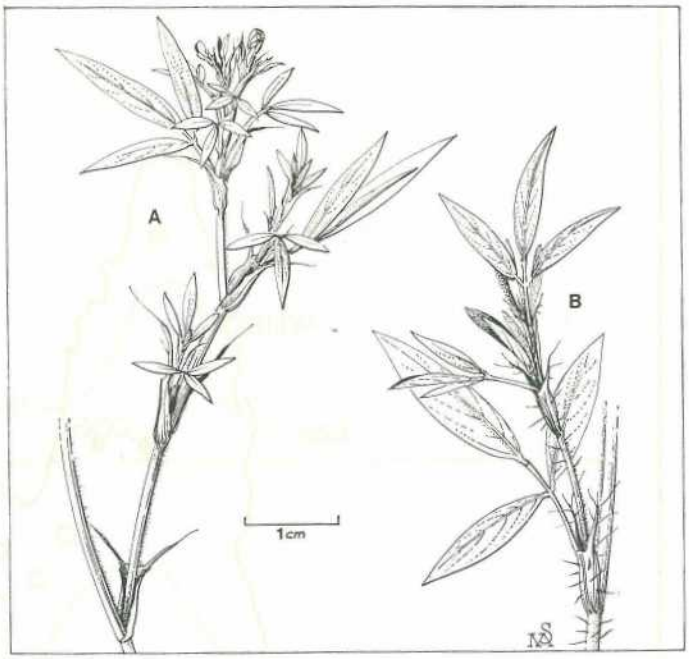
Chemical Name	Some Trade Names	Application Rate (Active Ingredient)	Withholding Periods To (Days)	
			Cereal Harvest	Grazing
Chlorpyrifos	Dow Lorsban 50 E.C.	350–450 g/ha	10	2
Trichlorfon	I.C.I. Klorfon Bayer Dipterex Liquid Bayer Dipterex S.P.80	550 g/ha	14	2
Madison U.L.V.	A.C.F.-Austral Malathion U.L.V. Cyanimid Malathion U.L.V. I.C.I. Malathion U.L.V. Lane Maldison U.L.V.	700 ml/ha	7	7
Diazinon	A.C.F.-Austral Diazinon 80 Gesapon 80 E.C.	800 g/ha	14	2
Methidathion	Supracide 40 E.C.	560 g/ha	42	7

NOTE

- Trichlorfon may be phytotoxic to some varieties of sorghum including Alpha and Pioneer 846.
- Maldison U.L.V. should only be applied via aeroplane.
- Insecticides should not be applied when rainfall is expected, or when plants are excessively wet.
- Withholding periods should be strictly observed.

Verano . . . A new stylo for the dry tropics

by P. J. McKEAGUE, C. P. MILLER and P. ANNING, Agriculture Branch.



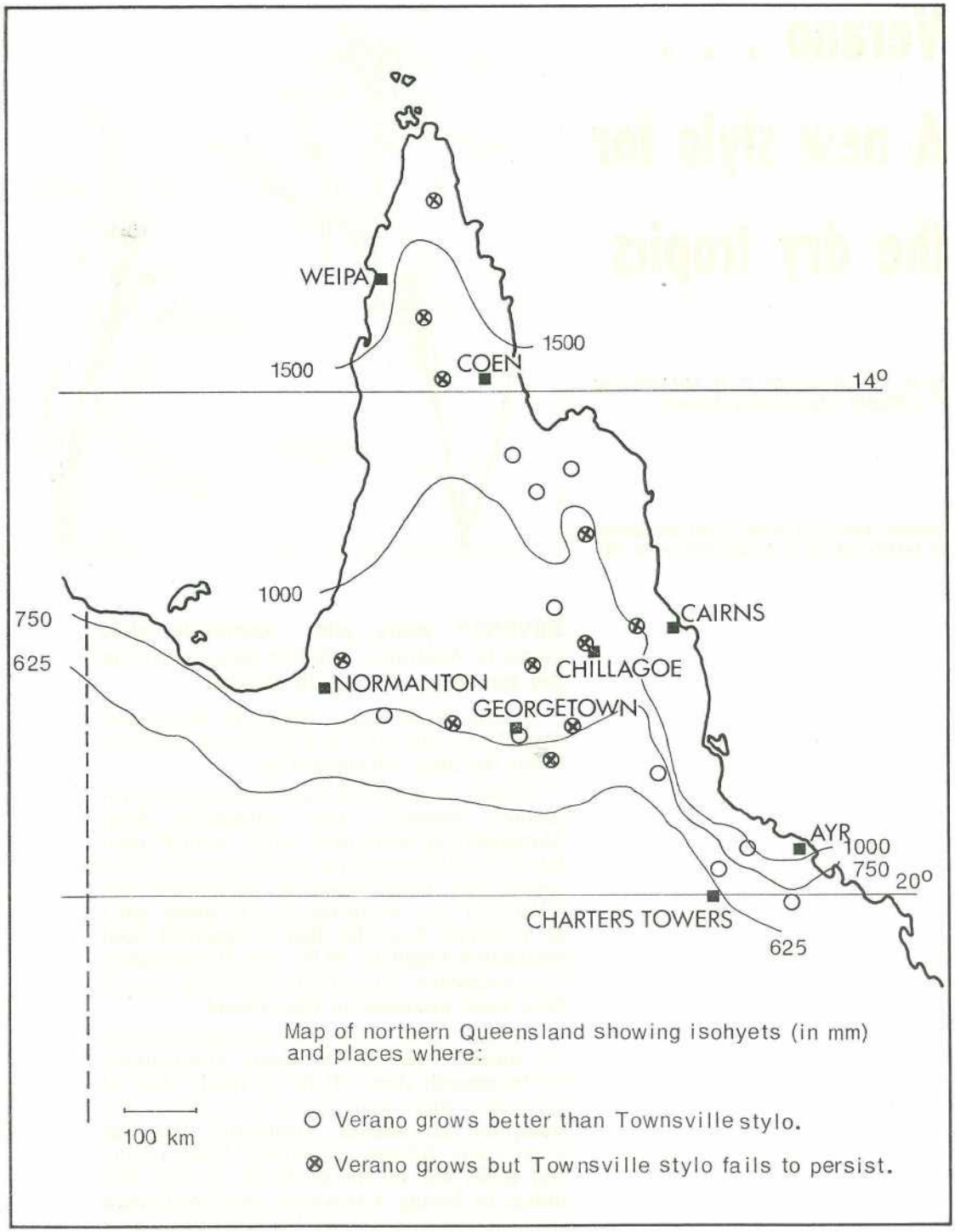
Smooth stems of Verano (A) compared to bristly stems of Townsville stylo (B).

SEVENTY years after Townsville stylo came to Australia, a better legume for the dry topics is now on the market.

Verano grows longer into the dry season than Townsville stylo and will grow in places where the latter will not survive.

Verano, a cultivar of Caribbean stylo (*Stylosanthes hamata*), was introduced from Maracaibo in Venezuela, where annual rainfall is less than 600 mm and temperatures are always high. It was grown in experiments from 1966 and was so spectacular in many parts of northern Australia that commercial seed production began in 1974, only 9 years after its introduction. Since then, 50 000 kg of seed have been produced in Queensland.

Verano looks very like Townsville stylo (*S. humilis*) but can be easily distinguished by its smooth stems. It has a similar line of very fine, white hairs down one side of the stem, but no bristles. Townsville stylo has conspicuous bristles around the bases of the leaf stalks and on the seedhead. Verano also differs in having a two-piece seed pod, each segment carrying a seed but only the upper one having a hook.



Map of northern Queensland showing isohyets (in mm) and places where:

○ Verano grows better than Townsville stylo.

⊗ Verano grows but Townsville stylo fails to persist.

Areas suitable

The success of Verano is shown on the map. This depicts both commercial experience and the results of C.S.I.R.O. and D.P.I. experiments. The map shows that this new legume grows in many places where Townsville stylo fails. In those areas where both legumes persist, Verano usually produces more forage. Three factors are involved, namely, soil type, climate and resistance to disease.

- SOIL TYPE—Verano competes better with grass and so can be grown on heavier soils than can Townsville stylo. It will grow on soils ranging from sands to clay loams but not on heavy clays. Townsville stylo is a weak competitor and has been restricted to sandy soils. An exception is in heavily grazed areas where grass growth is reduced.
- CLIMATE—Verano is better suited to areas of erratic rainfall than Townsville stylo because it can flower at any time. Unlike Townsville stylo, the plant flowers while still actively growing. Verano can persist in annual rainfall environments as low as 600 mm. Although it is quite successful under high rainfall, more productive legumes may be preferred above 1 200 mm.

  Like Townsville stylo, Verano does not grow or flower well when nights are cool (minimum below 20°C). Thus it also is unsuited to highland areas. Frost kills the top growth but most plants survive.
- DISEASE—Verano is quite resistant to anthracnose, a leaf and stem spotting disease. Since 1973, and particularly in wet years, this disease has severely attacked dense Townsville stylo pastures reducing both forage and seed production.

Better grazing

The best indication that Verano's higher yields and longer growing season give practical benefits has come from Wrotham Park, near Chillagoe. Average annual rainfall here is about 900 mm. Since the late 1960s, Mr Gordon Arnold, manager of Wrotham Park, has been developing fertilized Townsville stylo pastures on poor tea-tree (*Melaleuca* spp.) country. These pastures have been very successful and now cover more than 8 000 hectares.

On the same country, stocked at a steer to 1·25 hectares, cattle grazing Verano gained weight for a month longer into the dry season and started growing a month earlier at the beginning of the next wet season than cattle grazing Townsville stylo. Mr Arnold was impressed sufficiently to plant 800 hectares to Verano as soon as he could get seed.

Easier sowing

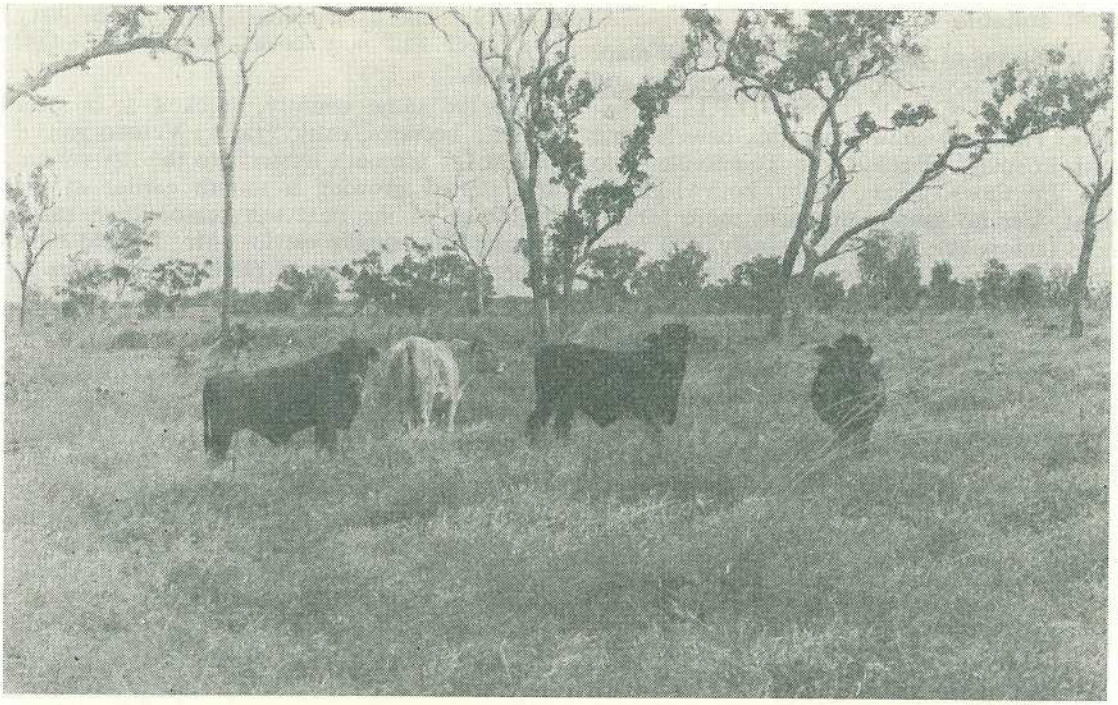
Verano can be sown in exactly the same way as Townsville stylo. It has a notable advantage in that the seeds do not hook together in clumps. By far the cheapest way of getting a Verano pasture is to sow the seed just before the wet season into burnt or short grass. Aircraft or ground equipment can be used, but markers are needed for accurate aircraft sowing into standing timber.

It may be necessary with some equipment to mix the seed with about five times the volume of filler (sawdust, superphosphate). Sowing rates of 1 to 4 kg per ha have been successful, though a quick cover will rarely result from less than 2 kg per ha. Because Verano spreads readily, partial (strip) sowing can be used to reduce costs. Sowing strips across the slope assists spread by movement of seed in run-off water.

As with Townsville stylo, Verano is more productive on country that has been cleared, cultivated and fertilized. This, with superphosphate at 200 kg per ha and seed at 5 kg per ha or more, is essential in paddocks used for hay production. As with Townsville stylo, Verano hay paddocks need resting from hay harvesting every third or fourth year to allow seed reserves to build up.

Grazing

Newly sown Verano needs early grazing to check grass growth and to encourage the legume to branch. Spelling in the April to June period of the first year encourages seed set. This can be overdone, however, and if Verano grows and flowers unchecked for too long, it may drop its leaf and die. Regeneration from seed is usually reliable, but weeds are more likely to invade when the legume is allowed to act as an annual.



ABOVE. Steers grazing Verano at Wrotham Park.

BELOW. Close-up of Verano at Wrotham Park.

Verano is at its best and cattle prefer it during the seeding period. There is no point in saving much for the late dry season; grazing aimed at leaving a 10 cm stubble by July or August will make best use of wet and dry season growth.

Seed production simple

Seed growing is straightforward, and methods developed for Townsville stylo give yields of 300 to 600 kg per ha. Regular renovation may be required to even up the stand and to kill old, weak plants. Seed handling and cleaning is easier because the seeds do not bunch, but has the complication of dealing with two kinds of seeds, hooked and hookless.

Bright future

Verano will probably replace Townsville stylo for new pastures, as well as providing a legume for some areas where Townsville stylo fails. As a hay crop, Verano will produce higher yields. Like Townsville stylo, Verano is protected from fire by having some hard seed.

The costs of obtaining pastures of this longer-lived and more versatile legume are about the same as for Townsville stylo, and seed is available commercially at comparable prices.

TABLE 1
VERANO AND TOWNSVILLE STYLO COMPARED

—	Verano	Townsville stylo
Identification:		
Bristles around nodes of stem	no	yes
Seed pods hooked	half (more or less)	all
Growth:		
Plants surviving for more than one year	often	never
Flowering before growth ceases	yes	no
Growth in dry season	some	none
Climate:		
Lower rainfall limit	600 mm	700 mm
Winter rain response	grows	spoils
Soil:		
Heaviest suitable	clay loam	loamy sand
Survival with water-logging	high	moderate
Grazing:		
Competition with grass	fair	poor
Most palatable period	March–July	March–July
Period of no forage	none	month after first rain

Brand returns

Did you know that:

- The brand return and stock return you have been submitting are two entirely different returns required by different Acts of Parliament and used by different sections of the Department of Primary Industries?
- Brand returns are still required and should be submitted on January 1 each and every year?
- There is no fee associated with a brand return?
- If a brand return is not submitted for three consecutive years, your brand can be cancelled under Section 18 of the Brands Act, 1915–1975?

For further information on brand returns contact:

The Registrar of Brands,
Department of Primary Industries,
William St.,
Brisbane. 4000.

Release of QP2B

a random mating grain sorghum population

by R. G. HENZELL and P. J. KEYS, Agriculture Branch and M. S. VINCENT, formerly of Agriculture Branch.

SORGHUM breeders have had limited success when endeavouring to improve characters, such as grain yield, which are controlled by many genes.

The use of traditional breeding methods (pedigree and backcross) is probably one reason why this lack of improvement has occurred. A similar situation was experienced by maize breeders. This was the stimulus that made maize breeders in the 1950s and 1960s and sorghum breeders in the 1970s adopt a new breeding method for yield called 'population breeding'.

Results to date in maize have been encouraging and limited results from Uganda and Nebraska indicate that some real improvement has also been achieved in grain sorghum.

Population breeding differs from the usual use of pedigree and backcross breeding in that recurrent selection and recombination of selections are the key operations. In population breeding, selections are made from within a segregating (that is, genetically variable) population and these selections are then recombined (that is crossed together in all combinations) to give the next generation. The same process is repeated (hence recurrent selection and recombination) for as many generations as desired.

The theory is that the population gradually improves because the frequencies of desirable genes and gene combinations are increased with each generation of selection. The theory also is that inbred lines (which can be crossed to produce the hybrids grown by graingrowers) derived by inbreeding from the improved population should be better than those derived from earlier stages of the population.

The population breeding method also allows the breeder to incorporate a wide genetic base by the use of a number of genetically diverse parents and the method is designed to conserve, in part at least, the genetic variability (which must obviously be present for selection to be effective) of the base population.

Recombination of selections is simple in a cross pollinated crop such as maize but in sorghum, which is mainly self-pollinated, genetic male-sterility is usually used.

In the early 1970s, the Queensland Department of Primary Industries sorghum breeding team under the direction of the late R. F. Moore initiated a population breeding programme. Two populations have been set up—QP1R and QP2B, the former being a population of R lines (which can be used as the male-parents of hybrids), and the latter a population of B lines (which can be used as the female parents of hybrids).

QP1R is still in the process of being developed whereas QP2B's development is now completed and selection in it can therefore commence. In general, the development process involves introducing the genetic male-sterility gene, ms_3, into the component lines by backcrossing. The component lines are then crossed in all combinations. Crossing, with the aid of the genetic male-sterility, amongst plants in the population thus formed is then continued for three generations to ensure thorough 'mixing'.

The component lines of QP2B, which are now being released to Government and private plant breeders, are as follows: Wheatland, KS4 (a red-seeded Combine Kafir-60), Tx618 (a head smut resistant Combine Kafir-60 type), Redbine 66, Redbine 3042, KS24, N34, I.S.3922, B120, Q7624C, B132 and B124.

Selection in QP2B commenced during the summer of 1977–78. Separate selection programmes will be conducted for central Queensland (based at Biloela Research Station) and for southern Queensland (based at Hermitage Research Station). Results from 5 to 6 years' selection will indicate the effectiveness of this relatively long term method of breeding grain sorghum.

Soybean growing in the South Burnett

by E. C. Gallagher,
Agriculture Branch

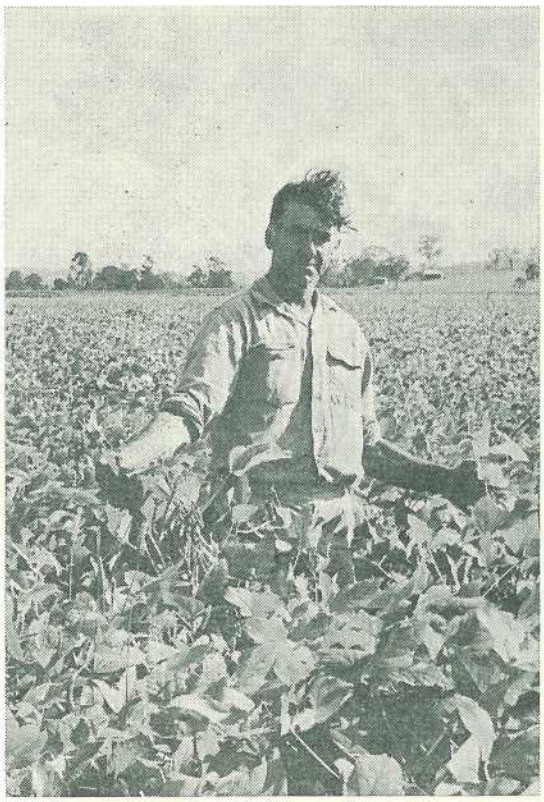
SOYBEANS have been grown in the South Burnett since 1935.

In the period to 1968, several hundred varieties were imported and tested but only two, Nanda and Yelnando, were grown commercially in the district. These varieties were prone to shattering, so local breeders produced Mamroy, Delroy and Semstar which were more amenable to harvesting.

In the early 1970s, soybeans became more commercially important and attracted higher prices. A concentrated effort was made to improve the varietal situation. New varieties were released and the 'old', with the exception of Semstar, were replaced. Some of the newer ones such as Hill, Hood, Wills and Leslie have themselves been replaced (or are being replaced) by more recently improved varieties.

The South Burnett accounts for approximately 15% of Queensland production. Peak production was reached in the 1974/75 season when returns were at a record level. Although production fell with reduced prices in the 1975/76 season, levels will increase if higher returns are realized in the future.

Details of production in the region, over the last 4 years, are given in table 1.



Max Grimmett of Brooklands with a good crop of Bragg soybeans.

Arthur Whieldon formerly of Brooklands inspecting a well grown crop of Semmes soybeans.

TABLE 1

SOYBEAN AREA, PRODUCTION AND YIELDS IN THE SOUTH BURNETT REGION

Season	Area (hectares)	Production (tonnes)	Yield (tonnes/hectare)
1972–73	3 425	3 553	1·037
1973–74	6 500	6 000	0·923
1974–75	7 338	9 138	1·245
1975–76	4 000*	5 000*	1·250*

* Estimated

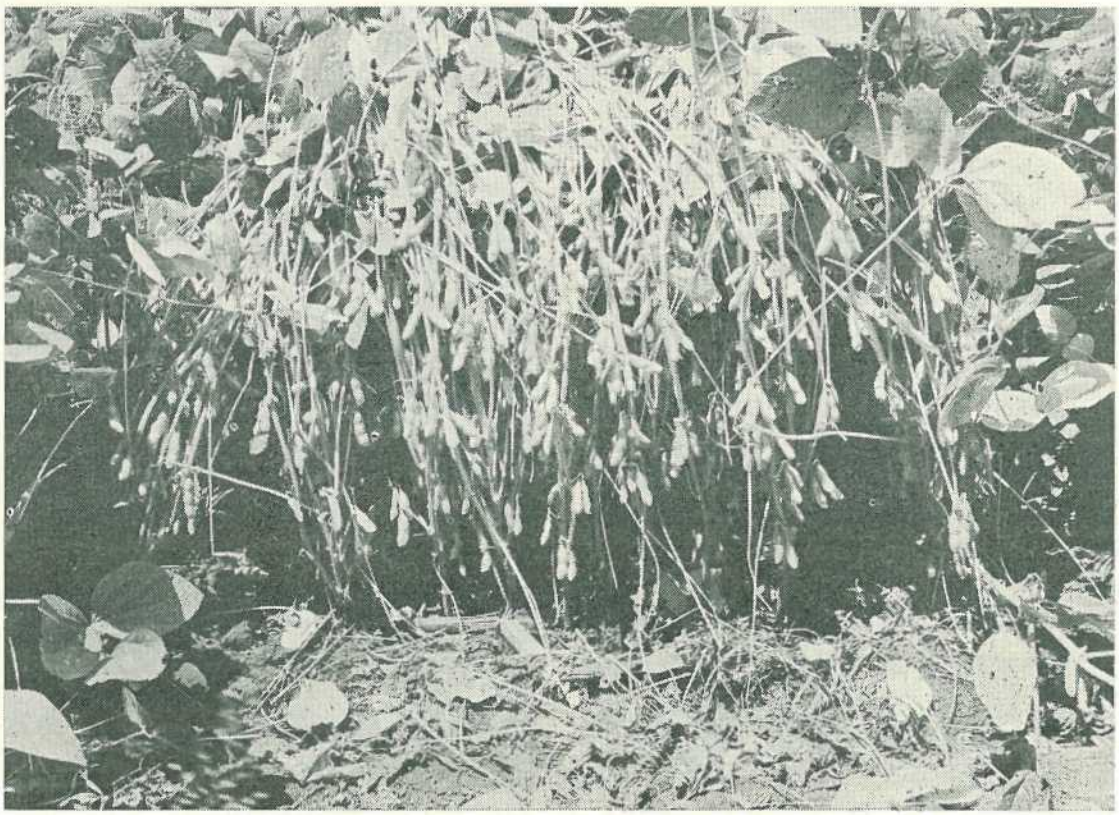
Soils and fertilizers

The heavier soil types in the South Burnett have proved to be the most consistent producers of soybeans mainly because of their higher inherent fertility and higher moisture holding capacity. It is only recently that production has moved into this area from the traditional red soil belt.

Soybeans can be grown in almost any soil type though they do best in soils slightly acid in nature (pH 6.5 to 7). More acid soils should be limed for best results. While inoculation was not deemed necessary in the acid red soils in the early days, it is essential in new areas and particularly in the heavier, more alkaline soils.

Soybeans can withstand periods of waterlogging and even flooding, particularly if they have sufficient vegetative growth. However, aeration is necessary for the nitrogen fixing bacteria in the root nodules to maintain efficiency in supplying nitrogen.

No fertilizer is recommended on most of the dark grey (black) soils provided the soil is well worked and the seed is inoculated. Superphosphate is required on all other soil



Hood soybeans

Bragg (left) and Davis (right) soybeans ready for harvest.

types especially where the soil test shows less than 25 p.p.m. of acid extractable phosphorus. Depending on soil content, up to 45 kg per ha of phosphorus may be required. Potassium is required on most of the poorer red, brown and grey forest soils. The critical level appears to be between 60 and 80 p.p.m. Nitrogen is not generally needed but may be required on hastily prepared ground, on areas with excessive amounts of unrotted organic matter, or on excessively water-logged ground.

Although moderate amounts of superphosphate can be applied with the seed, it is advisable to separate seed and fertilizer at planting. While nitrogen and potassium can and should be applied separately before planting, it is recommended that phosphatic fertilizers be applied in a band about 5 cm to the side of the seed at planting for best results.

Rotation

As peanuts and navy beans are grown almost exclusively on the more friable loams, another legume such as soybean is not an ideal rotation crop in this situation. Much of the reduction in area sown to soybean in the 1975/76 season occurred in areas of these soil types.

The heavier soils are more suited to soybean growing and future production will probably be concentrated on these soils. Grain sorghum is the main rotational crop but lucerne, wheat, barley and maize are also used. Barley, followed by soybeans is a common rotation with sorghum being used sometimes in an alternate year. However, soybeans appear to do best following maize or lucerne.

Varieties

Considerable experimentation has been directed towards finding soybean varieties suited to the South Burnett region. While many varieties have shown some potential, the district recommendations have been limited to Bragg, Davis and Semstar. Davis, though the most consistent variety in respect of yield, is only recommended where there is easy access to harvesting machinery as it shatters readily 2 or 3 weeks after maturity.

Collee, an early maturing variety similar to but more resistant to shattering than Hill, is now being recommended for trial areas. Flegler, a mid season variety, has performed well in trials and should prove a valuable addition to the varietal material available in the near future.

Late or slow maturing varieties such as Hampton are not recommended. Their longer growing season exposes them to rust attacks which tend to occur late in the season. They are also liable to suffer yield losses from moisture stress during the pod-filling period which extends into the normal dry autumn.

Details of results of variety trials are given in tables 2 and 3.

TABLE 2

AVERAGE OF RESULTS OF EIGHT VARIETY TRIALS CONDUCTED AT KINGAROY SINCE THE 1972/73 SEASON

Variety	Yield (kg/ha)	Plant height (cm)	Height of lowest pods (cm)
1. Davis ..	2 023·9	78·9	15·0
2. Flegler ..	2 009·1	68·1	13·4
3. Bragg ..	1 894·4	76·0	14·7
4. Collee ..	1 869·7	70·7	12·9
5. Semstar	1 861·7	86·3	15·5
6. Hampton	1 784·5	72·1	16·3
7. Hill ..	1 781·3	76·7	14·0

Shattering 3 to 4 weeks after maturity was quite severe in Davis and Hill, moderate in Semstar and insignificant in the other varieties.

Land preparation and tillage

Soybeans can be grown successfully in a double cropping situation with winter cereals. Best results are invariably obtained following thorough land preparation. This will provide a good seed bed, better weed control and good subsoil moisture reserves.

Weed control is essential in the seedling stages and two strategic inter-row cultivations will usually be sufficient until the plants are big enough to shade out further regrowth. Shallow cultivation is necessary to prevent damage to the prolific surface root system and to avoid too big a hill around the plant. Such a hill hinders the harvesting operation.

Should emergence be affected by soil compaction due to heavy rain or hail following planting, an early light harrowing may assist. Care must be taken not to run directly over the planted row.

Time of planting

Under rain-grown conditions, deciding on a planting time is not always easy. As a general rule, a proportion (say 25 to 30%) of the crop should be planted after the first suitable rains in mid November. Planting should be completed by mid December. Invariably, most crops are planted in December and good results can be obtained until mid January.

Too early planting on ideal soil types is a disadvantage as the bush grows too prolifically. This encourages lodging and disease and may also lead to crop failure in dry weather.

Inter-row spacings

The main factors influencing inter-row spacings are soil moisture reserves (or availability of irrigation), weed control methods and planting equipment. In weed-free situations or where weeds can be controlled chemically, any inter-row spacing which fits the planting equipment can be used. As mechanical weed control and row crop equipment is generally all that is available in this area, the same inter-row spacing that is used for peanuts, maize and grain sorghum is used. This spacing varies from 70 to 100 cm.

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TABLE 3

SOYBEAN VARIETY TRIALS IN THE NORTH AND SOUTH BURNETT REGIONS
MEAN YIELDS IN kg PER ha

Varieties	Kingaroy 1972–73	*Monto 1972–73	Kingaroy 1973–74	Kingaroy 1973–74 †	Monto 1973–74	Kingaroy 1974–75	Kingaroy 1974–75 †	Kingaroy 1975–76	Kingaroy 1975–76 †	Cloyna 1975–76	Monto 1975–76	Means
Bossier	..	..	..	..	..	..	..	1 959	1 674	2 310	3 304	..
Davis	2 569	2 422	1 917	1 052	1 332	2 044	2 187	2 057	1 799	2 581	3 455	2 129
P24	..	..	..	..	..	..	..	2 085	..	..	..	..
Flegler	2 657	2 277	2 024	1 013	1 326	1 919	2 089	2 120	1 674	2 581	3 100	2 071
Rhosa	2 283	1 816	..	..	..	..	..	..	..	..	..	..
Bragg	2 439	2 785	1 913	1 113	1 342	1 939	2 207	1 760	1 502	2 355	2 649	2 000
Collee	2 832	..	1 889	1 070	..	1 580	1 900	1 950	1 535	2 264	2 977	2 000
P25	..	..	..	..	..	..	..	1 965	..	..	..	..
Hood	3 050	2 228	2 198	1 144	1 333	1 610	2 153	..	..	..	..	1 959
P13	..	..	..	..	..	..	..	1 959	..	..	..	..
Wills	1 736	2 325	1 974	1 190	1 274	2 039	1 952	1 941	1 516	2 355	3 072	1 943
P3	..	..	..	..	..	..	..	1 941	..	..	..	..
Semstar	1 634	2 277	1 915	1 105	940	1 976	1 991	2 031	1 597	2 762	3 031	1 933
Semmes	2 437	2 688	2 026	1 155	1 444	1 791	1 808	..	..	..	..	1 907
70/39	..	..	2 100	1 298	857	1 850	2 017	1 970	1 752	2 400	2 786	1 892
Hill	2 253	2 495	1 847	1 244	1 283	1 632	1 806	1 702	1 713	1 993	2 472	1 858
Ruse	..	..	..	..	..	1 660	..	1 824	1 567	2 355	..	..
HR2	2 503	..	2 102	1 102	..	1 468	1 837	..	..	..	..	..
P10	..	..	..	..	..	..	..	1 802	..	..	..	..
Hampton	1 984	1 768	2 183	1 251	864	2 009	2 081	1 787	1 405	1 721	2 649	1 791
Leslie	2 085	2 470	1 767	1 179	1 176	..	..	..	..	..	..	..
Pickett	2 349	872	2 281	972	1 102	..	..	..	..	..	..	..
Means	2 344	2 202	2 010	1 135	1 189	1 809	2 002	1 928	1 612	2 334	2 950	..

* Denotes irrigated trial.

† Denotes late planted trial.

When planting late (January), closer inter-row spacings and increased planting rates are a distinct advantage. Later plantings produce smaller plants and closer spacing between the plants assists in obtaining a complete canopy cover to smother weeds.

Planting rates

A population of 250 000 to 300 000 plants per hectare is recommended so a planting rate of 25 to 30 seeds per metre of row is necessary. Under irrigation, this should be increased by at least 25%.

An even stand is required for maximum yield, most efficient weed control and easier harvesting. A closer plant stand helps prevent branching and setting of pods close to the ground.

Soybeans can be planted through most planting equipment. The basic requirement is a shallow (no deeper than 5 cm), even depth. Deep planting is not recommended as emergence is reduced. Very light rollers can be used though heavy rollers or compacting equipment such as tractors or planter wheels must not run over the row. Split press wheels followed by light covering harrows are the most effective means of ensuring good emergence.

Weed control

Broad-leaved weeds and grasses can be a serious problem in soybeans in the South Burnett. Heavy weed infestation after crop emergence usually results in a reduction of grain yield. Weeds such as thornapples (*Datura* spp.), Noogoora burr (*Xanthium pungens*) and bellvine (*Ipomoea plebeia*) can seriously hinder harvesting of the grain.

The soybean crop will suppress weed growth once a complete canopy cover is obtained soon after flowering. Early weed control is essential and one or two inter-row cultivations is all that is generally necessary.

However, if weeds are a problem, chemical control measures can be employed and their use is becoming more widespread in the district. Herbicides which control weeds pre-emergence are trifluralin (marketed as Treflan), chlorthal (marketed as Dacthal) and linuron (marketed as Afalon). Trifluralin is the most widely used. It controls most annual grasses and some broad-leaved weeds including pig-weed (*Portulaca oleracea*), fat hen (*Chenopodium album*) and amaranths (*Amaranthus* spp.). Trifluralin is applied pre-planting at the rate of 1.4 to 2.8 litres per hectare and must be immediately incorporated in the soil using disc or tine implements.

Chlorthal and linuron are applied post-planting and control similar weeds to trifluralin. However, they are rarely used in the South Burnett because they are expensive and require rain or overhead irrigation to activate the chemical.

Recently, a post-emergence herbicide has been registered for use in soybeans. It is bentazone (marketed as Basagran) which controls broad-leaved weeds resistant to trifluralin such as thornapples, Noogoora burr and bellvine. Bentazone is applied at the rate of 1.5 to 2 litres per hectare while the weeds are very young.

Hormone-type herbicides must not be used as soybeans are not resistant to them. Hormone-contaminated spray equipment should not be used and care should be taken to prevent spray of these herbicides drifting on to soybeans while spraying other resistant crops.

Irrigation

Soybeans respond well to irrigation and a strategic watering at flowering time is all that is usually necessary to ensure a good crop. For top yields, a high soil moisture level should be maintained until the grain is well filled.

Pests and diseases

Soybeans are relatively pest and disease free. However, green vegetable bug, Heliothis and loopers are insects which may build up into pest proportions. For further information on the green vegetable bug and its control see the *Queensland Agricultural Journal*, September 1971.

Rust can be a problem. Control measures are available but must be applied early. The effects of rust can be minimized by not planting late maturing varieties.

Wildfire attacks the Semstar variety. However, as the other recommended varieties are resistant to this disease, it is no longer a major problem.

The effect of *Sclerotinia* can be minimized by using wider row spacings and avoiding early planting. This produces smaller bushes and gives greater aeration. Crop rotation with resistant crop species also helps.

Bacterial blight and sudden wilt (*Macrophomina phaseoli*) are also present to varying degrees in the district. For further information on soybean diseases see the *Queensland Agricultural Journal,* June 1974.

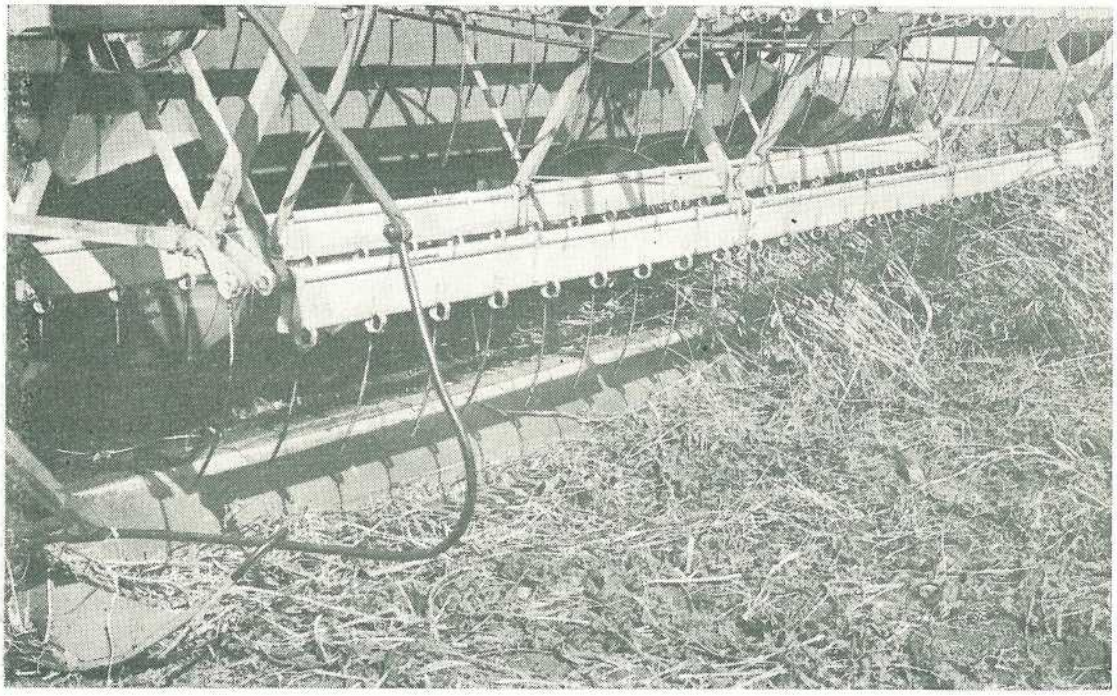
Harvesting

Harvesting should commence as soon as possible after maturity. This will reduce losses from shattering but may necessitate subsequent grain drying.

Combine harvesters successfully harvest soybeans and the manufacturers' recommendations should be consulted. Drum speed and ground speed should be slow. Comb height should be as low as possible to avoid missing low set pods but not so low as to pick up extraneous matter such as sticks, stones and soil. The use of a floating cutter bar has many advantages and in many instances will pay for its cost in one season. It allows the crop to be cut low and provides the operator with an added insurance against header damage.

ABOVE. Harvesting Semstar soybeans on the property of Elmo Semgreen at Wooroolin.

BELOW. Harvesting Bragg soybeans with a floating cutter bar fitted to a John Deere header on Elmo Semgreen's property at Wooroolin.



Yields

Considerable expertise is necessary to produce high yielding crops. A yield of 1·5 tonnes per hectare should be expected but experienced growers consistently achieve yields of 2·5 tonnes per hectare.

Marketing and returns

Soybeans are normally marketed under contract to processing companies. The price paid is subject to the laws of supply and demand and more particularly to world vegetable oil prices. Small sales are made privately, particularly for seed supplies or for the human food trade.

All contracts should be carefully studied before signing. The price paid can be subject to conditions such as extraneous matter, moisture content, oil content, storage, terms of payment and seed supplies. The average price paid for soybeans in the 1975-76 season was $140.00 per tonne.

GROSS MARGINS FOR SOYBEAN PRODUCTION

Price $ per tonne	Gross Margins	
	Yield 1 200 kg/ha	Yield 1 800 kg/ha
140	86	170
180	134	242

Variable costs approximate those for maize production and for the 1976/77 season are estimated at $82 per hectare. These costs include seed, fertilizer, insecticides, herbicides, tractor running costs and contract harvesting. Gross margins, which differ from net profit by not allowing for fixed costs, are the most convenient way of comparing profitability of alternative crops. If the yield of soybean is 40% of that of sorghum or maize, the figures suggest it can be just as profitable.

Cattle earmarks

Did you know that:

- Cattle earmarks can only be registered **in conjunction with** a three piece horse and cattle brand?
- Cattle earmarks must not be made on a beast **unless** the beast has been branded with a three piece, or symbol, horse and cattle brand?
- Cattle earmarks are registered by district and cannot be used outside the district for which they are registered?

For further information on the registration and use of cattle earmarks contact:

The Registrar of Brands,
Department of Primary Industries,
William St.,
Brisbane, 4000.

Field techniques and economics of beef A.I. programmes

BEEF producers conducting A.I. programmes on their properties are aware that any long term profits will be derived only from programmes based on sound genetic and technical principles.

The purpose of this article is to review the technical guidelines for maximizing profits or minimizing losses.

Organization of the programme

Choice of females

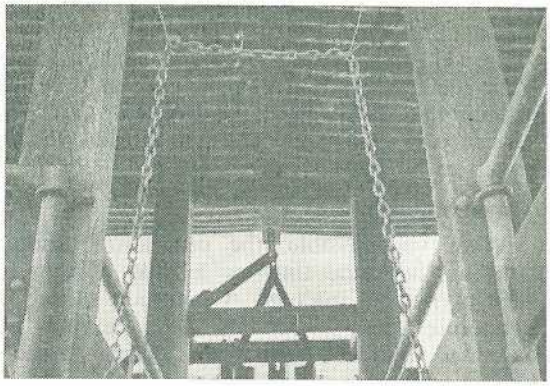
Selected females for A.I. need to be empty, disease free, cycling and in forward store condition. Cows suckling calves less than 50 days of age should be excluded because of the probability of lowered conception rates. When possible, the first calf cow should also be avoided partially because she is susceptible to nutritional stress and partially because she is an inexperienced mother.

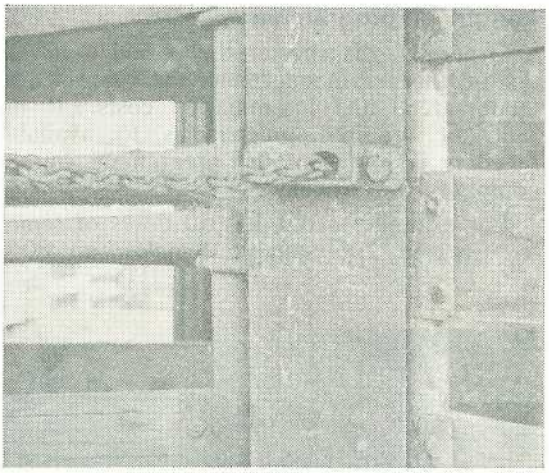
In making a decision to inseminate maiden heifers, you should consider their age and weight, the breed and size of sire and the experience of the inseminator. Heifers are also easier to handle than cows and calves in the A.I. programme.

Feed supplies

Animal body condition should be forward store or better and nutrition should be sufficient to produce weight gains. The essential problem is the supply of the maximum amount of feed in a small area (to minimize oestrus detection costs).

by W. J. A. HALL, Beef Cattle Husbandry Branch and F. W. QUINTON, Dairy Cattle Husbandry Branch.





TOP. Tindall chain in hanging position at rear of crush—'Impari', Wolvi.

CENTRE. Tindall chain lock through post—'Impari', Wolvi.

BOTTOM. Side tyre used to ease inseminator arm fatigue.

Each property faces its own nutritional constraints and will tackle the problem in different ways. However, the system of bushing cows from the observation area as soon as they are inseminated rather than waiting for a second service can reduce the amount of feed needed by up to 50%.

Time of year

Whenever possible, the programme should start at the same time or a little before the start of normal mating. A common source of economic loss is holding cows empty for extended periods before the commencement of A.I.

Length of programme

Generally, the shorter the period that A.I. disrupts normal management, the lower will be labour, feed and insemination costs. If the ratio of required pregnancies to available breeders is low then the programme can be completed very quickly.

For example, if one has 50 doses of semen to use and 200 suitable females, an 80% oestrus detection programme will mean the completion of A.I. in 7 days.

Facilities

The provision of luxurious cattle handling equipment has a very marginal effect on results.

Wooden crushes are preferred to metal because of the noise factor. The provision of shade, clean water and cement crush floors are essential. A popular combination for insemination is a 'Tindall chain' to restrain the animal and a side tyre to ease arm-fatigue. With excitable cattle, the provision of a pacifier cow or the use of the 'Warlana black box" is justified.

Identification

Although not ideal, the flexible plastic ear-tag appears to be the best alternative. Where a permanent A.I. herd is being maintained, freeze branding is valuable. Cutting out cows on heat can be simplified if calves are identified with mothers.

Chin-ball harness.

Heat detection

In Queensland, it is probable that the greatest increases in conception rates on many properties will come from improved methods of heat detection. Several studies have demonstrated that the so-called silent heats and other assumed causes of failure are inversely proportional to the intensity and effectiveness of detection.

Visual observation of standing heat and other physical symptoms remains the basis of efficient detection. However, there is a clear role for some of the aids to detection.

The mechanical heat detectors (for example, Kamar, Matemaster) are often effective under extensive conditions but are costly and labour consuming in their initial application.

An alternative is the use of paint (5 cm square) applied to the backbone 15 to 18 cm forward of the hilt of the tail. During standing heat, the paint is completely rubbed off. The paint should be touched up on a weekly basis. Plastic paints are thought to be the most effective.

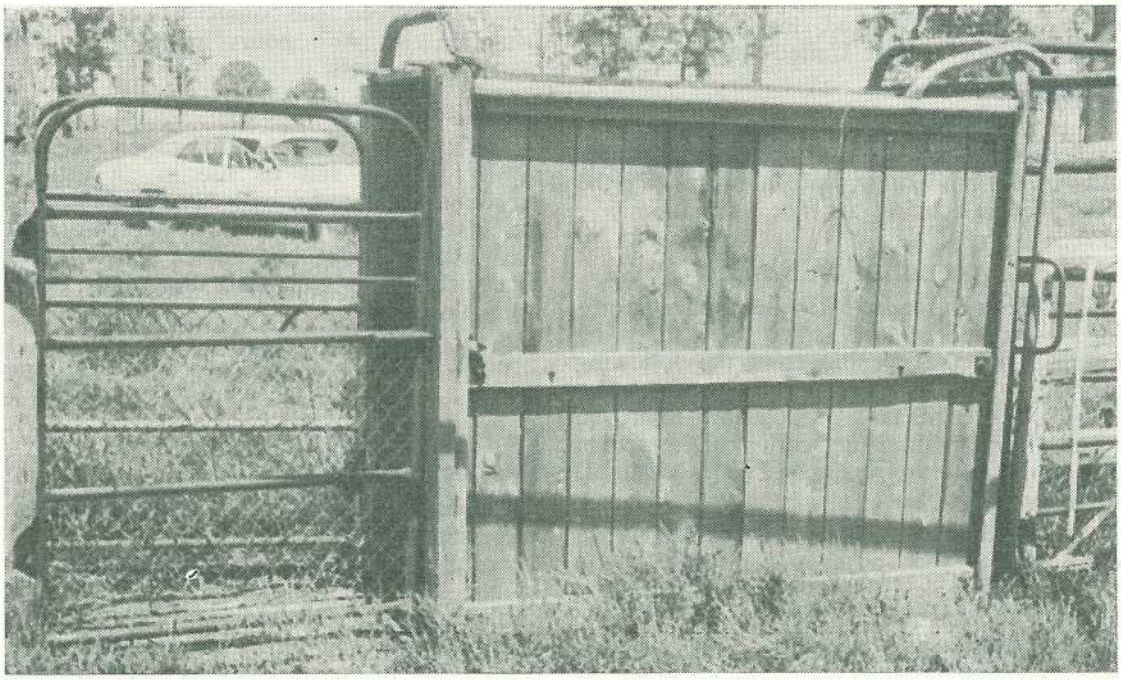
A most successful aid is the 'sidewinder' (surgical deviation of the penis) or a vasectomized bull combined with a chinball mating harness. Usually 4% to 6% of teasers to breeders is satisfactory, although rotating the teasers in the A.I. herd can increase their interest and activity. The removal of oestrus cows from the observed mobs will avoid the development of harem groups of cows.

Generally, dairy breed teasers prove more active than beef breeds. A recent experiment compared the efficiency of heat detection with and without teaser bulls; for 83 checks with the bull and 62 without, the percentage of undetected heats was 10·8 and 64·0 respectively.

Insemination

Over-exposure of semen

This remains the most common fault of experienced technicians and one of the faults most likely to significantly lower conception rates.



Warlana black box.

Three common errors have been observed:

- During the day to day operations the raising of the buckers too high in the neck of the unit, exposing the straw for identification.
- Allowing the nitrogen level to fall too low before topping up.
- Incorrect handling when transferring semen from the transporter to the field unit.

Incorrect deposition

The recommendation is that 50% of the semen is placed in the uterine body and 50% traced back in the cervix. Deposition too far into the uterus is a major problem among technicians. Care must be taken with repeat services as a percentage of cows will continue to cycle after conception. Incorrect deposition may cause abortion.

Thawing technique

Most of the recent experimental evidence demonstrates some advantage from thawing in water at 35°C over thawing in iced water. Maintaining water at that temperature may be a problem for travelling dairy technicians, but it should be straightforward on beef properties. A battery operated thawing device, consisting of an electrically heated, insulated box, has been developed in the United States.

Loading

Incorrect loading of the insemination gun, particularly failure to roll the manufacturers plug in the mini-straw, and failure to dry the straw before loading are not uncommon.

Insemination timing

Traditional practice is to inseminate morning observed oestrus cows the following evening and the evening cows the following morning. This practice is sometimes questioned by technicians who claim improved results from inseminating earlier or later than the above, but no research data is available to support this view.

The traditional practice is based largely on dairy studies such as the recent N.Z. study reported in table 1. Interactions with bull fertility, the presence of teasers and variable oestrus length are, of course, possible but the effects of such interactions are largely unknown.

TABLE 1. TIME OF INSEMINATION

Time cows observed			Description	Average N.R. rate
P.M.	A.M. Insemination	P.M.		
No	Yes	Yes	Early oestrus	66·9
No	Yes	No	Mid oestrus	69·8
Yes	Yes	No	Late oestrus	74·9
Yes	No	No	Post oestrus	71·9

Source: Macmillan, K. L., New Zealand Journal of Experimental Agriculture 3 : 21–8.

Pre-insemination massage

A significant increase in conception rates has been obtained from 2 or 3 minutes of uterine massage before insemination. The degree of response was higher in younger cows. More recent studies indicate that response levels vary considerably between technicians and that 1 minute's massage may achieve a similar result.

A number of technicians have adopted the practice of manually massaging the clitoris. A comparison of 10 seconds' massage, after insemination, with no massage resulted in conception rates of 58·4% and 52·1% respectively. Massage also reduced the interval between the onset of oestrus and ovulation by 4·7 hours relative to non-massaged controls.

Oestrus synchronization

Effective oestrus synchronization is technically feasible and its use in an artificial breeding programme will be determined by the aims of the programme and the costs involved. It must be stressed that the cost aspect should be examined thoroughly before using the technique.

Prostaglandins are now available commercially for use by veterinarians. Other methods including subcutaneous implants of progesterone compounds are being promoted.

Programme evaluation

Common sense ratios to measure technical success need to be calculated. It is pleasing to see a decline in the use of non-return rates. In one study, semen extender that was inadvertantly frozen without the sperm produced a 60 to 90 day non-return rate of 18% which rose to 24% when the extender contained dead semen.

A simple measure of oestrus detection is:

$$\frac{\text{Nos. of first inseminations in 23 days}}{\text{Total nos. of cows observed}} \times 100$$

A measure of insemination success is:

$$\frac{\text{Nos. of pregnancies}}{\text{Total no. of inseminations}} \times 100$$

A measure of the technical effectiveness of the whole programme:

$$\frac{\text{Total nos. of live calves}}{\text{Total nos. of cattle observed}} \times 100$$

Economics

A recent examination of 12 beef A.I. programmes in Queensland showed the average adjusted extra cost of producing a live calf by A.I. to be $26.76. Costs for the 12 programmes were adjusted by valuing labour and semen at standard charges of $3 per hour and $4 per dose. The adjusted costs per live calf ranged between $19.10 and $49.22 with live calf ratios of 76·1% and 35·0% respectively.

The break-up of average adjusted cost per live calf was:

	Quantity	Cost ($)	% of Total
Semen	2·25 doses	8.98	34·0 (Unadjusted semen cost was $8.57)
Insemination		4.07	15·0 (Including unit and liquid nitrogen)
Labour	4·06 hours	12.17	45·0
Others		1.54	6·0
		26.76	100·0%

A manager who expects to achieve average performance can substitute semen and labour costs based on the amounts which will apply in his particular case and estimate his likely cost per live calf.

Obviously, any improvement in management or technique which increases final results at a greater rate than costs will lower the cost of the A.I. calf. The costs presented here do underline the need for careful selection of genetic material if it is to economically justify the use of an artificial insemination programme.

Queensland dairy cattle breeds

by I. K. GOODCHILD, Dairy Field Services Branch and F. J. SLATTER, Dairy Cattle Husbandry Branch.

AUSTRALIA'S first dairy cattle arrived at Port Jackson in February 1789 on the 'Sirus', a ship that was part of Governor Phillip's First Fleet.

They were brought from Cape Town in South Africa and were animals of Zebu and Indian strains.

Six years after landing this small herd of one bull, one bull calf and four dairy cows, Australia had 61 dairy cattle. By 1800 when Governor King took office, the herd had grown to 560.

This was the humble beginning of the Australian dairy industry, an industry which is now an important money earner for our country and supports thousands of dairy farmer families throughout Australia.

In Queensland, dairying is confined mainly to the south-east quarter of the State in the Moreton, Lockyer, Darling Downs, Wide Bay and Burnett regions. Smaller areas of dairying are concentrated around the Central Queensland towns of Gladstone, Rockhampton and Mackay and on a larger scale on the Atherton Tablelands.

Standards of production

There has been a steady increase in the average yield per cow during recent years. For production recorded cows, the average (1976–77) yield was 2 541 litres milk per lactation. Production recording figures for butterfat yield show an average of 105 kg per lactation with an average lactation length of 263 days.

Environmental limitations

Queensland dairymen face problems unknown to their counterparts in southern States. The main impediments to dairy production, especially in the heavier rainfall areas, are external parasites of cattle.

Of these, the cattle tick is by far the most important, involving regular costs of dipping and inoculation against tick fever. Control is made more difficult by the continual development of tick strains resistant to the chemicals used in dips and sprays.

Other parasites such as buffalo fly and lice are troublesome in particular areas of the State.

Summer temperatures and humidity are high in most districts. Strict attention must therefore be paid to dairy hygiene and refrigeration to preserve the quality of milk.

High temperatures increase stress on the animal. This causes a decrease in feed intake and a decline in milk production. Rainfall incidence is highly variable between districts, between seasons and within seasons.

These production limitations are constantly in mind when selecting breeds for use in Queensland.

Breeds of dairy cattle

A breed can be defined as a group of animals that have a common origin and possess certain distinctive, heritable characteristics which separate them from other members of the same species. These characteristics are transmitted uniformly from parent to offspring.

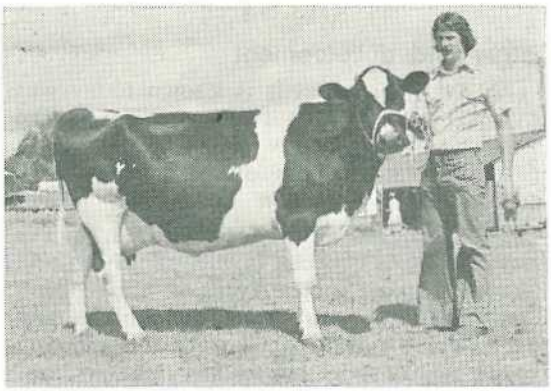
Some of the more readily observed heritable characteristics that can be used to distinguish breeds of cattle are coat colour and pattern, whether the animal is polled or horned, the presence or absence of a hump, and body conformation. These characteristics cannot be related to production potential but are useful to identify breeds.

Since man has domesticated animals, both natural and artificial selection have led to the development of new strains and breeds each with a particular use, for example, beef or milk It is common practice today that when a new breed has evolved or has been developed a breed society or association is formed. These associations set certain standards and regulations to ensure that each and every animal is a true representative of the breed.

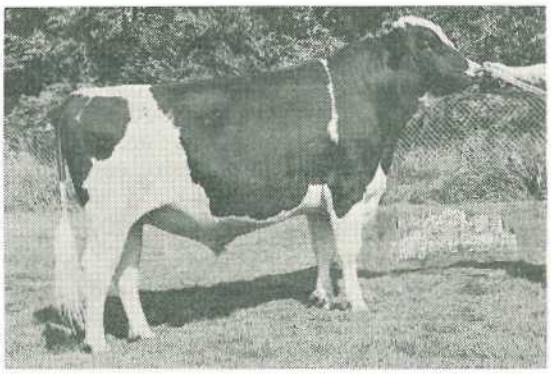
At present, there are 350 000 dairy cows in Queensland managed by approximately 4 500 farmers. The number of farmers has declined at an annual rate of about 10% since 1970.

Breeds used in Queensland include Australian Illawarra Shorthorn (A.I.S.) Jersey, Friesian, Guernsey, Ayrshire, and the new Sahiwal crossbreeds—the Australian Milking Zebu (A.M.Z.), and the Australian Friesian Sahiwal (A.F.S.). A.I.S., Friesian and Jersey cattle predominate.

The larger breeds, Friesian and A.I.S., are gaining in popularity while other breeds are declining because of increased emphasis on high milk yields per cow and on sideline beef production when beef prices are good. A brief description will now be given of all breeds in Queensland as well as those breeds being developed through crossbreeding programmes.



Friesian cow.



Friesian bull.

Friesian

History and development

Friesians have been bred for nearly 2 000 years and were originally developed in North Holland and West Friesland. From these two provinces in Holland they were taken to Northern Europe and England where they were used to improve local breeds. Friesian cattle as we know them today were developed largely from herds in these countries.

The first Friesians (or Holstein-Friesian as they are called in some countries) were introduced into Australia from New Zealand in 1886. Subsequent importations were made from Canada and the United States of America as well as many more from New Zealand. The original importations were of Dutch origin.

The Friesian Cattle Club of Australia was founded in 1914 at Toowoomba. The Friesian breed was well established in Queensland by that time. Since the turn of the century, numbers have increased to the present day total of 172 000 which represents 37% of all dairy cattle in Queensland. Friesians are found in both the southern and northern regions of the state.

Breed characteristics

- Typical Friesians are black and white—varying from nearly all black to nearly all white. Red and white animals are found chiefly in Europe.
- They are one of the largest breeds, with mature cows weighting between 540 and 680 kg and bulls averaging 800 kg or more.
- Calves normally weigh between 40 kg and 43 kg at birth.
- Friesians are late maturing, often attaining maximum growth, development and production at about 7 years of age.
- Their build is strong and their udders are large and capacious.
- Cows are quite docile while bulls are more easily disturbed.

Production

Friesians hold many records for both milk and butterfat production. In Queensland the 1976–77 average figures for milk, butterfat and test were 3 852 *l*, 148 kg and 3·8% respectively. The record 300 day production for a mature Friesian cow in Queensland is 12 352 *l* milk, yielding 453 kg butterfat with a test of 3·7%.

Australian Illawarra Shorthorn (A.I.S.)

History and development

The A.I.S. breed as it is known today was developed a little over 100 years ago in the Illawarra district in New South Wales. Until recent times it was the only breed of dairy cattle to be developed in Australia.

The A.I.S. has been developed through a series of crosses between mainly shorthorn and longhorn cattle. Some Ayrshire and Devon blood lines were also used, but not to any great extent. In the early days of this crossing programme, farmers culled any animals that did not meet the standards of type, conformation and production (from herd recording figures).

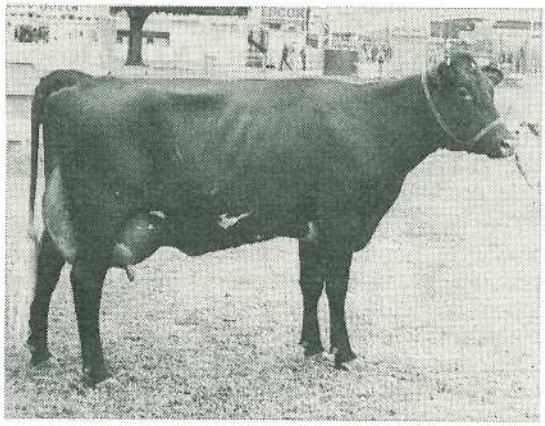
Great emphasis was placed on milking competitions in those early days. The breed is distributed throughout the State (but mainly in the Darling Downs and South Burnett regions) and present numbers are around 190 000 (37% of the State's dairy cattle).

Breed characteristics

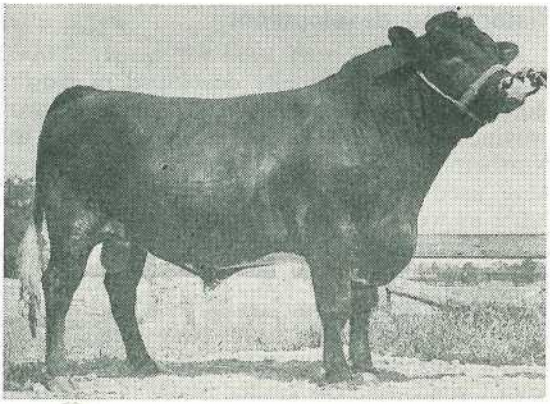
- The dominant colour is red (dark red to light red). Roan animals are also common. Animals showing black or brown markings are not preferred.
- Mature cows average between 500 kg and 600 kg, while bulls are slightly heavier and usually weigh about 800 kg.
- Calves are 33 kg average birthweight.
- A.I.S. are of good temperament. They have capacious udders with large teats.
- Persistency of production is not always good.

Production

The breed achieved world-wide prominence when Melba XV of Darbalara set the world record (now Australian) for butterfat production by producing 723 kg butter from 14 755 kg milk at an average test of 4·96% in 365 days. This record was established more than 45 years ago. Queensland herd recording figures for all officially tested A.I.S. cows show that in 1976–77, average production was 3 524 *l* milk, 140 kg butterfat with a test of 4·0%.



A.I.S. cow (Queensland Country Life photograph).



A.I.S. bull.

Jersey

History and development

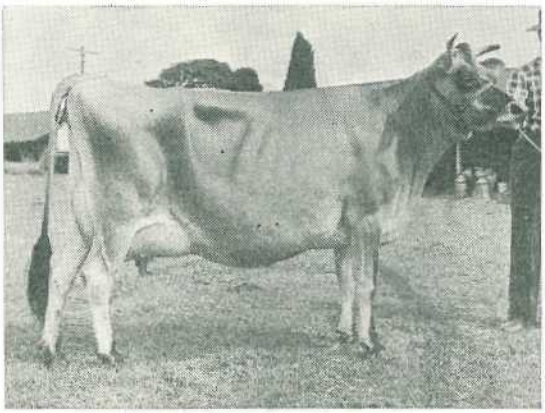
The Channel Islands, particularly the island of Jersey, have been credited as the birth place of the Jersey breed. By 1900, there were considerable numbers of Jersey cattle in Australia. Aided by the activities of the breed societies, the breed made rapid headway.

At present in Queensland, Jersey cattle number about 117 000 (20% of dairy cattle) and are distributed over most of the State.

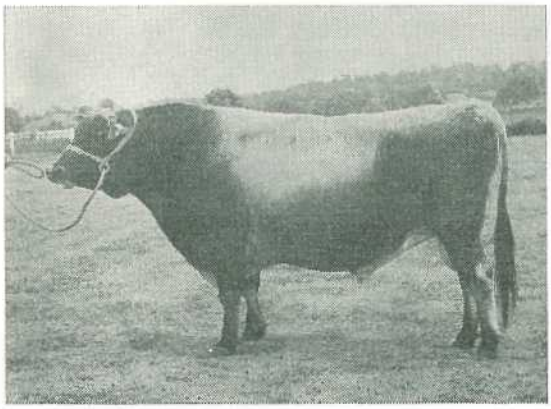
Breed characteristics

- Colour is variable from fawn to dark brown; both whole and broken coloured animals occur. Broken coloured animals show white patches.

- One of the most distinguishing characteristics of the breed is the colouring of the muzzle—Black, surrounded by a light coloured area.
- The head has a typically 'dished' appearance.
- Being one of the smallest breeds of dairy cattle, the mature cows only weigh between 360 kg and 500 kg. Bulls are slightly heavier and usually weigh around 680 kg.
- Calves are small at birth and normally weigh about 24 kg.
- Most members of the breed mature at an early age.
- Cows are very sensitive and react quickly to external conditions.



Jersey cow (Queensland Country Life photograph).



Jersey bull.

- Bulls can become quite vicious.
- Cows possess good-shaped, angular udders with strong udder attachments. Milk from Jerseys has high fat and total solids contents and they are noted for good persistency of production.

Production

Average production for recorded cows in Queensland (1976–77) was 2 428 *l* milk and 121 kg butterfat with an average test of 5%. The Queensland record for a mature cow is 7 096 kg milk and 418 kg butterfat.

Guernsey

History and development

The Guernsey breed also originated in the Channel Islands, on the island of Guernsey, and its development has been similar to that of the Jersey. Even though the islands are in close proximity, the breeds have evolved in slightly different ways.

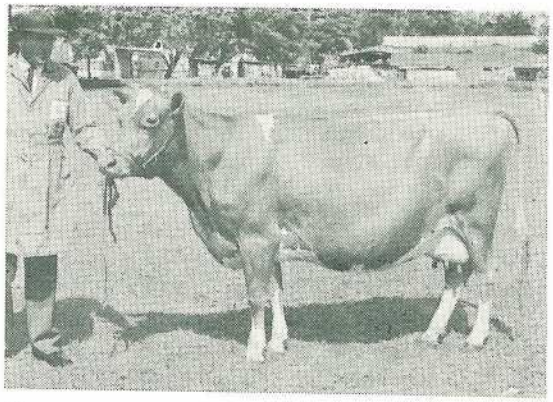
Guernsey cattle have similar attributes to the Jersey but have not been as popular. Present numbers in Queensland are low.

Breed characteristics

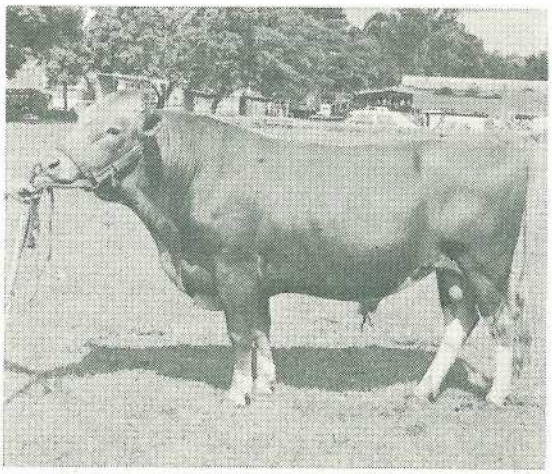
- They are similar in colour to the Jersey, but a certain amount of white is nearly always present.
- The head has a slightly 'dished' appearance.
- Muzzle is usually light coloured.
- Udders are usually well-shaped, but less symmetrical than those of the Jersey breed.
- Mature cows vary in weight from 385 kg to 550 kg while bulls average about 726 kg liveweight.
- Average weight of calves at birth is 28 kg.

Production

Average production (1976–77) in Queensland was 2 906 kg milk, and 134 kg butterfat, with an average test of 4·6%.



Guernsey cow.



Guernsey bull.

Ayrshire

History and development

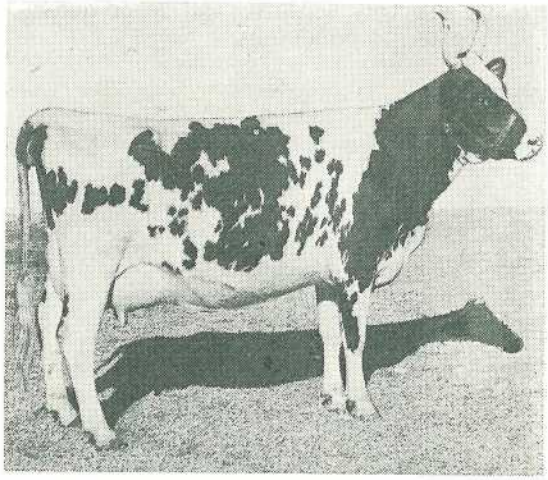
The Ayrshire breed is of Scottish origin and it is supposed that Shorthorn, Friesian and other selected animals were used in its development. Little is known of its development in Australia.

Breed characteristics

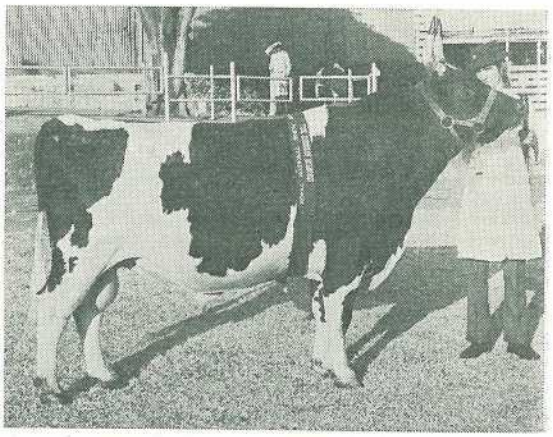
- The typical Ayrshire is red, with white patches. The extent of white varies greatly, with some animals being almost entirely white, while others are almost completely coloured.
- Ayrshires are a particularly active breed and cows can become quite nervous and difficult to manage. Bulls are frequently vicious in disposition.
- Some members of the breed may lack persistency of production.
- Mature cows commonly weigh between 500 kg and 635 kg, while bulls have average weights varying between 725 kg and 1 000 kg.
- Calves have a birth weight of approximately 27 kg.
- Long, upright, curved horns are a distinguishing feature of the breed.

Production

Production of around 2 843 kg milk and 111 kg butter (3·9% test) can be expected (Queensland averages 1976–77).



Ayrshire cow (Queensland Country Life photograph).



Ayrshire bull (Queensland Country Life photograph).

Recent developments in breeding

The increase in ticks becoming resistant to the insecticides used for their control, has stimulated great interest in alternative methods of tick control. In the beef industry there has been considerable use of pasture spelling and the development of tick-resistant strains of cattle. Control through pasture management is not practical for dairy cattle, and there are difficulties in introducing tick resistance into high milk-producing animals.

However since the early 1950s, cross-breeding programmes have developed two new breeds of tick-resistant and heat-tolerant dairy cattle. A brief description of each is given below.

Australian Milking Zebu (A.M.Z.)

History and development

The A.M.Z. is one of the new breeds of dairy cattle. Its development has occurred in three stages.

1. Sahiwal and Red Sindhi bulls (presented by the Government of Pakistan) were mated in 1952 to Jersey cows at C.S.I.R.O.'s McMaster Field Station, Badgery's Creek, New South Wales, to produce several generations of half breeds. After heavy culling, females which would milk under Australian conditions were selected. From these cows, young bulls for progeny testing were selected.

2. The second stage of the breeding programme was based on the progeny testing of young bulls from the best cows available. The object in this second stage was to test at least six bulls a year.

3. In the third stage of the programme, only the sons of sires selected in the progeny test out of females selected for their own high production, were submitted for screening and progeny testing.

The breed has now become established and interest in A.M.Z.'s has increased from both Australian and overseas breeders.

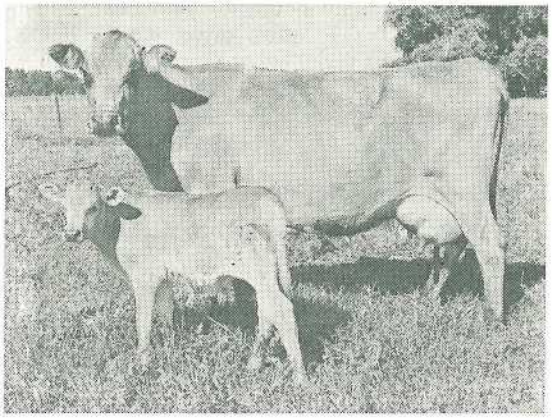
Breed characteristics

- Colour varies, but a golden to reddish brown colour predominates.
- They are tick-resistant and heat-tolerant.
- Their temperament and foraging ability is good.
- The carcass at the end of productive life is acceptable for beef.
- Females are normally lighter than males. Weights range from 350 to 400 kg and 500 to 550 kg respectively.
- Calves weigh between 20 and 30 kg at birth.

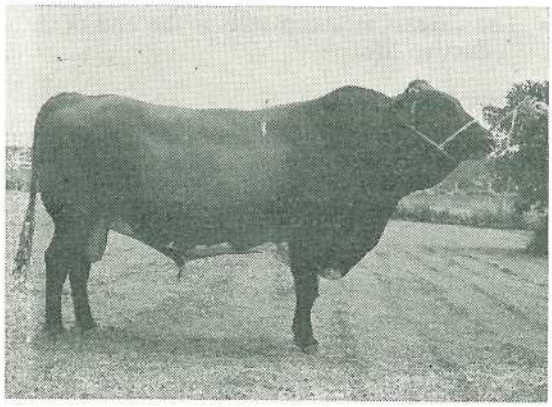
Production

For a 300 day lactation, 4 150 kg milk and 197 kg butterfat (4·9%) have been obtained.

At present, breed numbers are small in Queensland. Animals are currently on selected farms where they are undergoing further testing and development.



A.M.Z. cow and calf (Queensland Country Life photograph).



A.M.Z. bull.

A.M.Z. semen is available from the Wacol A.B. Centre.

When Friesian cattle became more popular in Queensland, the possibility of developing a breed with higher levels of milk production and the ability to pass tick resistance to subsequent generations was considered. Thus was the conception of the Australian Friesian Sahiwal breed.

Australian Friesian Sahiwal (A.F.S.)

History and development

Development of the A.F.S. breed by the Queensland Department of Primary Industries commenced in 1960.

Originally Friesian, Jersey and A.I.S. cows were bred to Sahiwal bulls. However, it was decided that the Friesian cross would be the most reliable in terms of milk production. As a result, most A.F.S. cattle today are half Friesian–half Sahiwal: Friesian for milk production and Sahiwal for tick resistance.

Breed characteristics

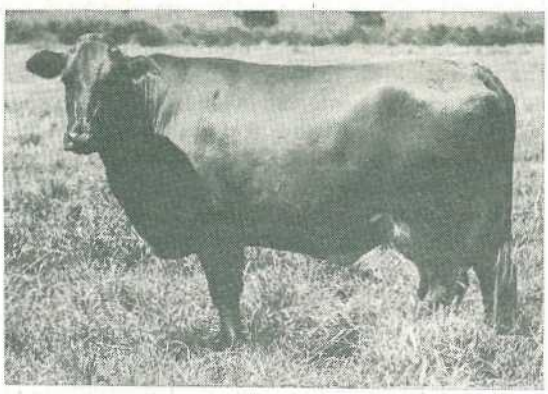
- The most common colours are black, tan and red.
- Mature cows average 580 kg in weight, with bulls averaging 650 kg.
- Calf weights range from 25 to 34 kg at birth.
- They are tick-resistant.
- Coats are smooth and sleek.
- The carcass is acceptable at the end of productive life.

Production

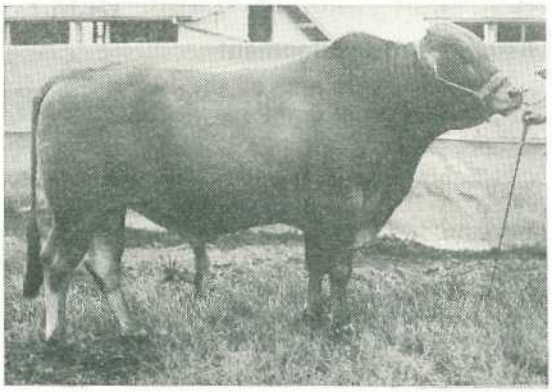
The following production figures have been recorded from A.F.S. and Friesian herds on the same property and being fed a comparable grain supplement ration.

	Days	Milk kg	B.F. kg	B.F. %	S.N.F. kg	S.N.F. %
A.F.S.	300	4 159	157	4·09	332	8·70
Friesian	300	4 631	153	3·42	379	8·56

The development of this new breed, both in numbers and performance, will be successful with the full co-operation of farmers who realise the value of high-producing, tropically-adapted, tick-resistant dairy cattle.



A.F.S. cow.



A.F.S. bull.

Crossbred dairy cattle

Commercial dairy herds are rarely comprised of pure bred animals, except on farms where animals are bred for stud purposes. One breed does not usually satisfy all market requirements, so it is common to find an animal that is a cross between two or more breeds.

One common cross is between the Friesian and the Jersey. This cross combines the high fat and solids content of the Jersey breed with the high milk yield of the Friesian. Many farmers consider this type of animal to be close to the ideal dairy cow for Queensland market conditions.

The macadamia flower caterpillar

THE adult of the macadamia flower caterpillar *(Homoeosoma vagella* Zellar) is a moth which lays its eggs on the flower racemes, usually while still at the bud stage.

Feeding by the larvae then destroys the buds and flowers and, during severe infestations, few nuts are set. In completing their development, the larvae may also attack young nuts set earlier in the season or young, lush shoots.

Host plants and distribution

The macadamia flower caterpillar occurs widely throughout eastern Australia but in cooler, elevated areas (above 300 m), infestations are usually less severe. All the known host plants of this insect are native trees belonging to the family Proteaceae. They include both cultivated and wild trees of *Macadamia integrifolia* and *M. tetraphylla,* and wild *M. ternifolia,* red bottle brush (*Grevillea banksii*), silky oak (*G. robusta*), *G. pinnatifida, G. glauca,* and woody pear (*Xylomelum pyriforme*).

Seasonal Incidence

In south-eastern Queensland, studies using mercury vapour light traps in cultivated macadamias have shown that the insect occurs throughout the year, but the greatest numbers are found during the main flowering period from July to October. Everbearing types of *M. integrifolia* and other host plants allow the development of successive generations.

The time and severity of infestations in relation to the time of flowering determines the degree of the insect's damage to macadamia flowers. Infestations on the main flowering begin with the migration of adult moths, frequently in large numbers, from other hosts.

The time when this happens can vary greatly, as shown by the percentages of infested racemes for two different seasons in figure 1, but it most commonly occurs during August.

In most seasons, varieties flowering early, or over a short period during winter, avoid attack while those flowering later, or over a prolonged period into spring, become heavily infested. Thus the earlier the flowering, the more likely it will avoid the attacks of this insect.

Life history, habits and damage

ADULT. The small, grey moth is 6 to 7 mm long and 14 to 18 mm across the outspread wings. When at rest, the wings are held folded back so that three transverse, darker grey stripes at the tip of each forewing match and appear as inverted V-shaped marks. The insect is nocturnal and most activity occurs during the first 4 hours after dusk.

EGG. The egg is oval and its average size is 0·5 mm x 0·3 mm (less than half the size of a pinhead). It is white when first laid, becomes yellow and the brown head of the larva becomes visible before hatching. Eggs are laid singly or in groups of 2 or 3 anywhere on the buds or the raceme stem; they are often hidden beneath the small bracts between adjacent bud stalks. Over 400 eggs may be laid on one raceme. Generally, moths prefer to lay eggs on racemes when the buds are about 3 to 7 mm long but they may still lay on the racemes when the flowers are at the full bloom stage.

LARVA. The larva passes through five stages during its development. On hatching, it is yellow in colour and about 0·75 mm long. It soon enters a floret bud, and during its first two stages, feeds within the bud mainly on the stamens and pistol. A drop of sap on the side of the bud often indicates the point at which a larva has entered. The edges of the entry hole soon become brown and larval excrement may protrude from the hole.

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by D. A. IRONSIDE, Entomology Branch.

The macadamia

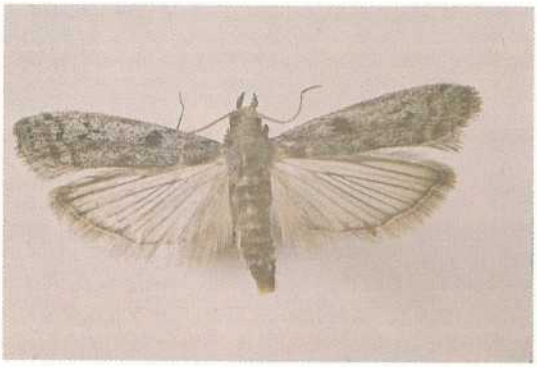


Plate 1. The moth of the macadamia flower caterpillar (wing span 14 to 18 mm).

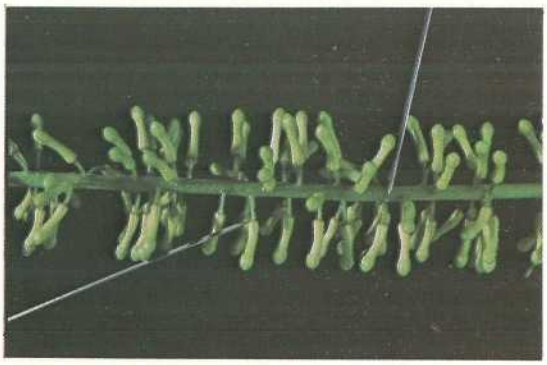


Plate 2. Macadamia flower raceme in the bud stage infested with eggs, two of which are pointed out with pins.

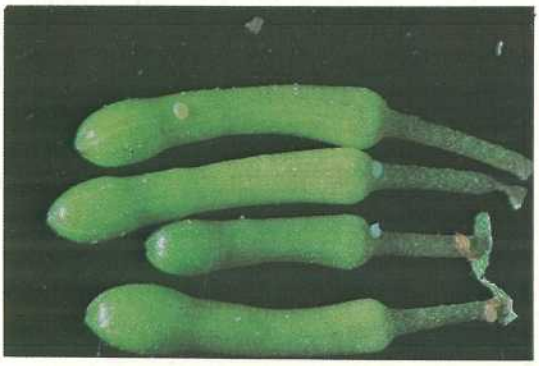


Plate 3. Eggs on the buds and under the tiny bracts at the base of the bud stalks. On the raceme, the bracts occur between adjacent bud stalks.

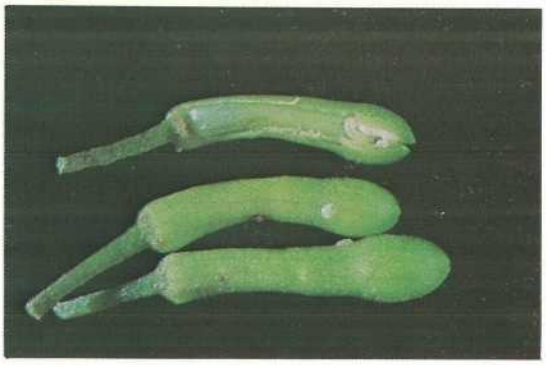


Plate 4. Hatched eggs, larval holes in the buds and a young larva within a sectioned bud.

flower caterpillar

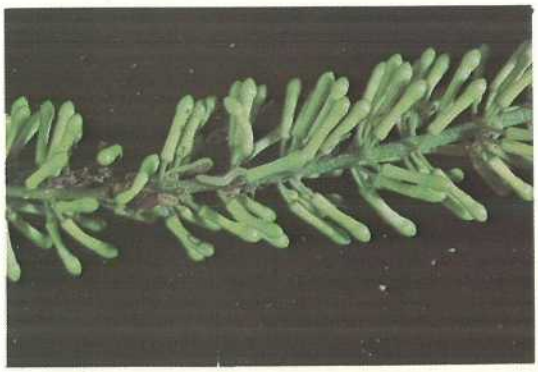


Plate 5

Plate 6

Plate 7

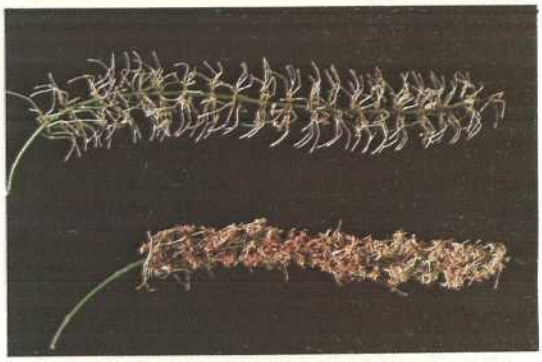


Plate 8

Plate 5. Older larvae feeding outside the buds.

Plate 6. A full grown larva (about 12 mm long) of the macadamia flower caterpillar.

Plate 7. A predatory mirid bug, Termatophylum *sp, (about 3 mm long). The nymphs and adults of this bug attack and feed on larvae of the macadamia flower caterpillar quickly causing their death.*

Plate 8. Destroyed flower raceme on the top and undamaged on the bottom.

Plate 9. The centre racemes are damaged and the outer undamaged.

Plate 9

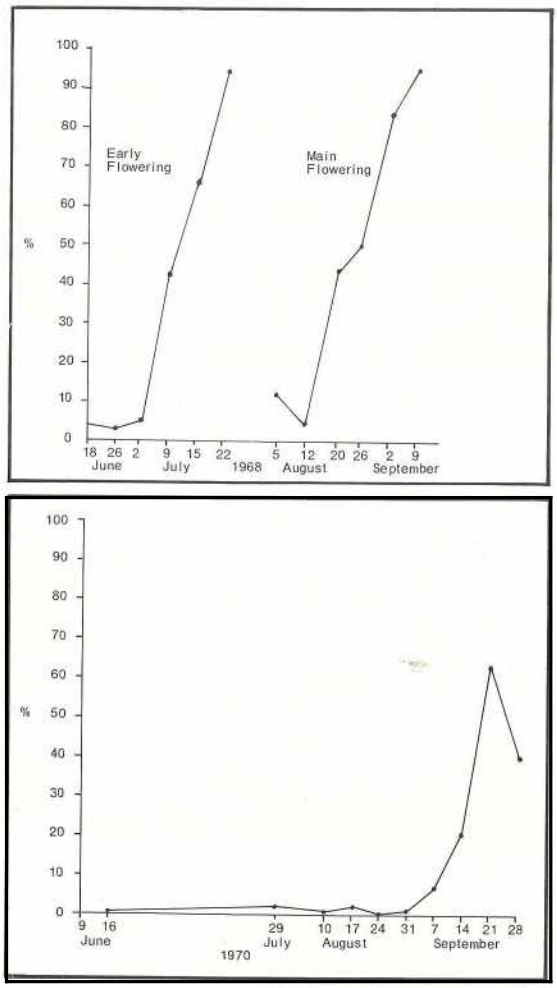


Figure 1. Percentages of macadamia flower racemes infested with eggs or larvae of the macadamia flower caterpillar in an orchard at Beerwah during the 1968 and 1970 seasons. In 1970, the insect attacked only the late flowering varieties.

Longitudinal stripes appear on the body of the third stage and become progressively darker in colour during the later stages. When full grown, the larva is about 12 mm long and reddish brown though it can vary in colour from light green to a slaty grey. These later stages feed mainly on the outside of the buds eating even the outer layer of the raceme stem and festooning the raceme with webbing excrement and the remains of damaged buds.

PUPA. The mature larvae usually leave the tree and pupate in a silken cocoon in debris on the ground but some seek out sheltered sites on the tree in which they pupate.

Life cycle

The life cycle time from egg to adult increases with decreasing temperature. The duration in days for the various stages of the insect's development in south-eastern Queensland is shown in table 1.

TABLE 1

Season	Egg	Larva	Pupa	Total
Winter	9	31	23	63
Spring	4	15	10	29
Summer ..	3	12	8	23

Natural enemies

Over 20 different insect species are either predatory or parasitic on the macadamia flower caterpillar. The more important of these include the small wasps *Agathis rufithorax* (Turner), *Brachymeria* sp. and *phaneratoma* sp. which parasitize larvae, *Trichogrammatoidea flav* Grit. which parasitizes the eggs, and a small mirid bug *Termatophylum* sp. which preys on the larva. These natural enemies are considered important in regulating numbers of the pest in seasons of low infestation and their destruction with insecticides should be minimized.

Monitoring the insect

As activity of the macadamia flower caterpillar is quite variable and some damage to macadamia flowers can be tolerated without loss of crop, it is desirable to monitor the insect to determine when spraying is needed. This involves taking a sample of the flower racemes, examining them for the insect and then using the number of infested racemes to determine the need for spraying. Details of a sampling technique will be included in a separate article on control.

Buffel grass in Queensland

Buffel grass *(Cenchrus ciliaris)* is the outstanding improved pasture grass in the drier areas of Queensland.

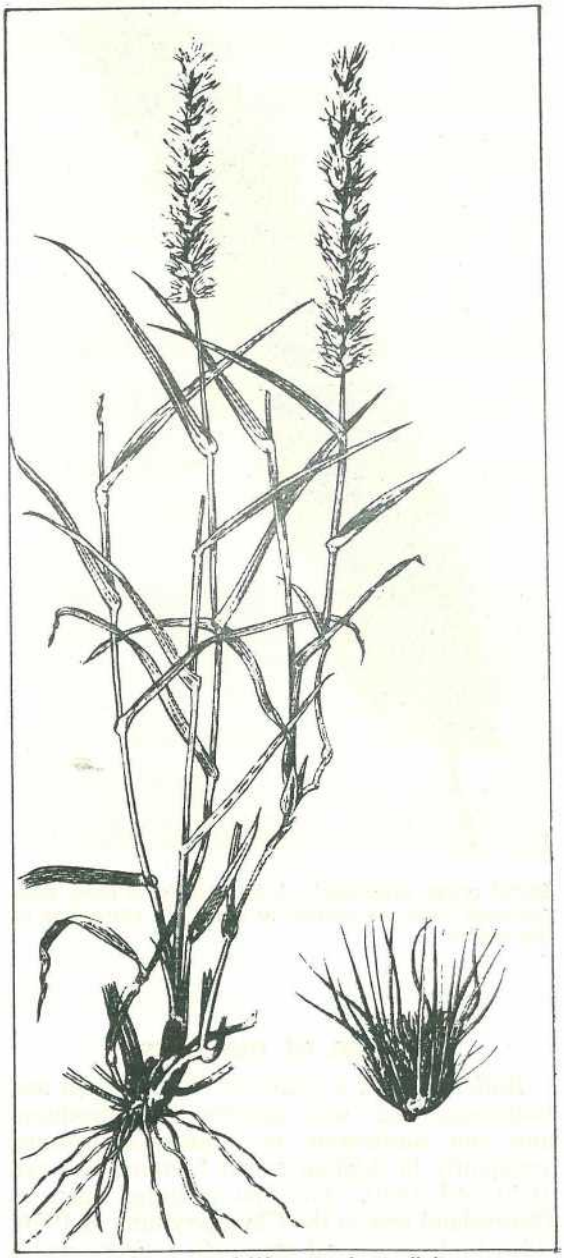
It has demonstrated its ability to establish, spread, persist and produce under harsh climatic conditions and has converted low producing scrublands to highly productive grazing lands.

Some 0·8 million ha of gidgee (*Acacia cambagei*), brigalow (*A. harpophylla*), box-sandalwood (*Eucalyptus* spp. *Eremophila mitchellii*) and mixed tree communities have been cleared and sown with buffel grass, while an additional 0·7 million ha of buffel are present in mixtures with other sown grasses such as green panic (*Panicum maximum* var. *trichoglume*) and Rhodes grass (*Chloris gayana*). Most plantings have taken place since the late 1950s.

Description

Buffel grass is a deep-rooting, summer-growing, erect, tussocky perennial grass. Tillers originate from the crown which is below ground level, and some cultivars have short rhizomes. Stems are often branched, and in the taller cultivars can grow up to 1·7 m high under good conditions. The seedhead is cylindrical, 2·5 to 15 cm long and 8 to 16 mm in diameter. Leaves are 7 to 30 cm long and 3 to 8 mm wide.

The rachis of the seedhead is a serrated stalk to which clusters of one to three spikelets are attached by very short stalks. (The serrations in Cloncurry buffel (*C. pennisetiformis*) are further apart than in *C. ciliaris*). Each cluster (fascicle) is surrounded by a cup-shaped circle of bristles (involucre) in two rows, the outer being finer and shorter than the inner. The inner bristles are joined at the base for 0·1 to 0·2 mm except in Cloncurry buffel where they are joined for 1 to 3 mm.



Buffel grass (Flora of Western Australia).

by C. J. Paull and G. R. Lee,
Agriculture Branch

Buffel grass seedhead. A few fascicles have been removed from the bottom to show the serrations on the rachis.

Origin of cultivars

Buffel grass is a native of Africa, India and Indonesia, and was accidentally introduced into the north-west of Western Australia, apparently in Afghan camel harness, between 1870 and 1880. The first recorded entry to Queensland was in the Cloncurry area in 1926, when both Birdwood grass (*C. setiger*) and a white seeded buffel were planted on Maronan Station with seed obtained from Western Australia.

Western Australian seed was sown at Rockhampton in 1928 while in the early 1930s experimental sowings were made in many other Queensland districts. Since then, seed of many other types has been introduced from overseas and to date nine cultivars have been registered by the Queensland Herbage Plant Liaison Committee. They are:

Tall cultivars (up to 1.7 m)

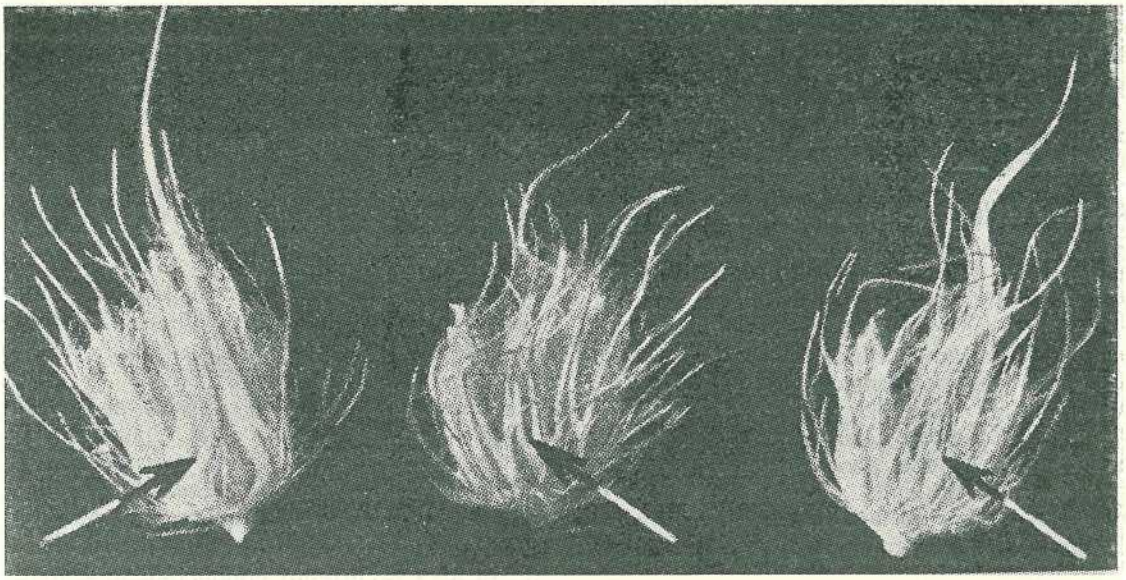
BILOELA: Seed of this cultivar was received from Dodoma, Tanganyika as Type D in 1937. It was originally grown as CPI 6934 by C.S.I.R. (now C.S.I.R.O.) near Rockhampton, and later by the Department of Agriculture and Stock, in a number of central Queensland localities. In 1950, evaluation commenced at the Biloela Research Station and it was released to commercial growers in 1955.

BOORARA: This cultivar from Kenya was grown by the Queensland Department of Agriculture and Stock as Q2953 from 1950. In 1955, a small seed sample was sent by Mr S. Marriott of the Department to Mr W. H. Rich of 'Boorara', Yalleroi, who rapidly multiplied the seed for sowing into cleared gidgee scrub country. In 1962, it was named Boorara.

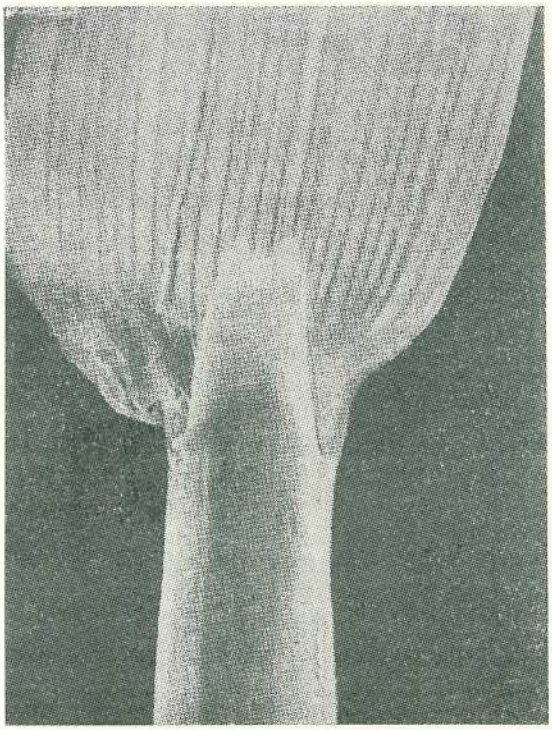
NUNBANK: Nunbank was derived from seed (CPI 12778) imported from Uganda in 1949. It was tested by C.S.I.R.O. at a number of centres and gave particularly good results on the property of Mr B. C. Clark, 'Nunbank', Taroom. It was released as a commercial cultivar in 1961.

TAREWINNABAR: Seed of this cultivar was introduced from Kenya in 1950 as CPI 13246. It was tested by the Queensland Department of Agriculture and Stock and C.S.I.R.O. at a number of sites throughout Queensland, including W. A. Gunn's property "Tarewinnabar', near Goondiwindi. It was released as a commercial cultivar in 1962.

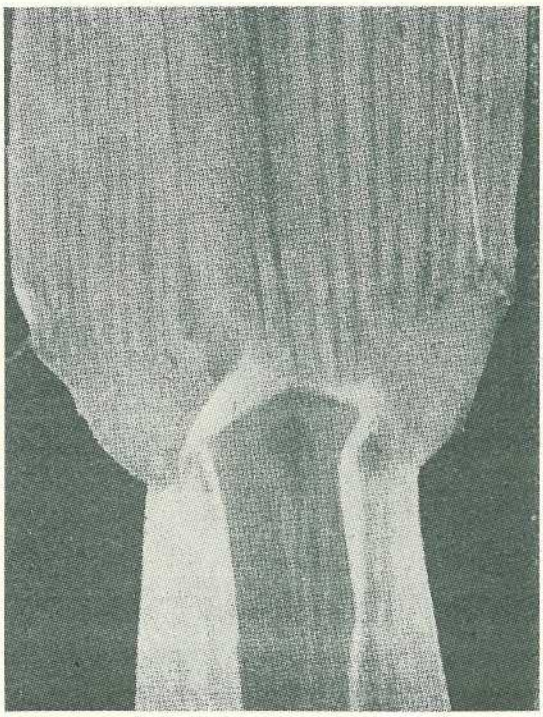
MOLOPO: Molopo buffel, originating from the western Transvaal, was first introduced into Australia by the New South Wales Department of Agriculture in the early 1940s. Testing by the Queensland Department of Agriculture and Stock began in 1954.



Cloncurry buffel. Note that the bristles are joined to well above the base of the seed (Agricultural Gazette of New South Wales).



The ligule of Molopo is up to 2 mm long and the leaf and sheath are hairless (Agricultural Gazette of New South Wales).

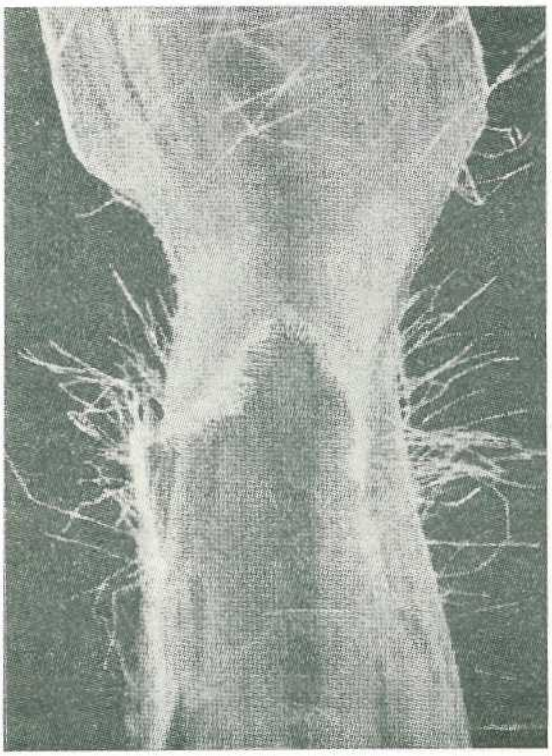


The ligule of Biloela is about 1 mm long. The leaf and sheath are hairless (Agricultural Gazette of New South Wales).

LAWES: This cultivar was derived from seed obtained as CPI 14365 from the Department of Agriculture, Pretoria, South Africa, in 1951. It was tested by C.S.I.R.O. and released in 1962. Commercial seed is not available. It is identical with the American cultivar T3782, Blue buffel, and is very similar to Molopo.

Medium height cultivars (up to 1 m)

GAYNDAH: A small quantity of seed of this cultivar was introduced in 1930 from Kenya as CPI 1848. In 1934, C.S.I.R. included it with a number of pasture species which were sent to Queensland schools for use in 'hobby plots'. It became dominant in the grounds of the Gayndah State School and the teacher, Mr F. L. Rasmussen, encouraged the pupils to pick seed, which was distributed to local graziers. The stand on a property purchased by Mr C. J. Pinwell became the major source of Gayndah buffel seed in the 1950s.



The ligule of Gayndah is less than 1 mm long. The leaf and sheath are hairy (Agricultural Gazette of New South Wales).

AMERICAN: This cultivar was imported commercially into Queensland from the U.S.A. in 1956, or possibly earlier, and is identical with the American material T4464 (=Q4841).

Short cultivars (up to 0·4 m)

WEST AUSTRALIAN: This cultivar is believed to have been introduced into the north-west of Western Australia between 1870 and 1880 in Afghan camel harness.

Hybrid buffel

Commercial buffel grass cultivars, like many grasses, produce their seed apomictically (that is, without sexual reproduction). However, odd plants reproduced sexually and from such a plant discovered in Texas, U.S.A., a cultivar was bred and released there in 1967.

C.S.I.R.O. is currently conducting an evaluation programme on hybrid material obtained from the U.S.A. Of particular interest are hybrids between buffel and Birdwood grass where the objective is to select for lines of higher forage quality and greater cool season production than existing cultivars.

Related species

Two other useful species and three weeds are closely related to buffel grass.

CLONCURRY BUFFEL OR SLENDER BUFFEL GRASS (*Cenchrus pennisetiformis*):

This medium height Indian type has colonized river frontages between Cloncurry and the Gulf of Carpentaria. It is also spreading onto the stony hillside country between Cloncurry and Mt. Isa. Cloncurry buffel has never become popular in other areas of Queensland and has not been registered as a cultivar.

BIRDWOOD GRASS: This species is native to the region from East Africa to India. It is an early-seeding short type and is less productive than buffel grass. Birdwood grass is rarely sown commercially but has colonized some areas south of Cloncurry particularly around Malbon. The seed is easily distinguished from buffel seed by its rigid, erect bristles. These are usually purple but a straw-coloured type also exists.

TABLE 1

CHARACTERISTICS OF BUFFEL CULTIVARS

Cultivar	Leaf colour	Habit	Leaf appearance	Ripe seed colour	Stems	Seed fascicle (1)	Rhizome (2) Development	Ligule length (3)
West Australian	green	short, erect	narrow (5), hairy sheath	intensely purple	short, 5–8 nodes (4)	harsh texture (10)	negligible	0·7 mm
Gayndah	green	Medium, semi-prostrate	narrow (7) hairy sheath	straw or reddish tinge	medium height, 11–18 nodes	harsh texture (10)	negligible	less than 1 mm
American	green	medium, semi-prostrate	narrow (5) hairy sheath	reddish purple	medium height, 6–10 nodes	Soft texture (10)	negligible	1·3–1·5 mm
Biloela ..	bluish-green	tall, erect	broad (6) sheath hairless	straw	moderately tall, 7–11 nodes	soft texture (9)	medium	1·0–1·5 mm
Boorara	bluish-green	tall, erect	broad (6) sheath hairless, sheath and lower surface of leaves minutely rough	straw	moderately tall, 6–13 nodes	soft texture (9)	medium	1·5–2·0 mm
Nunbank	bluish-green	tall, erect	broad (6) sheath hairless	straw	moderately tall, 7–10 nodes	soft texture (9), bristles straw coloured at base	medium	1·5–2·0 mm
Molopo	bluish-green	tall, erect	broad (6) sheath hairless	straw	tall, 9–13 nodes	soft texture (9)	strong	1·5–2·0 mm
Lawes	bluish-green	tall, erect	broad (8) sheath hairless	straw	tall, 9–11 nodes	soft texture (9) bristles green at base	strong	1·5–2·0 mm
Tare-winnabar	green	tall, erect	broad (7) hairy sheath	straw	tall, 9–13 nodes	soft texture (10)	strong	1·0–1·3 mm

NOTES

1. Fascicle—the seed kernel and covering bristles.
2. Rhizome—an underground stem which emerges from the ground outside the crown of the plant.
3. Ligule—a membranous outgrowth arising from the junction of the leaf-blade and the leaf-sheath on the inner side.
4. Node—a knob on a plant stem from which a leaf and shoot arise.
5. Leaf blade at its maximum width is narrower than the unrolled leaf sheath at its mid-point.
6. Leaf blade at its maximum width is approximately as wide as the unrolled leaf sheath at its mid-point.
7. Leaf blade at its maximum width is as wide as or wider than the unrolled leaf sheath at its mid-point.
8. Leaf blade at its maximum width is wider than the unrolled leaf sheath at its mid-point.
9. Seed stalk smooth or almost smooth below the spikelets,
10. Seed stalk rough for some distance below the spikelets.

WEED SPECIES: Weeds belonging to the same genus as buffel and found in Queensland are Mossman River grass (*C. echinatus*), hillside burr grass (*C. caliculatus*) and sand burr (*C. incertus*). All have a hard, spiny seed coat which is particularly troublesome in wool.

Identification of cultivars

Identification of the cultivars is difficult, particularly dried specimens of those cultivars with similar morphological characteristics. For this reason, it is possible that some stands have been incorrectly identified.

Characteristics of the commercial cultivars are set out in table 1 and these can help in identification.

Climatic requirements

The major buffel areas in Queensland are in the 375 to 750mm rainfall zone where about 60% of the rain falls during summer. Buffel grass is less productive than other species in high rainfall coastal areas.

Growth is checked by frosts but significant plant deaths have occurred only in areas of prolonged heavy frosting such as the Warwick-Texas-Stanthorpe district and on the eastern Darling Downs. The taller growing cultivars are less affected by light frosts than the shorter ones but all succumb to heavy frosts. Tarewinnabar and Molopo have greater frost tolerance and grow better at low temperatures than other cultivars.

Buffel grasses are very drought tolerant, far more so than green panic and Rhodes grass. Observations in the central west indicate that the taller types remain green for longer under moisture stress conditions. Their recovery following these periods is also quicker than that of the shorter types. West Australian is always the first to dry off and the slowest to recover after lengthy dry spells.

Soil requirements

The lighter textured soils are the most suitable. Establishment problems are usually associated with heavy soils although in some brigalow areas successful stands have been established on heavy cracking clays.

Establishment is quicker on high phosphate soils and the seedlings possess a greater degree of drought tolerance than on low phosphate soils.

Where soil fertility is low, the Biloela, Nunbank and Boorara cultivars (which are very similar) maintain better production than the shorter ones.

The optimum soil reaction for buffel is neutral to slightly alkaline (pH 7 to 8) but stands occur on soils with pH as low as 5.5. Buffel grasses are less tolerant of salt in the soil than Rhodes grass. The Biloela cultivar is tolerant to slightly higher levels than the other cultivars.

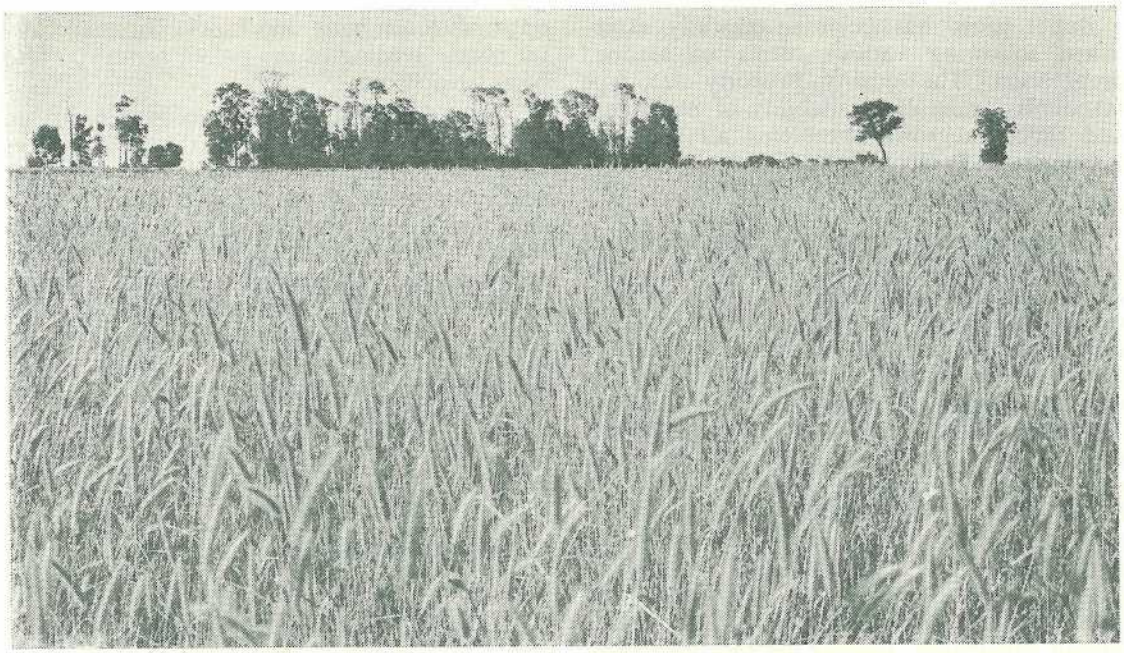
Choice of cultivars

Past performance, availability and cost of seed, the particular situation and type of enterprise are the main factors influencing cultivar selection. The three most widely sown cultivars are Biloela, American and Gayndah, with plantings of the remaining cultivars representing only a small proportion of total buffel sowings. Seed of these three is readily available at most times and all are comparably priced. Seed of Molopo and Tarewinnabar is usually in short supply and highly priced as both are shy seeders; hence plantings of these varieties are limited.

Tall, rhizomatous types are better suited to heavy soils than the shorter types and are frequently used for such situations. Because of inferior overall performance, West Australian is no longer recommended for Queensland conditions.

In flood prone country, tall buffels have an advantage; their height helps them to survive as most floods do not cover them completely. Tarewinnabar has greater flood tolerance than Nunbank and Boorara, which in turn have greater tolerance than Biloela and Molopo. As flood duration increases, or on recently grazed areas, these differences vanish.

The tall varieties are often favoured for cattle enterprises whereas Gayndah and American are preferred for sheep. However, the tall types are suitable for sheep particularly when grazing with cattle. The larger amounts of forage from the tall cultivars are often wasted through inability of stock to utilize the feed before maturity. Differences in palatability between cultivars will be important only where different cultivars are sown together. There are examples in western Queensland where stands are now dominated by Gayndah, the more palatable American having been eaten out.



This excellent stand of Biloela buffel growing in the Callide Valley is typical of buffel grass pasture in cleared brigalow country. This stand is carrying a heavy seed crop.

The tall cultivars mature later than the shorter ones. The latter however, are more palatable and have greater seed yields and better seedling survival under dry conditions.

Distribution in Queensland

The three main buffel grass areas are:

- The Near South-western region which includes the western Downs and Maranoa. Main development has been on land formerly under brigalow and associated scrubs, also poplar box/sandalwood communities. Buffel and buffel mixtures had been planted on approximately 500 000 ha by June 1976.
- The Central Western region encompassing the Shires of Tambo, Blackall, Barcaldine, Aramac, Jericho and Isisford. Development has been in the gidgee and mixed scrublands including brigalow and fringing poplar box and ironbark woodlands. Total area under buffel at June 1976 was 281 000 ha.
- The Capricornia region extending from Rockhampton to the Drummond Range in the west, and from Nebo in the north to Taroom. Most development has been in brigalow and associated softwood scrubs in Brigalow Development Areas I, II and III. By June 1976, an estimated 750 000 ha contained buffel grass.

Less extensive areas occur through the Burnett from Gayndah to Monto, and in the Far South-western region centred on Charleville. In the North-western region considerable areas of the high phosphate river frontage soils carry Cloncurry buffel.

Establishment

For good germination and establishment, buffel seed needs to be moist for about 5 days. The seed will not germinate on light falls of rain. Generally, at least 25 mm is required. Rain over several days together with cloudy weather provides ideal conditions. A rough surface provides a better seedbed as the small depressions remain moist for longer than level ground.

Buffel grass has been successfully established following various forms of seedbed preparation. The locality, property size, type of country, rainfall, availability of machinery and timber regrowth problems all influence the method finally selected.

Ash seedbeds

The ashes resulting from pulling and burning scrub, such as gidgee, brigalow and softwood make good seedbeds. Competition from native vegetation has been removed, the soil surface has been partly sterilized and is in a loose, friable condition, and soil fertility is high. In addition, burning is mostly carried out in the summer months which correspond with the most favourable period to sow buffel grass. Seed should be broadcast as soon as the ashes are cool, which is about 2 to 3 days after burning. In early season burns where a heavy body of ash is present, good establishment has occurred when sowing has been deferred until a period of higher rainfall expectancy, despite the fact that some crusting of the ash has probably occurred and some has been lost by winds particularly whirlwinds.

Scrubs are frequently pulled on a face up to 1 km wide leaving untouched shade lines on either side. These also serve as fire breaks and, if at right angles to prevailing winds, can reduce wind erosion on the pulled area. Shade lines should be at least 40 m wide. If narrower, buffel grass will colonize over a period, particularly in above average rainfall years, and reduce their effectiveness as fire breaks.

In the central west, successful establishment has also been achieved in the ashes of burnt, windrowed timber after pulling *Eucalyptus* woodlands. Rate of spread from these nucleus areas is influenced by soil fertility, the amount of native grass between the planted strips and rainfall. Eucalypt regrowth is a severe problem following this treatment unless cultivation follows timber removal. The problem can be reduced if the trees are first killed either by ringbarking or by an aboricide. At the drier end of the gidgee country, some scrubs are too thin to carry a fire after pulling. In these, and in some of the heavy clay brigalow or gidgee soils where establishment is difficult, the areas can be seeded before or immediately after pulling. This approach can also be used on some *Eucalyptus* woodlands. In unsuccessful burns, seeding of the pulled scrub has also been carried out.

Establishment in all these cases depends on a good season following, but initially plants will establish in protected areas such as underneath the heads of the fallen trees and beside logs, and in disturbed areas such as the stump holes. The buffel, together with volunteer native grasses and herbage when thick enough can be used as fuel for a fire to remove some of the fallen timber should this be desired, and to at least check regrowth. Once the bark has been shed, however, it is difficult to start the logs burning.

Poplar box country in the Maranoa has been developed by this method but regrowth is a continuing problem.

Cultivated seedbeds

In many circumstances, some form of seedbed preparation is needed for satisfactory establishment. This applies particularly in the higher rainfall areas where cultivation is necessary to break up a hard soil surface, to eliminate weeds and native pasture species and to reduce or eliminate timber regrowth. The degree of cultivation varies considerably. Some pastures have been established after a single strip cultivation, sowing seed simultaneously, among standing timber. Often root raking or stick raking to remove fallen timber will disturb the soil surface sufficiently for satisfactory establishment.

Many pastures have been planted following a full seedbed preparation consisting of a number of cultivations, sometimes following a cropping phase of several years. In regrowth prone communities such as brigalow and box/sandalwood, precropping will effectively eliminate the problem.

When preparing a seedbed for buffel, the surface should be left in a rough, cloddy condition as results can be disappointing where excessive cultivation has powdered the surface. Leaving deep tine marks on the contour is often an advantage.

Buffel can be established in contour pasture furrows, which are used to recolonize hard, bare areas resulting from over-grazing. The seed can be broadcast behind the implement used to construct the furrow. As moisture concentrates along the furrow, a green pick will

often be present during dry periods. Additional pasture furrows can be constructed mid-way between existing ones to promote further spread of the buffel.

Some graziers have successfully established buffel grass under cover crops. However, results are often disappointing. Seed of the cover crop germinates immediately while the buffel seed, which is planted on the surface, will not germinate until after further rain. The cover crop then tends to deprive the buffel of moisture and nutrients and smothers the grass seedlings.

In southern Queensland, buffel seedlings emerging in winter from April to mid June sowings with winter crops can be frosted. Sowings after mid June generally will not germinate until warmer conditions in late August–September by which time the crop has made sufficient growth to smother grass seedlings.

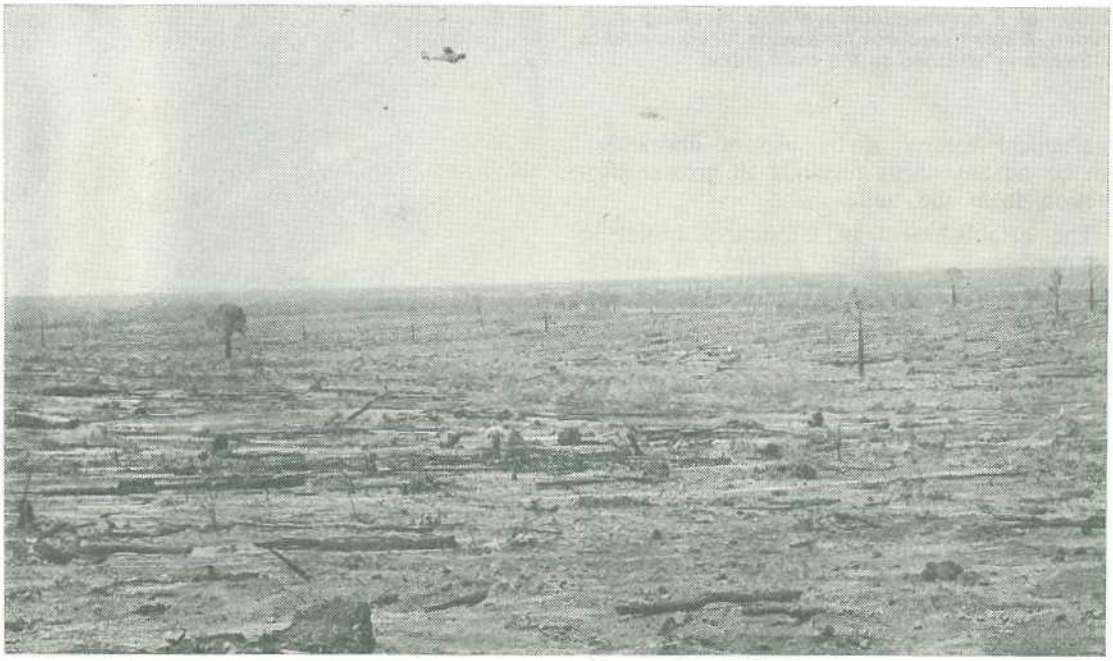
Sowing buffel between the rows of a summer crop offers better prospects of success particularly if the crop seeding rate has been reduced.

Buffel grass should not be used in crop/pasture rotations as, once established, it is extremely difficult to eradicate.

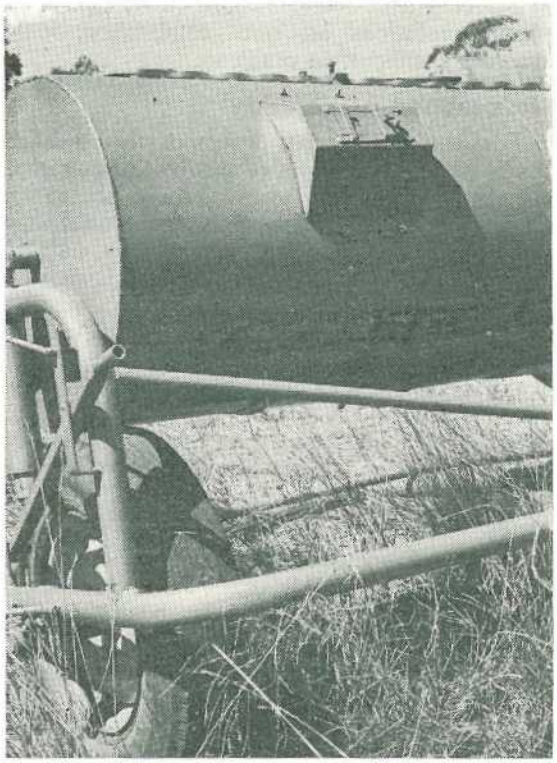
No seedbed preparation

For the most part, attempts to establish buffel without any form of seedbed preparation are disappointing. However, there are cases, where over a number of years, buffel has colonized large areas of country by natural spread from small nucleus areas. Examples of this are found in some mulga country of south-west Queensland, and in parts of the eucalypt woodlands of the central west. In both areas, paddock plantings have not been successful primarily due to the low soil fertility. However, buffel has established, without seedbed preparation, under the canopy of poplar box and some other trees where soil fertility is higher than in the inter-tree spaces.

Spread from these areas does occur in above average rainfall years. In the mulga, buffel established under poplar box trees can supply about 20% of the total available forage. In the box woodlands where tree density is greater some strategic thinning, either by



Aerial seeding after a scrub burn.



Portion of a commercially available revolving drum seeder. A small seed box for sowing lucerne, medics or Siratro is attached to the main box.

mechanical means or by use of aboricides, can be advantageous resulting in greater production from the buffel.

The establishment of Cloncurry buffel in the north-west is another example of natural spread without any form of deliberate seedbed preparation.

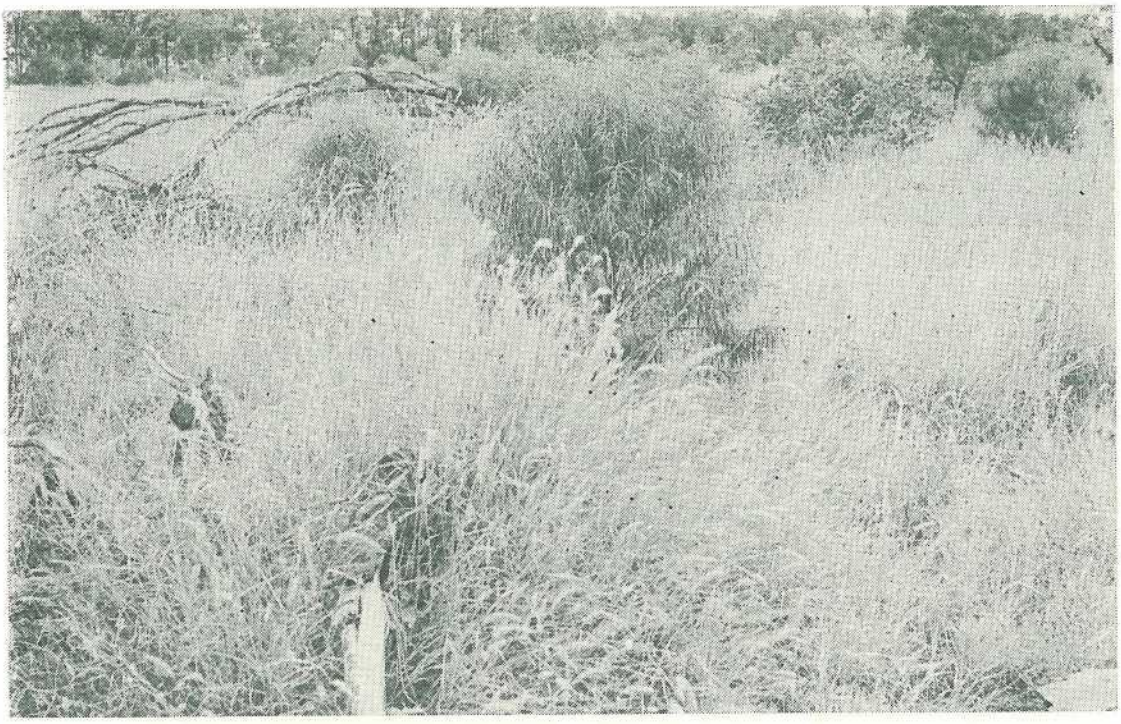
Methods of planting

Broadcasting on the soil surface of a cultivated seedbed or on the ash surface after a burn and allowing rain to cover the seed usually gives best results. Where a legume is planted with the buffel it is necessary to cover the seed but this should not be deeper than 5 mm. Rolling to compact the soil around the seed and to prevent the top layer of soil from drying out too quickly can be advantageous on loose soils. On powdery soils, however, it can cause hard setting after rain and impede establishment.

Seed can be hand broadcast on small areas and from a vehicle, implement, horseback or aircraft on larger areas. A number of specially developed planting machines including two types of home made seeders have proved very successful for sowing buffel seed. The most effective is the 'revolving drum' seeder. In this machine, a cylindrical seedbox rotates on an axle while internal agitators force the seed out of adjustable slots. The second type has a circular bottom on the seedbox and rubber fingers rotate on a central shaft above the slots.

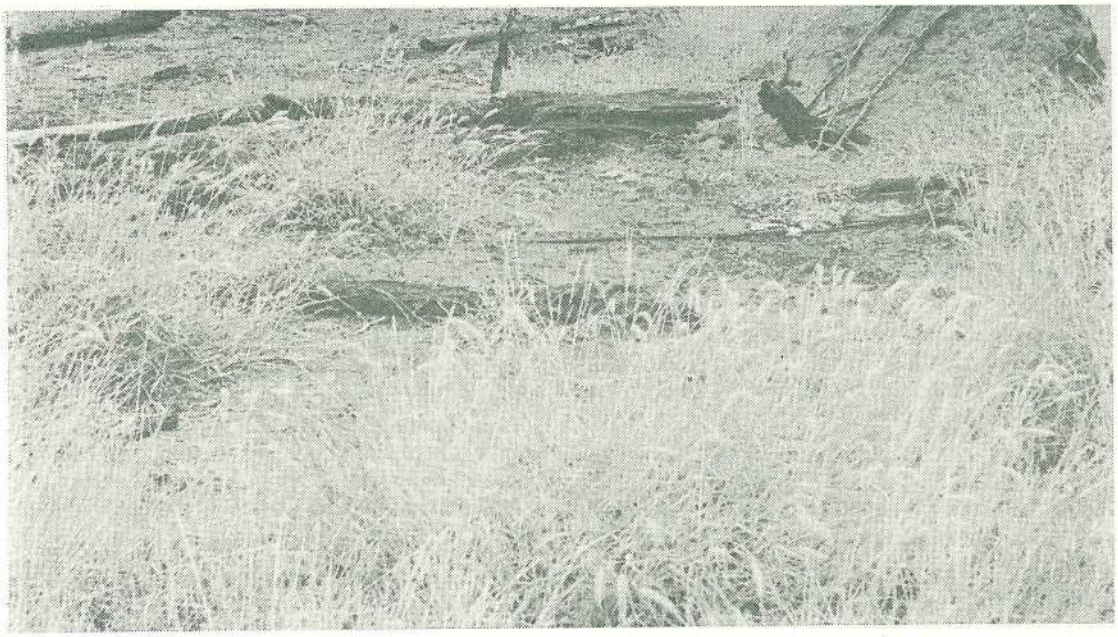
Both these machines are simple to make. Their main advantage is that they will distribute trashy seed.

In this type of broadcaster, seed is forced out of adjustable slots at the base of the box by rotating rubber fingers.



ABOVE. This area of ironbark, poplar box and mulga country was aerially seeded with 1 kg of Biloela buffel and 1 kg of Sorghum almum *immediately after pulling.*

BELOW. The same area after burning 3 years later. Regrowth has been killed and buffel is colonizing the bare areas.



A well established strip of buffel grass on belah country in the Maranoa.

Another method successfully used for spreading buffel is to introduce the seed into the air blast of a power mister or tractor exhaust.

On large areas, aircraft are commonly used because they can plant seed quickly, evenly and at low planting rates. Under ideal conditions, an aircraft can sow up to 1 600 ha per day at rates as low as 200 g per ha if in strips.

The cost of aerial seeding (1977) ranges from $1.00 to $1.60 per ha depending on the size of the area, the distance from the operator's base and the amount of seed applied per hectare.

Buffel grass and mixtures based on buffel grass can be sown through a combine fertilizer box provided the seed is at least 95% pure. Vertical agitators attached to the outside edge of the star wheels are necessary to prevent bridging of the seed.

Where lucerne is to be sown with buffel grass it is best to establish the lucerne with or without a winter cereal before the introduction of buffel. The planting rate of the winter cereal should be reduced by 30 to 40%. After the cereal crop has been harvested, the lucerne should be renovated before it is too well established and the buffel broadcast immediately afterwards.

Further details of the various planting methods are in the article by C. J. Paull, published in the *Queensland Agricultural Journal,* November 1973.

Time of planting

January–February is the most reliable planting period in the main buffel growing areas of Queensland. Spring plantings are risky, particularly on light soil types. Many fail because of lack of post planting rain for germination or the onset of hot, dry conditions after germination, or both.

Mid to late summer plantings are preferred because rain expectancy is high and the peak of summer temperatures has passed. However, only in warmer parts of the State would plantings after March be expected to survive. Seedlings up to 25 mm high will survive frosts but more advanced plants are easily killed.

Seed quality

Under the Agricultural Standards Regulations (1969), the minimum prescribed purity and germination standards for buffel are 90% and 20% respectively. Recommended planting rates assume that the seed meets these standards. If poorer quality seed is planted, the planting rate should be increased proportionately. Seed with a purity of 95% and germination of 40% is quite common and much sought after.

Freshly harvested seed has a very low germiation percentage and should be stored for 9 to 12 months before testing and use. Good quality seed, stored under cool, dry conditions should retain high viability for up to 5 years.

Seed treatment

Where seed harvesting ants are prevalent and particularly when small quantities of seed are sown, dusting with a 20% lindane dust at 1 kg per 80 kg of seed has been recommended to reduce seed removal. Lime pelleting of the seed to increase its weight will also reduce an ant problem. These treatments are not widely used, however.

Seed can be hammer-milled or singed to facilitate planting through a seed drill. Such treatment brings the seed kernel and soil in closer contact. This gives increased germination. However, there are serious disadvantages. Buffel seed with the bristles removed will germinate much more readily (that is, on small falls of rain), and seedling mortalities could be high from desiccation if hot, dry conditions follow. The potential damage from ants is also increased. For these reasons, singeing or hammer-milling of seed is neither recommended nor practised.

Associated pasture species

In the drier areas (annual rainfall below 500 mm), buffel grass is invariably planted alone at rates varying from 0·25 kg per ha (overall) when sown in strips, to 2 kg per ha for complete coverage.

In higher rainfall areas it can be sown at 1·5 to 3 kg per ha or combined with other grasses, particularly green panic and Rhodes grass. Because of its aggressive nature, greater drought tolerance and lower stock acceptance, in time, buffel usually dominates the stand. Rhodes grass can be particularly useful in the establishment phase in situations where erosion can occur.

The following basic pasture mixtures are suitable for use on brigalow country:

Type of Country	Species and Planting Rates (kg per ha)	Remarks
Brigalow/softwood scrub ..	Buffel grass 1·5 Rhodes grass 0·5	Buffel can be partially or fully replaced by green panic at up to 3 kg per ha Part of major species may be replaced by *Sorghum almum*
Flooded brigalow communities	Buffel grass 2 Rhodes grass 1 Bambatsi panic 0·5 *Urochloa mosambicensis* 1	Establishment is precarious on these heavy soil types
Other brigalow communities	Buffel grass 1 Rhodes grass 1	These species can be partially or wholly replaced by *Sorghum almum* at rates up to 4 kg per ha. Where some softwood occurs, particularly in high rainfall areas, green panic at up to 1 kg per ha can be included, or used as a replacement species at 3 kg per ha

Sorghum almum (at 0·5 to 1 kg per ha) has been sown with buffel to provide a greater body of feed in the first year or two. Because it is preferentially grazed it can also reduce marsupial damage to seedling buffel stands. As well, it helps the flow of buffel seed in some types of aerial distributors.

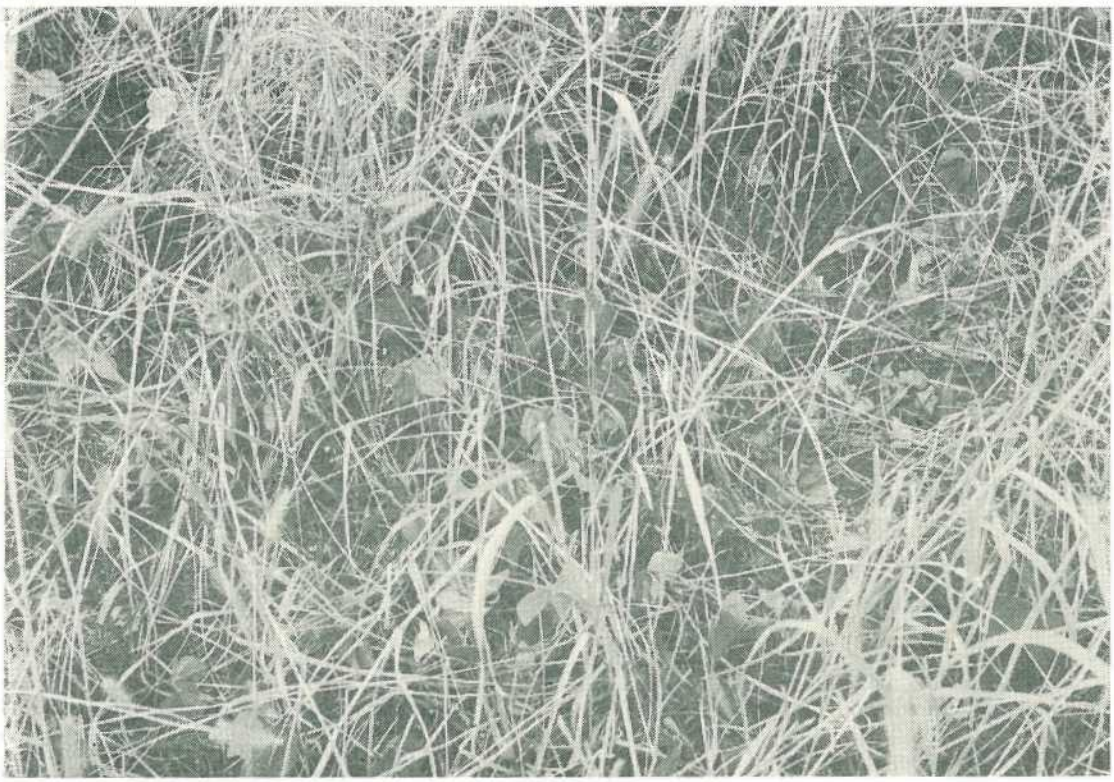
In all cases, forage sorghum types can be used to replace *Sorghum almum*.

Legumes

In lucerne (*Medicago sativa*) growing areas, lucerne will persist with buffel grass for 4 or 5 years if strict rotational grazing is adhered to. This is comparable to its life with other grasses and as a pure stand. Under continuous grazing, lucerne can be lost within the first 12 months.

Siratro (*Macroptilium atropurpureum*) will grow with buffel in areas which receive 500 mm or more of rain in the summer months. In order to introduce Siratro, an established buffel stand should be ploughed well with a disc plough to provide a seedbed and reduce competition from the grass. The Siratro seed, which does not need inoculation, is then broadcast on the area at a rate of 1·5 kg per ha.

In areas of southern Queensland receiving sufficient rain for a winter crop it is worthwhile including annual medics (*Medicago* spp.) in all buffel plantings. Medics will persist in the buffel stand because they are winter growers, but production is restricted to high rainfall winters. Medics can be planted with buffel in February/March or they can be oversown into an established pasture during a renovation. This can be carried out from late summer to autumn, preferably when the soil is moist.



A Biloela buffel grass-Siratro pasture at Narayen Research Station near Mundubbera on granite country originally carrying narrow-leaf ironbark. Research has shown that this pasture can safely carry one steer to 1·2 ha without any deterioration in the stand.

A mixture of the three cultivars Jemalong, Cyprus and Harbinger should be used at a rate of 1 to 2 kg per ha (total seed). Snail medic (*M. scutellata*) is a useful species on gilgaied country. To encourage medic regeneration, grazing in the late February-March period might be necessary to prevent the development of a large bulk of grass growth in late summer.

Production and feeding value

Dry matter yields rarely exceed 3 000 kg per ha for the highest producing cultivars in the drier western areas. However, yields can be more than double this in above average rainfall years and in more favoured localities such as the Dawson-Callide in the Capricornia Region.

Over a 5-year trial period at Blackall on cleared gidgee country, the tall cultivars Nunbank and Biloela consistently produced the highest forage yields. American was intermediate between these two and Gayndah, which in turn, consistently outyielded West Australian. There appeared to be no real difference between the protein content of cultivars except for differences caused by varying susceptibility to frost. Whole plant samples of new growth contained approximately 11% protein with the level in the leaf alone being approximately 15%. Mature growth averaged about 8% protein with selected samples at 10·5% and frosted growth in winter about 5 or 6% with selected samples at 9%. On less fertile soils, lower figures than these could be expected.

Experimental work at Biloela Research Station indicates that, at comparable stages of growth, both Gatton panic and Petrie green panic possess higher protein levels than the tall buffel cultivars.

Well established, thick buffel stands can withstand prolonged, heavy stocking and continuous stocking rates of one beast to 3·3 ha or a breeding sheep to 0·6 ha are not uncommon in central western Queensland. In poplar box country of the Roma-St. George area, buffel will increase stocking rates from one breeder to 10 ha to one breeder to 5 or 6 ha.

Buffel grass on brigalow soils will continuously carry from 1 breeder to 5 ha in the lower rainfall areas up to 1 breeder to 2 ha under the best of conditions.

Once established, buffel is an extremely difficult plant to kill by grazing but continuous heavy grazing can cause stand decline, particularly in low fertility and shallow soils. Plant deaths and a general thinning of the stand can occur under heavy grazing with sheep under drought conditions. However, with a return to normal seasons and lighter grazing pressures, the sward will thicken up rapidly.

The productivity of a newly established buffel pasture will decline unless there is some compensation for soil nitrogen losses. Where soils have high initial levels of nitrogen, such as in brigalow and gidgee country, this decline may not occur for several years. However, on poorer soils and on those which have been cropped for many years, a considerable decline may be evident after 2 or 3 years. The decline is hastened by heavy, continuous stocking which leads to an increase in weeds and undesirable grasses such as black spear grass and wire grass.

Fertility decline can be retarded by reducing stocking rates and allowing for a return of plant material, or litter to the soil surface. This also plays an important role in improving soil structure and protecting the soil surface from heavy storms and erosion.

Management

The aim of pasture management is to maintain a stable, highly productive pasture. During establishment, stock and, if possible, marsupials should be excluded until the plants are well rooted and have started seeding. On large areas, sufficient seed will mature even if the pasture is lightly stocked at the flowering stage. Newly established pastures can be used during winter and spring following planting, but may need to be locked up the following summer so the plant density can increase.

Where only a small proportion of a property is under buffel, this area should be saved for winter-spring grazing as the quality of buffel is superior to that of native species at that time. The native pastures should be used in preference to buffel during the summer.

As the area of buffel is increased, greater reliance can be placed on it until it is grazed throughout the year. In such cases, areas of the more cold-tolerant varieties could be reserved for winter grazing.

Maximum utilization of buffel pastures is unwise under the highly variable seasonal conditions which are experienced in western Queensland. A compromise should be reached between maximum animal production per hectare and the provision of enough standing fodder to provide insurance against dry periods.

Renovation

Renovation of buffel pastures can be an effective means of increasing stand density, or of promoting plant growth on hard-setting soils by improving moisture infiltration and root aeration. Where necessary, it should be carried out after rain in the spring or summer. Renovation can also be an effective means of reducing timber regrowth and introducing medics or Siratro to an established buffel stand. A chisel plough or a disc plough can be used.

Unnecessary renovation should be avoided as the operation accelerates the breakdown of soil organic matter and soil structure.

Weed control

Once established in areas that suit it, buffel is an aggressive species. It will compete with and usually eliminate weeds and other native pasture species from the sward. However, in the establishment phase, weeds can sometimes be troublesome particularly in old cultivations. Susceptible broad-leafed weeds can be controlled, if necessary, with 2,4-D at 1kg active constituent per ha. This will not affect the buffel seedlings provided they have developed at least four leaves. Run-down stands which can result from continued overgrazing during droughts are susceptible to weed invasion, although this effect might only be temporary.

One of the biggest problems is to control timber regrowth. A dense buffel pasture will reduce the rate of regrowth of woody weeds. Burning in spring will kill susceptible species such as cypress pine (*Callitris glauca*) and hopbushes (*Dodonaea* spp.) if the fire is hot enough, but will only cause a temporary check in the regrowth of brigalow suckers, sandalwood and eucalypts. In severe regrowth cases, the use of aboricides such as 2,4,5-T ester on the first two and Tordon on the eucalypts and even incorporation of a cultivation or cropping phase before reintroducing buffel, could be required. In cases of dense, tall regrowth, repulling and burning or root raking is usually necessary.

Burning

Regular burning of buffel pastures is to be avoided as it accelerates soil fertility decline by removal of plant litter. Strategic burning does have a useful role, however, in retarding regrowth of woody species as mentioned previously. As well, fire is an effective means of removing the bulk of dead, stalky forage which often accumulates during a run of wet seasons when the stocking rate is too low to cope with increased growth of the pasture. The standing forage, which could be 2 or 3 years old, is of no value to stock and prevents access to fresh growth.

Fodder conservation

All buffel cultivars will make a reasonable quality hay provided the crop has grown under good seasonal conditions and is cut at the early flowering stage. A good stand will yield about 2.5 tonnes per ha from one cut. The protein content of a well made hay ranges from approximately 6% to 10%. Alternatively, a poor quality hay can be made from buffel after seed has been harvested. In this case, the protein content can be expected to range from 6% down to as low as 4%.

Buffel grass can be used for silage but this has rarely been practised in Queensland.

Seed production

The main commercial seed production of buffel grass in Queensland is in the Dawson-Callide and the Central West. Many producers developing brigalow and gidgee in the 1960s produced their own seed. This considerably reduced costs and greatly accelerated the development programme. Seed plots can be grazed until good late spring to early summer rain is received. Stock should then be removed and if necessary the pasture slashed to remove old stubble and to ensure that an even height seed crop develops.

Most cultivars will hold the ripe seed for 14 to 20 days if not disturbed by adverse weather such as storms and strong winds. However, Molopo will retain ripe seed for only 6 to 8 days. Heat wave conditions or frosts at flowering can drastically reduce seed set. Consequently, it is wise before harvesting to open a number of fascicles to check whether plump kernels are present.

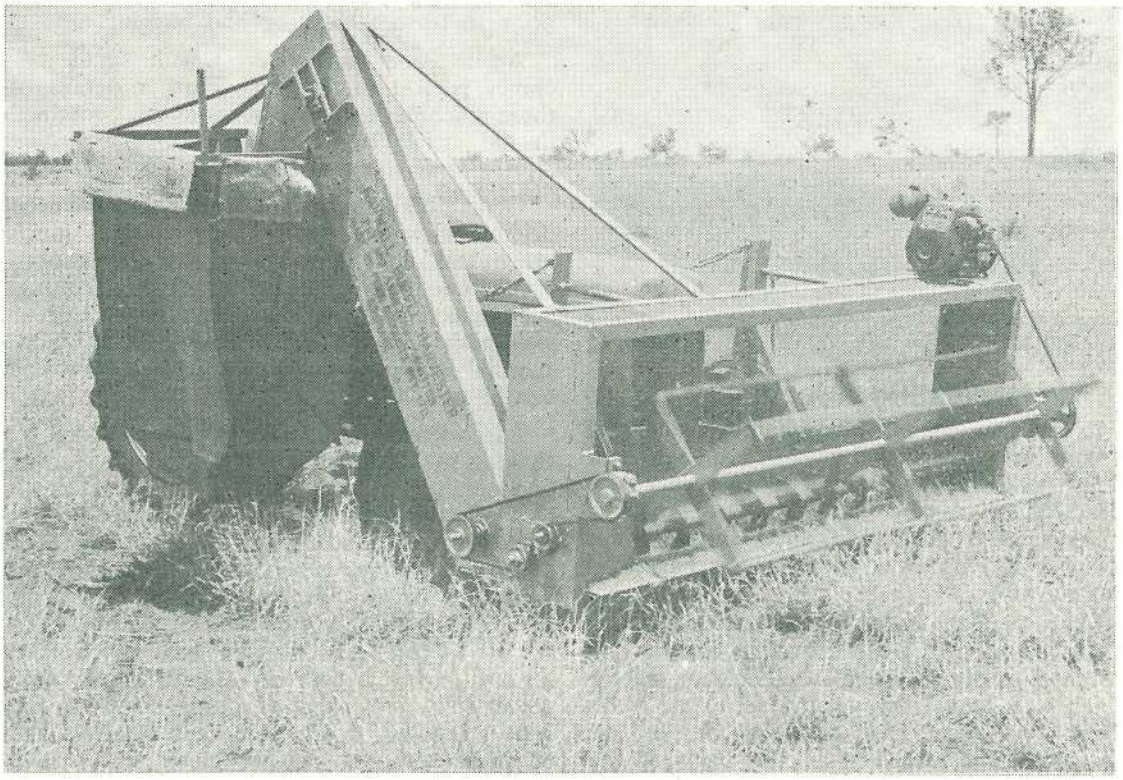
TABLE 2

BUFFEL GRASS SEED HARVESTED (000 s kg) IN QUEENSLAND

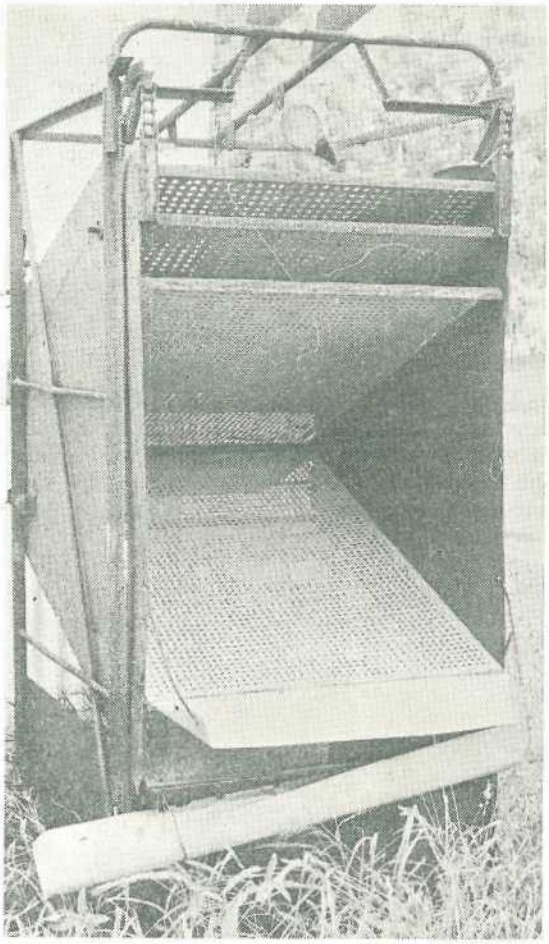
Cultivar	1971	1972	1973	1974	1975	1976	1977
American	23	106	147	161	99	41	68
Biloela	109	96	174	91	86	59	50
Boorara	1	1	1	..	0·3	..	..
Gayndah	59	34	72	39	31	22	33
Molopo	4	3	8	2	2	2	2
Nunbank	6	10	22	7	0·6	22	6
Tarewinnabar	0·2	..	1	1	..	..	..
Mixed and Miscellaneous ..	13	12	10	13	7	6	1
TOTAL	215	262	435	314	226	152	160

Seed yields vary considerably but are commonly in the range of 10 to 60 kg per ha of clean seed for each harvest. Molopo buffel is an exception in that it yields only 2 to 15 kg per ha of clean seed. In the more reliable rainfall areas, seed yields can be increased with an application of nitrogen (125 kg urea per ha) in spring. If rainfall conditions permit up to three harvests in a season are possible.

Total seed harvested in Queensland fluctuates considerably. Low summer rainfall as well as heavy rainfall or winds will reduce the harvest. In recent years, most of the seed harvested has been from the American and Biloela cultivars.



A buffel grass harvester in action in a short crop of American buffel.



A home-made buffel seed cleaner consisting of four vibrating screens.

Harvesting Machinery

In the past, considerable quantities of buffel seed were harvested by hand, an efficient picker collecting something like 25 kg per day. Hand-harvested seed often sold at premium prices because of its high purity and germination. Today, however, most seed is harvested mechanically.

Many graziers have made inexpensive harvesters. One of the earliest consisted of a box mounted on the front of a vehilcle or tractor which was driven through the crop at 20 to 30 km per hour. Ripe seed was knocked off the heads and collected in the back of the box. An improvement on this consisted of mounting an independently driven beater on the front of the box. This enabled seed harvesting at lower speeds and less seed was lost on the ground. To obtain the best results from a harvester, the positioning of the beater relative to the upturned front lip of the seedbox is important. Provision for some adjustment of the beater is an advantage and it should be mounted 5 cm forward and 3·75 cm above the leading edge of the seedbox. Additional refinements can include an auger to transfer seed from the box to a wool pack mounted at the rear of the tractor.

Several large commercial seed producers in the Dawson-Callide are using modified conventional headers to harvest up to 2 000 kg of seed per day. One grower uses beaters with thick rubber blades to strip off the seed which is then blown through a slowly rotating, circular, 1·9 cm wire mesh screen which removes the large trash. It then enters a large mesh bin which can be emptied by tipping sideways hydraulically. The seed is emptied onto a large bitumen area, allowed to dry, and is then pushed into a storage shed with a tractor blade prior to further cleaning and bagging.

An average daily harvest with small machines is 400 to 500 kg. Further details of these machines and modifications are contained in the article by D. L. Purcell, *Queensland Agricultural Journal,* October 1969.

Generally, buffel grass seed does not need drying. However, seed which contains much green leaf and stem should not be packed tightly into bags immediately after harvesting. Seed which is thrown loosely into a shed or weldmesh silo will dry quickly. Some commercial seed producers have seed driers which can be used if necessary.

Large leaves and stalks can be removed by shaking the seed through a 1·25 cm screen or fine netting, or by blowing it through a 1·25 to 1·9 cm rotating screen as mentioned above. Some seed producers have home-made seed cleaning machines which consist of a series of vibrating screens. In the Roma area, a combination of three screens with meshes of 1·25 cm, 0·84 cm and 0·62 cm has given good results. One grower in the Blackall area successfully uses four vibrating screens each with a 1·87 cm mesh. The main disadvantage of these cleaners is that cleaning is slow, throughput ranging from 20 kg to 45 kg per hour.

Harmful effects

Because of its oxalate content, buffel grass can cause Big Head Disease (equine *Osteodystrophia fibrosa*) in horses. The condition is caused by a calcium deficiency, resulting in any one or a combination of symptoms—lameness, ill thrift and swelling of the skull bones. If prolonged, it can lead to deaths.

The disease occurs when buffel grass is the predominant constitutent of the diet and is most prevalent in the wet season when lush pasture growth occurs. To date, there is no evidence to suggest that any one cultivar is less likely to cause big head than another. Owners of horses are advised not to run them for long periods on pure buffel stands. Where this is not possible they should be fed a daily supplement of ground limestone or dolomite. Refer to the article by J. C. Walthall in the July-August 1977 issue of the *Queensland Agricultural Journal*.

Buffel grass is regarded as a pest in many western Queensland towns. It grows prolifically on waste land along roadsides and footpaths and invades gardens and neglected lawns. Control is possible with 2,2DPA or with paraquat (Gramoxone) applied before flowering when the soil is moist. Diuron can be used as a pre emergence spray.

Q.A.C. Director to retire

MR E. P. S. Roberts, Chairman, Council of the Queensland Agricultural College, announced in January that Mr Briton, Director of the College, had requested and it had been approved that he be retired as from 6 November 1978.

In making the announcement, Mr Roberts paid tribute to the long and meritorious service given by Mr Briton to Agricultural Education in Queensland and Australia.

Mr Briton commenced duty in 1938 at the College as Lecturer in Animal Husbandry. In 1940, he was appointed Acting Principal during the absence of Sir Keith Murray on active service. In 1946, he was appointed Principal and has acted in this capacity since that time.

In June 1971, the College became an autonomous College of Advanced Education with its own governing Council. At that time, Mr Briton was appointed Director of the College.

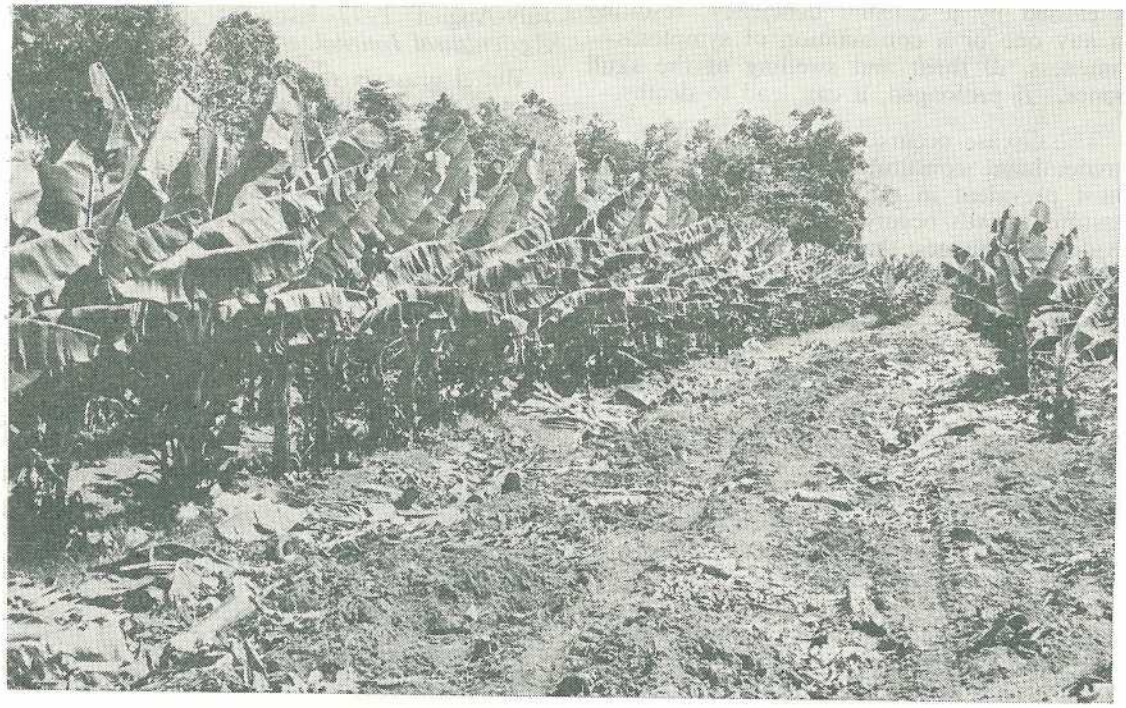
Mr Roberts said that during his 40 years of association with the College, Mr Briton had been responsible for a number of developments within the College. During the war and post war years, he had worked to ensure that the College would continue to operate and to provide suitable training for personnel to service the rural communities of Queensland.

Mr N. W. Briton

Mr Roberts said that the contribution of Mr Briton to the development of the College and to Agricultural Education generally was well recognized and it was with regret that the Council of the College had accepted his notice of retirement.

The Council will be taking early action in the appointment of a new Director.

Banana nurseries



for nematode-free planting material

by R. A. Broadley, Plant Pathology Branch.

BANANA root rot is caused by the burrowing nematode *Radopholus similis.*

Not native to Australia, this pest is spread to new areas in planting material. The problem has been increased by the common practice of using old plantations rendered uneconomic by nematode root rot as the major source of planting material.

The best method for producing nematode-free planting material is to use a nursery area. Hot water treated 'bits' and suckers are planted in a nursery and after growing for 6 to 12 months the stools are dug out and divided. Unless there is evidence of root rot, planting material can be used without further hot water treatment.

The procedure for using nurseries is outlined below. It has been tested experimentally and used successfully by leading growers for several years.

PHOTO ABOVE. A banana nursery on Mr. Stan McKay's plantation in north Queensland. The stools are ready for digging 6 to 8 months after planting.

Site selection

To minimize the risk of contamination, the nursery should be on virgin ground away from the main plantation.

If virgin ground is not available, use ground that has not grown bananas, sugar-cane, Sudan grass, or stylo for at least 3 years and fumigate with EDB, Telone (R) or DD 10 to 14 days before planting.

Disinfestation of planting material

The best type of planting material for the nursery comes from advanced plant crops or healthy first ratoons.

Using a sharp cane-knife, remove all roots, soil and all traces of discoloured tissue in the corm itself. When paring, make sure to remove the tissue where the outside leaves emerge from the corm because nematodes commonly occur there. If bits are used, select those with backward eyes as advanced eyes impede thorough paring and are too vulnerable to survive heat treatment. Pared bits and suckers should not weigh less than 1 kg.

After paring, treat the planting material in hot water at 53 to 55°C for 20 minutes. If the temperature is too low, nematodes survive; if it is too high the plants are killed. Hot-water tanks designed to maintain stable temperatures are available for loan to growers from country offices of the Department of Primary Industries.

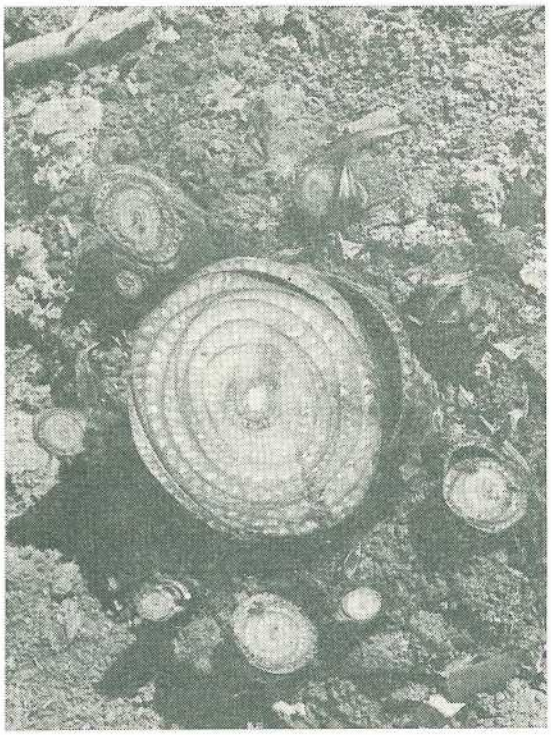
Avoiding recontamination

Allow the treated planting material to cool in the shade before planting. Take care to avoid recontamination from parings and root clippings. If fertilizer bags are used for moving the planting material, disinfest the bags by immersing them in hot water.

Paring should take place away from the nursery so that only treated material enters the area. A pile of parings and roots on the headland of a nursery plot will contaminate the area.

Nematodes are also spread by water and in mud adhering to farm implements. The risk of contamination by water is eliminated by siting the nursery on ground which is not prone to flooding with water from infested plantations.

Wash mud from implements with a high pressure hose and allow them to dry in the sun before using them in the nursery. This will further reduce the risk of contamination.



ABOVE. The pseudostems are cut and removed prior to lifting.

Planting the nursery

Plant the treated material as soon as practicable after it has cooled. Storage for more than a few days reduces germination. As the sole purpose of the nursery is to produce planting material, the bits can be close planted. Use recommended cultural practice for growing the nursery plants.

Digging the nursery

Nursery plants can be removed from about 6 months onwards—according to the area and the needs of the grower.

Plants are dug out with a cutter bar or planting plough. Cut the pseudostem close to the ground and straddle the row with the tractor. If a planting plough is used, one or two eyes on each plant may be damaged but it is reasonably efficient.

Dividing the planting material

Remove the soil from the uprooted stool. Cut off the suckers from the mother plant with a sharp knife, then cut the eyes from the mother plant. Slice a few roots and inspect them for nematode lesions and the material is ready for replanting. Because paring and heat treatment of material from a nursery is usually unnecessary, small, well-formed suckers weighing as little as 150g grow satisfactorily.

Multiplication rates

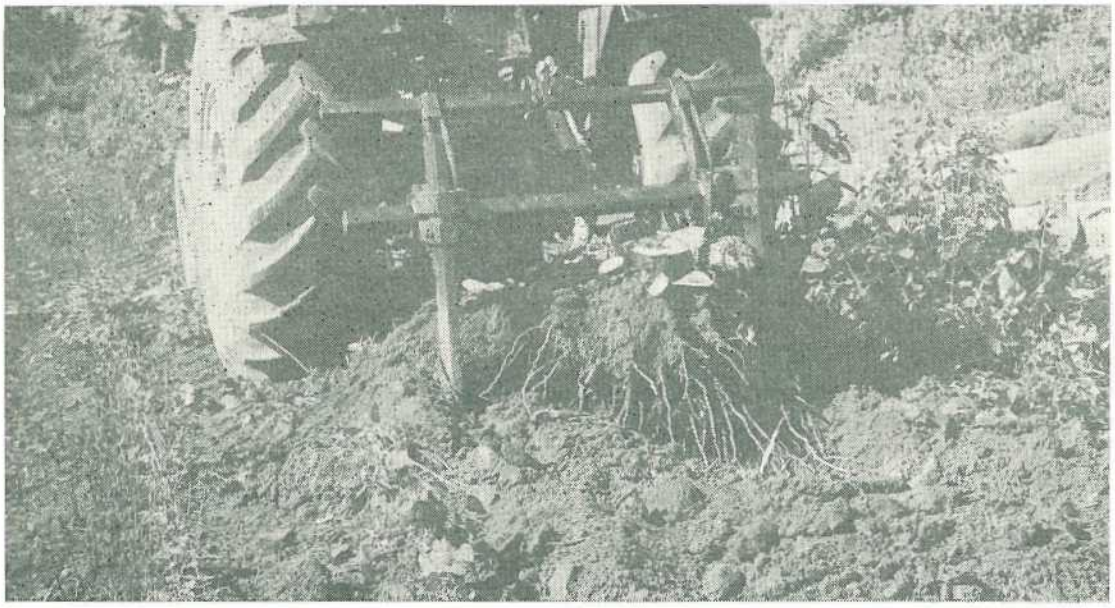
The multiplication rate depends on the area, age of the nursery and expertise of the farmer. In north Queensland, an 8-month-old nursery may yield eight planting pieces from each stool; a 12-month-old nursery should yield at least 12. Some growers have reported higher averages.

If, despite these precautions, a few plants show symptoms of nematode infestation, these must be destroyed. If the infestation is widespread, paring and heat treatment before replanting are necessary. However, provided the original material was correctly treated, very little, if any, nematode rot should appear in the nursery.

Conclusion

Nursery areas are a cheap and efficient means of producing high quality nematode-free planting material. Although nematicides are available for control of nematodes in established plantations, their efficiency is greatly enhanced when the plantation has been established from nematode-free planting material.

BELOW. A tractor-mounted blade designed by Mr. Stan McKay lifts the stool.



Water requirements of apples

by P. S. Crew, Horticulture Branch.

ABOVE LEFT. Microjet outlet. On large trees, normally two per tree are used. The jets wet a surface area with a radius of 1·2 to 3 metres, depending on the capacity of the jet.

ABOVE RIGHT. Travelling irrigator in an apple orchard.

WATER is probably the most limiting factor in the efficient production of apples in the Granite Belt.

As natural rainfall is inadequate, irrigation is needed to provide the full water requirement for optimum growth and cropping. An understanding of the water requirements of apples involves the factors affecting total water usage and a knowledge of the critical stages of tree growth.

How water is used

Water from the soil moves into the conducting tissues of the tree via the actively growing roots. The water then moves through the wood of the tree to the leaves. The water, as vapour, moves out of the leaves and into the air through small pores on the lower leaf surface, called stomates. Up to 30 000 stomates per square centimetre of leaf surface can be found.

A simple analogy to water movement through the apple tree would be a towel, with one end in water and the other end in the air. Water always tends to move along moisture gradients (wet to dry) and will move up the towel by capillary action. Water will be lost from the wet towel to the air by evaporation.

The movement of water from the soil, through the tree, and into the air, constitutes the 'transpiration stream'. Almost all the water taken up by the tree moves within the transpiration stream.

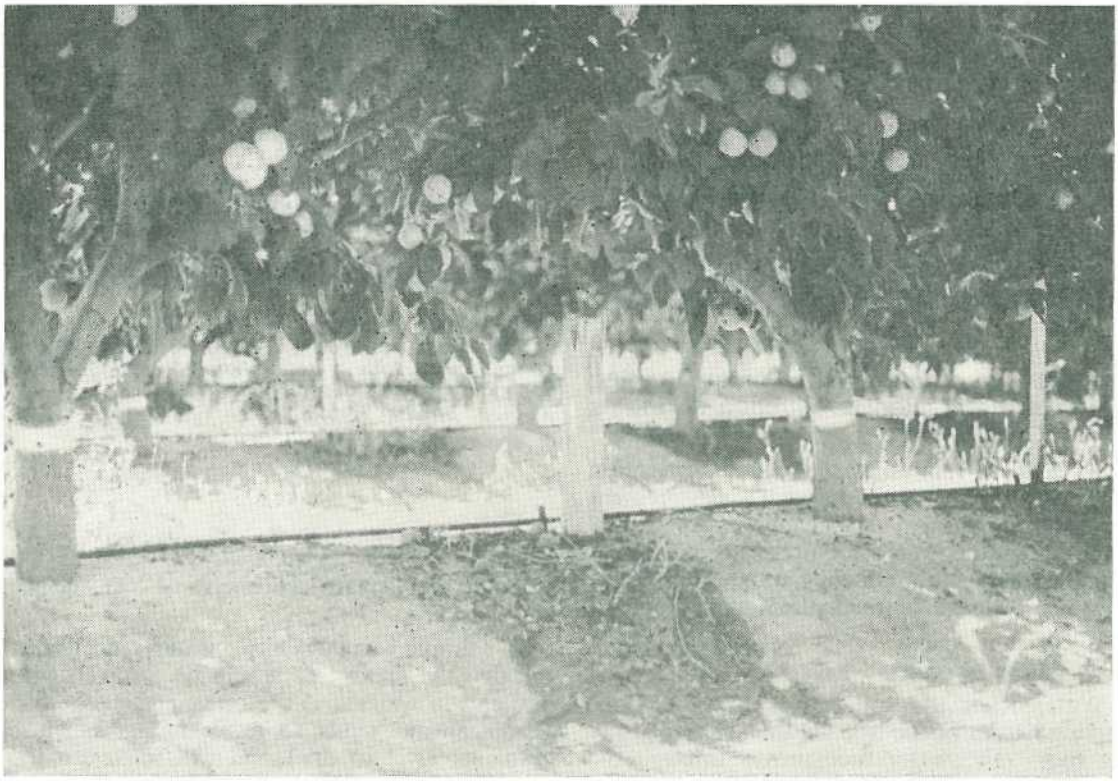
Factors determining water use

- Soil—A soil has a maximum amount of readily available moisture at field capacity, that is, the moisture content after the free drainage of a complete wetting. The drier a soil becomes, the more strongly the remaining water is held around the soil particles, and so, the less available the water becomes for plant uptake.

  When the remaining water becomes unavailable for plant uptake the soil is said to be at permanent wilting point. Soil water must be readily available so that plant uptake keeps pace with plant loss.

  It is very important that readily available moisture in the root zone is associated with adequate aeration in that area, and therefore good soil structure and good soil drainage are important.

- Plant—The stomates of the leaves open in response to light, and carbon dioxide is taken into the leaf for photosynthesis. However, this response is overridden by stomatal response to moisture stress within the leaves. If the leaves are losing moisture faster than the tree can take up water (for example on a hot, windy day or low soil moisture conditions), the stomates will close in an effort to conserve moisture.



Trickle irrigation of close-planted apple trees. There are two microtube outlets per tree.

Air

The water is lost from the tree as vapour through the open stomates. If the stomates are open, there are a number of factors which determine evaporation from the leaves. These factors combined, are the 'drying power' of the air and are the same factors which determine evaporation from a free water surface.

Relationship between water use and growth

If soil moisture is readily available, stomates will remain open for maximum periods during the day. This will allow for maximum uptake of carbon dioxide for photosynthesis, maximum availability of nutrients which are transported by the transpiration stream, and will contribute to evaporative cooling of the leaf canopy.

Importance of water at different stages of growth

Water stress at any stage of growth will affect the apple crop to some extent. However, there are certain stages of growth, during which water stress will have a major effect. These are:

- Flowering and fruit set.
- Early fruit growth (4 weeks after fruit set) —fruit cell dvision takes place and this has an effect on final fruit size.
- Early summer—this is the time when fruit bud formation for the following season's crop begins.
- Midsummer to early fruit maturity—adequate water is necessary for fruit cell enlargement and for continued development of the fruit buds.
- Good soil moisture from harvest to early leaf senescence will help to ensure a good build up of reserves for the following season and will help to ensure strong fruit buds and hence strong flowers for the following season.

It is generally not advisable to irrigate close to harvest time as this could lead to soft fruit, which is easily damaged during handling and has poorer storage qualities.

Estimation of water use

A guide to water requirement is the estimation of water use. Given good soil moisture conditions, the water consumed by an apple orchard is related to the evaporation from a free water surface and the leaf area of the orchard. If evaporation (E) is measured from the standard meteorological surface, such as the Class A pan, the estimated water use of a mature apple orchard at full leaf can be expressed as follows:

Estimated water use of a wide-spaced orchard $=(0{\cdot}5E$ mm x Total area $m^2)$ litres.

Estimated water use of a close-planted orchard$=(0{\cdot}7E$ mm x Total area $m^2)$ litres.

These are general estimations under conditions of maximum water use. Because the water use is proportional to the leaf area, the factor, for example, 0·5 and 0·7 above, increases quickly from zero at bud burst to its maximum value in early December when full leaf development has occurred. The factor would also increase as a tree increases in size from planting to the size of a mature, bearing tree.

Irrigation systems

Although irrigation is not generally practised on wide-spaced apple trees (for dryland farming), healthy trees will respond well to irrigation. In the case of close-planted apple orchards, permanent irrigation is a necessity. The main types of irrigation used are fixed and movable overhead sprinklers, drip irrigation and microjet irrigation systems.

Because drip and microjet systems wet a small area of the root zone under the canopy of the tree, they are very close to 100% efficient in the application of water. Overhead sprinklers wet the total area as well as the tree canopy. Because of losses to evaporation and water use by weeds or sod, the application of water by overhead sprinklers is somewhat less than 100% efficient, and extra water over and above the requirements of the tree is needed.

Irrigation requirements

The total water requirement for optimum growth in an average season would be about 550 mm for a wide-spaced orchard and about 750 mm for a close-planted orchard. The average rainfall during the growing season would be about 575 mm, but not all of this rainfall is effective (lost to surface run-off and underground drainage), and all the water held in the soil is not used by the apple trees.

It is estimated that, in an average year, about 150 mm of irrigation needs to be applied to wide-spaced orchards and about 300 mm to close-planted orchards to meet the total water requirement for optimum growth. These figures are based on total area, so that 150 mm is equivalent to 1·5 million litres per hectare.

The best way to assess day to day irrigation requirements is by regular examination of the irrigated areas. The ideal is to maintain a high moisture content within the root zone without impairing aeration. The use of evaporation measurements to assess water usage and then subtraction of rainfall during the same period can be used as a guide to irrigation requirements.

Water use estimation may not always be a reliable guide to irrigation. In the case of micro-irrigation systems, the total root zone is not irrigated and so the total water use will come not only from the irrigated root zone but also from the unirrigated root zone.

It is important to check the irrigated root zone, especially with micro-irrigation systems, to ensure that overwatering or waterlogging does not occur. This is especially important on poorly structured or poorly drained soils.

The frequency of irrigation should depend upon the rate of moisture depletion from the irrigated root zone. This will depend upon the rate of total water use and, in the case of micro-irrigation systems, the amount of water use from the unirrigated root zone.

Any part of the irrigated root zone should be irrigated before the moisture content falls below half way between field capacity and the permanent wilting point. Because the surface portion of the root zone dries out faster, irrigation may have to be adjusted accordingly. This is difficult to assess in practice, and the efficiency of irrigation will depend upon the grower's ability to maintain both high moisture and good aeration.

The volume of the root zone required to be wetted by micro-irrigation systems must be sufficient to supply the total water requirement of the tree during periods of peak water usage. In the Granite Belt, probably about 20% of the total root zone volume should be wetted.

Microjets may have advantages over drippers in some situations because they wet a larger surface area. Although a microjet system is generally a higher capacity system and hence a more expensive system to install, it would probably be an easier system to manage efficiently and safely.

Optimum results from an irrigation system will depend upon how efficiently the irrigation has been managed. This may mean the most efficient use of a limited water supply or just maintaining good soil moisture at all times. Of course, all the other factors affecting growth must be at optimum levels for maximum response to efficient irrigation.

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Good irrigation management is essential

IRRIGATION has been used for thousands of years to reduce crop stress in humid and sub-humid climates and to allow cropping in semi-arid areas.

However, the history of irrigation, particularly in more arid regions, has not been a successful one. Although the science connected with design and construction of systems bringing water to the farm has been well developed, the science of applying water to the soil has not.

Deterioration of irrigation lands has been attributed to three causes:

- SALINITY AND WATERLOGGING. Particularly in semi-arid regions, the soils and landscape have developed under conditions of low water supply. Increasing the water supply by irrigation places a strain on natural drainage which may lead to rises in water table levels and waterlogging of lower-lying lands. Also, in sub-humid and semi-arid regions, salts are not effectively leached out of the soil and may rise to the surface with drainage water causing loss of productivity through salinity.
- DECREASED INFILTRATION RATE. Infiltration rate determines the rate of replenishment of water during irrigation. The presence of silt in irrigation water and the deterioration of soil structure can both cause long term reductions in soil infiltration rate.
- SOIL STRUCTURE DETERIORATION. This can be due to soil dispersion by irrigation water, decreases in soil organic matter or to shearing and compression by cultivation implements. Large soil pores give way to small pores and movement of water and air and elongation of plant roots become limited.

Conservation of irrigation lands involves three basic approaches:

- Use of good quality irrigation water.
- Judicious water application techniques.
- Maintenance of soil structure.

Irrigation water quality

Irrigation water differs from rain water in that it invariably contains more dissolved salts. Irrigation water from surface sources is usually fairly low in salts but bore water often contains more than 50 times as much salt as rainwater. If these salts are not removed from the root zone of the crop being irrigated, either by excess irrigation or rainfall, salt levels will increase to a stage where uptake of water and nutrients by roots is limited. Some ions such as boron and chloride are harmful to plants. For example, tobacco is very sensitive to chloride in irrigation water.

Sodium, carbonate and bi-carbonate ions are also undesirable in irrigation water. Well structured soils normally contain a high proportion of calcium and magnesium ions adsorbed on to the clay as exchangeable cations. If the irrigation water contains a high proportion of sodium, it will exchange for the cations on the clay. Carbonate and bicarbonate have an additional adverse effect in that, when the soil dries, they precipitate calcium and magnesium from the soil water as relatively insoluble lime or dolomite. This increases the tendency for the soluble sodium to exchange on to the clay.

by K. J. Coughlan, Agricultural Chemistry Branch.

Clays with adsorbed sodium are notoriously unstable, take in water poorly and form hard crusts.

Because of the possible adverse effects of poor quality irrigation water, a water analysis should be obtained before plans are made to irrigate, particularly with underground waters. Your local Department of Primary Industries adviser should be consulted for information on obtaining water samples.

In many cases, it is not possible to give a definite answer on irrigation water suitability. The effect of the water depends (apart from water composition) on soil type, climate, amount of irrigation water applied and general soil management. Often, it is possible only to point out the likely problems from the use of the water. However, it must be stressed that adverse effects are often not obtained immediately. If irrigation water of doubtful quality is used, it is important to observe any effects on the soil or plants (for example, patchy growth, poor seedling emergence, reduced infiltration rate, or formation of hard crusts on drying. Analysis of soil samples from irrigated and non-irrigated areas should provide information on these problems and on likely remedial action. Also, the irrigation water should be analysed at least once a year to detect any changes in quality.

If poor quality water must be used, it is desirable to add gypsum to the soil, either in the irrigation water, or to the soil surface. The gypsum acts as a source of calcium and can counteract the adverse effects of sodium if the salt content of the irrigation water is not too high. Gypsum application rates of 2 to 8 tonnes per hectare per annum are required depending on the amount and quality of the irrigation water used. An information bulletin on the use of gypsum has been produced by Consolidated Fertilizers Limited and copies are available from them for distribution.

Irrigation techniques

Improvements in tillage techniques, fertilizer usage, crop varieties and insect and disease control have meant that water is more often limiting to plant growth, even in humid climates and under irrigation.

The aim of good irrigation is to keep soil water contents within a range optimum for crop production. The upper limit of this range is the maximum soil water content, while the lower limit is the wilting point. The wilting point is the soil water content at which the soil becomes unable to supply water to plant roots fast enough to satisfy atmospheric demands for evaporation of water from the leaf surfaces (plant transpiration). As a result of this, plant wilting occurs and growth processes are disrupted. The wilting point is actually a range of water contents since it depends on environmental conditions for example plants will wilt at higher soil water contents on a hot, windy day than on a cool, cloudy day. Added to this, all crops are more sensitive to low soil water contents at some stages of growth than at others. If the soil water content falls below the wilting point range, plant growth will be reduced. Also, fertilizers will not be efficiently used if water is limiting.

The maximum soil water content, as the name infers, is the maximum amount of water which can be added to the root zone by irrigation. Any additional water will be wasted as surface run-off or as drainage to depths below the root zone. Drainage leaches nutrients beyond the reach of plant roots. Also, over-irrigation of higher lands often causes waterlogging and salinity problems on lower lands.

The amount of water held between the maximum soil water content and wilting point is called the available water range. It varies between soil types but values of 2 cm of water per 10 cm of soil depth for medium to heavy textured soils and 1 cm per 10 cm for light textured soils are approximate guides.

The most common questions asked on water application techniques are:

- How frequently (or when) to irrigate?
- How much water to apply?
- How best to apply the water?

The answers to these questions are to irrigate before plant wilting occurs, to irrigate to the maximum soil water content, and to choose a method allowing even distribution of water over the irrigation field. These answers are unfortunately, of little practical benefit.

However, there are some aids which farmers may use in improving irrigation effectiveness.

These include:

- Plant observation
- Meteorological measurements
- Soil consistence (or feel)
- Soil water potential (soil suction).

Although plant observation has been widely used to decide when to irrigate, it is not recommended for most crops. Wilting may occur on hot, dry days even when the soil water content is high. On the other hand, by the time wilt symptoms are obvious under normal weather conditions, yield reduction from water stress has often occurred. However, the first sign of midday wilt may be a useful indication of the need to irrigate under some conditions.

Meteorological measurements, such as evaporation, temperature, sunshine and rainfall are generally available to assist growers in deciding when to irrigate. Irrigation scheduling schemes, based on standard evaporation pan figures, have been used in a number of irrigation areas. The information is collected by the local weather station and is often broadcast over radio as a community service.

Irrigation scheduling from evaporation measurements is based on the assumption that water evaporates from the plant leaves in the same way as it will from the evaporation pan if the plant is not suffering water stress. However, plant leaves do not always cover the ground surface, and the vigour of plant growth varies with the stage of growth. To account for these variations, 'crop factors' relating plant water use to evaporation have been devised. Using evaporation, 'crop factor' and rainfall information, an approximate water budget can be worked out. For example:

Evaporation since irrigation (corrected for rainfall)	= 10·3 cm
Rainfall on crop	= 0·8 cm (8 mm)
Evaporation minus rainfall	= 9·5 cm
Crop factor	= 0·85
Estimated water use by crop	= (9·5 x 0·85) cm = 8·1 cm

The water budget can be calculated on a daily basis until water use suggests that the crop should be watered. Evaporation figures are usually obtained from the district weather station, but it is important to measure the rainfall actually falling on the crop.

The major problem with this system is that the amount of water which can be used before irrigation depends on both soil type and the age (and rooting depth) of the crop. Therefore, water budgets can only be used to supplement a farmer's own practical knowledge. They do have the advantage that they can give a rough estimate of the amount of water that should be applied in the irrigation. This may aid in irrigation planning.

Other methods which may improve the irrigator's judgement are based on the observation of the soil itself. The measurements and equipment required are simple and observations can easily be carried out by the farmer. All that is required is a spade (or preferably a soil auger) and a soil probe. All tests rely on the well known changes in soil consistency (or feel) with water content.

The 'feel' test is very useful and is carried out on soil removed by augering to a depth greater than the expected root zone of the crop. The top 10 cm of the soil is normally neglected except for very shallow rooting plants. This part of the soil is dried rapidly by evaporation. The use of the feel test is illustrated in table 1.

Six feel categories are described, from very wet to dry. If the feel test places the soil in category 5, or for some soils category 4, irrigation is indicated. It is important to note that the test is only a guide and can be modified on the basis of a farmer's experience.

The soil probe measures the increase in soil resistence to penetration as soil water content decreases. Probes are of use in estimating the depth to which water is used and, with experience, the degree of drying. They can also be used to determine the evenness of water application during irrigation. Probing has the great advantage that it is fast and does not require soil excavation. Therefore, it is possible to take a large number of probe measurements over the paddock.

TABLE 1

Moisture condition	Feel category	Sand and sandy loams	Loams	Clay and clay loams
Wet	1	Free water appears on surface when a ball of soil is bounced in the hand or squeezed	Free water can be squeezed out	Soil is very sticky and sloppy
	2	No free water when squeezed but a ball leaves a wet outline on hand	Soil sticky. No free water when a ball is squeezed but wet outline on hand. Possible to roll long, thin rods 1·5 mm diameter between finger and thumb	As for loams
Moist	3	Slightly coherent. Forms a weak ball under pressure but breaks easily	Soil is coherent and pliable. Will not form 1·5 mm rods	Soil is coherent. Ribbons out between fingers easily. Has slick feeling
Irrigate	4	Appears to be dry. Ball will not hold together	Soil is coherent and will ball under pressure	Forms a ball and will just ribbon out between thumb and forefinger
	5	Appears to be dry. Will not ball	Forms a crumbly ball under pressure	Will still form a ball. Will not ribbon out
Dry	6	Soil is dry and will flow through fingers	Crumbly. Will not ball. Small lumps will powder	As for loams

Over recent years, irrigation scheduling methods based on more scientific principles have been developed. These methods measure soil water potential (soil suction) which gives an indication of the amount of work that the plant must do to remove water from the soil. Critical values of soil water potential to give optimum plant growth are known for a wide range of crops. These methods are preferred since plants respond to soil water potential and not soil water content. Other methods described earlier are aimed indirectly at predicting when critical soil water potentials will occur.

Equipment used to measure soil water potential includes tensiometers and gypsum blocks. These are not commonly used commercially in Queensland, but they have gained wide acceptance overseas. They have the advantage that they can be incorporated in automatic irrigation systems. Water can be turned on or off depending on the tensiometer or gypsum block reading.

Water addition by irrigation

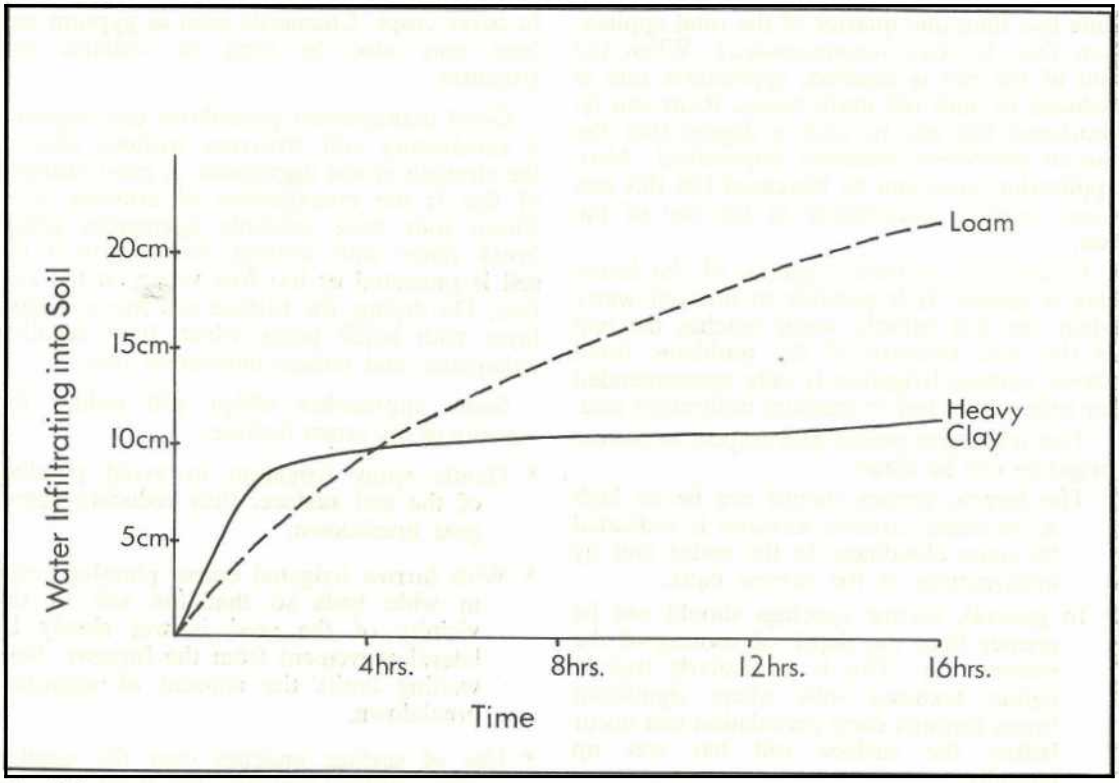
Good irrigation has two important requirements—wetting the soil to the maximum water content and applying the water evenly over the irrigation paddock. These requirements will determine the best irrigation technique to use under a given set of circumstances.

Basically, two methods of irrigation are used:

- Spray or sprinkler irrigation
- Surface irrigation—furrow or flood.

Spray irrigation has a number of advantages. It can be used on soils with high or low infiltration rates, or in paddocks where infiltration rate varies over short distances. This is because the rate of water intake into the soil can be determined by the application rate. Land levelling is not necessary and soil erosion by irrigation can be avoided. Also, if the system is properly designed and is operating efficiently, an even application rate can be obtained over the whole area. Generally, capital and operating costs are higher than for surface irrigation. However, with increasing labour costs and limitations on water availability, surface systems are being replaced by spray systems in some areas.

There are two important things to remember, in spray irrigation:



Graph 1.

- Application rates should not be greater than the rate at which the soil can accept the water. If water ponds on the surface, run-off and erosion can occur and application will be greater in low spots. Puddling of the surface soil may also occur and this can lead to soil crusting. Suitable application rates can be determined by observation.
- It is necessary to check from time to time that the irrigation system is, in fact, providing an even application. System faults such as blocked nozzles and operation at incorrect pressures can be picked up in this way. Suitable spray gauges (for example, jam tins) can be strategically placed to check evenness of application.

The success of surface irrigation, particularly with respect to evenness of application, is dependent on the infiltration rate of the soil. To illustrate this, the amount of water infiltrating into two soils over a period of time is shown in graph I.

The problem with surface irrigation is that water is ponded at the top of the run for a longer period of time than on the bottom. This is relatively unimportant for the heavy clay since after 2 to 4 hours ponding little extra water is taken in. However, in the loam, infiltration rate continues to be high and a longer period of ponding means more water entering at the top of the run. If the top part of the run is properly irrigated, the bottom part is under-irrigated. If the bottom part receives adequate irrigation, the top receives too much water. The two major results of poor surface irrigation are losses of water and nutrients at the top of the run through drainage below the rooting zone of the crop (deep percolation) and incomplete watering at the bottom of the run. Therefore, inefficient irrigation often results in poor yields at the top and the bottom of the run.

To overcome problems in lighter textured soils, it is necessary to advance the water to the bottom of the run as fast as possible (a

time less than one quarter of the total application time is often recommended). When the end of the run is reached, application rate is reduced to limit tail drain losses. Runs can be shortened but not to such a degree that the use of machinery becomes impractical. Also, application rates can be increased but this can cause erosion, particularly at the top of the run.

In contrast, surface irrigation of the heavy clay is simple. It is possible to turn off water when (or just before) water reaches the end of the run. Because of the problems listed above, surface irrigation is only recommended for soils with a low to medium infiltration rate.

Two important points with respect to furrow irrigation can be made:

- The furrow stream should not be so high as to cause erosion. Erosion is indicated by some cloudiness in the water and by undercutting of the furrow bank.
- In general, furrow spacings should not be greater than the depth of rooting of the mature crop. This is particularly true in lighter textured soils where significant losses through deep percolation can occur before the surface soil has wet up laterally.

Maintenance of soil structure

Good soil structure requires the presence of soil aggregates which remain stable to wetting, and the existence of stable pores which allow the interchange of water and air between the soil surface and sub-surface. Deterioration of soil structure (breakdown of aggregates and destruction of large pores) is indicated by reduced infiltration rate, a tendency towards waterlogging, difficult cultivation and formation of surface crusts and compacted sub-surface 'pans'.

Maintenance of soil structure can be achieved in one of two ways:

- By strengthening or increasing the stability of soil aggregates.
- By managing the soil in such a way that aggregate breakdown does not occur.

Soil aggregates may be strengthened by increasing the soil organic matter content. Good management should aim to keep soil organic matter as high as possible by methods such as retaining crop residues and ploughing in cover crops. Chemicals such as gypsum and lime may also be used to stabilize soil structure.

Good management procedures can maintain a satisfactory soil structure without altering the strength of soil aggregates. A good example of this is the management of crusting soils. These soils have unstable aggregates which break down with wetting, particularly if the soil is saturated or has free water on the surface. On drying, the surface soil forms a hard layer with small pores which limit seedling emergence and reduce infiltration rate.

Some approaches which will reduce the severity of soil crusts include:

- Gentle spray irrigation to avoid ponding of the soil surface, thus reducing aggregate breakdown.
- With furrow irrigated crops, planting seeds in wide beds so that the soil in the vicinity of the seed is wet slowly by lateral movement from the furrows. Slow wetting limits the amount of aggregate breakdown.
- Use of surface mulches over the seeding row—surface mulches slow down the rate of drying of the surface soil. This reduces the strength of crusts since crust strength increases rapidly as the soil dries. Also, the mulch protects the soil aggregates against breakdown by rainfall between planting and seedling emergence. This is a danger period since the soil is usually wet from irrigation and saturation of the surface soil occurs much more readily.

Excessive or ill-timed cultivation and vehicular traffic can be detrimental to soil structure, particularly under irrigation. In some areas where vegetables are grown for canning, harvesting has been carried out under wet conditions to fulfil contract requirements. This has caused rapid deterioration of soil structure on some farms.

Research has repeatedly shown that the minimum amount of tillage required to control weeds, level land, and shape furrows, planting beds, etc. gives the best crop response in most soils. Water content at which a soil is cultivated can be very important. If clay soils are cultivated too wet, puddling, compaction and

development of sub-soil 'pans' may result. Since irrigation increases soil wetness, the possibility of soil structural deterioration is greater.

It is important to note that water content and consistence will vary within the soil layer to be cultivated. Even though the surface of a clay soil may be dry enough to cultivate, soil at the bottom of the cultivated layer may be too wet. Soil compaction and formation of sub-surface pans may occur under these conditions.

The feel test given earlier can also be an aid in deciding when it is best to cultivate. Clay soils should be cultivated at feel category 5 or 4, at which stage the soil has low plasticity yet is not too hard. Sandy soils are often better cultivated when the soil is moist and slightly coherant (for example, feel category 3).

State Government drought relief aid

THE Minister for Primary Industries, Mr V. B. Sullivan, expressed concern that many drought-affected primary producers were not aware of the various State Government relief measures which have been operating for some time.

He advised producers who were in doubt as to their eligibility for assistance to contact their local Stock Inspector without delay.

'Currently, the measures fall into three categories—freight concessions on movement of stock and fodder, drought relief loans and a slaughter subsidy on stock unsaleable due to drought,' he stated.

Mr Sullivan said that, by arrangement with the Commonwealth Government, the State Government financed all natural disaster concessions up to $2 million in each financial year.

Beyond that figure, the Commonwealth met the cost of 'approved measures', provided the amount for any single natural disaster exceeded $200 000 within any 1 year.

These amounts already had been spent by Queensland on natural disasters this fiancial year.

'In addition to diverting the staff of my Department, and of others, towards initiating, developing and administering drought relief concessions, the State Government forgoes certain revenues,' the Minister said.

'No charges are made for registration fees on mortgages and for stamp duty on drought relief documents.'

Mr Sullivan said current relief measures were:

- A rail freight concession of 50% on stock for forced sale or slaughter, to and from agistment and for re-stocking; and on fodder for drought feeding, or storage in anticipation of drought.
- On stock where the journey generally is not competitive with rail, or where rail transport is impracticable or unavailable, a 50% concession of the cost of the loaded journey up to 40c a km for a 10 tonne truck.

No subsidy is payable on the first 60 km of a journey.

The concession also applies to transport of fodder from railhead to property—50% of the cost of the loaded journey up to 4c km per tonne.

Where rail is unavailable and a full road journey is involved, the rate is the same as above, less the first 60 km.

- Drought relief loans. Carry-on loans of up to $5 000, with provision for extension to $10 000 in special circumstances, at 3% interest over 7 years; up to 2 year deferment of repayment possible.
- Re-stocking loans on similar terms and conditions up to $10 000 per property.

  Loans are administered by the Agricultural Bank.
- Slaughter subsidy. Payment of $10 a head on unsaleable animals slaughtered on property. Animals to be over 5 months of age and claims to be made through local Stock Inspectors.

Vitamin instability and low production . . . are they your problems?

by G. D. Stewart, Pig and Poultry Branch

THERE have been many recent reports of vitamin deficiency in Queensland.

Reliable vitamin assays of a range of mixed feeds and premixes have shown that some products are not measuring up to guaranteed levels. It is important that producers buy and use only registered and properly labelled products.

There are many reasons why vitamin levels can be lower than expected. These reasons are outlined in this article.

Over the past few years, there have been many reports of vitamin deficiency cases occurring in the field. Some of these reports can be attributed to the feed mixer physically leaving ingredients out of the diet, others to feed formulation changes allowing some vitamins to become marginal, and yet others due to lack of potency of the vitamins included in the diet.

The stability of vitamins depends on many factors and methods for determining stability in the laboratory are varied. For example, laboratory tests can involve measurements based on time, high temperature, high moisture, high mineral content, steaming, compression, oxidation, etc. Each of these tests can provide a stability figure provided the results are interpreted in the right context.

Because of the variability of stability of vitamins in different situations, it is difficult to apply a standard to allow for all field situations.

Feed micro-ingredients are inclusions such as vitamins, minerals, antibiotics, some growth promotants, or other drugs.

When considering a low micro-ingredient assay result, it is necessary that certain physical and chemical factors are not overlooked. These are:

- Micro-ingredient premix properties.
- Uniformity of the feed product.
- Sampling procedure employed.
- Test methods used and their applicability.

Many factors may lead to a non-uniformly mixed feed product such as:

- Physical differences between ingredients.
- Differences between shipments of the same ingredient (for example, particle size, shape and density).
- Poor mixing equipment design, installation and operation.

In general, it would appear that there have been more problems regarding vitamin potency with bagged feed than with bulk feed. The main factor involved here being time as bulk feeds are normally consumed reasonably soon after mixing whereas bagged feeds may be stored, often under unfavourable conditions, for long periods of time.

When discussing factors which affect vitamin stability in feeds, there are two broad categories to consider.

- Those factors outside the feed formulation itself, that is, the external environment around the feed or the macro environment.
- Those factors which are within the feed itself, that is, the internal environment or the micro environment.

Both macro and micro environmental factors are important when considering vitamin stability. The major macro environmental factors are:

- Moisture
- Temperature

Consider moisture

Water can have a major effect on vitamin stability whether it is present as high humidity or as high moisture content in grains or other feed ingredients. In general, the rate of potency destruction is directly related to moisture content, that is, potency loss increases as moisture level in the mixed feed rises. Such potency losses are actually the result of chemical reactions caused by the presence of the moisture.

Micro particles can acquire a film of moisture around them during storage and in fact may gradually dissolve in this film causing a potency loss. It can easily be recognized that during such operations as steam pelleting, the supply of an aqueous film around micro ingredient particles and their subsequent gradual dissolution can be greatly enhanced.

Associated with moisture levels in a feed can be changes in the pH of the mix (that is, the measure of the acidity or alkalinity). Certain micro-ingredients can be extremely sensitive to acidity or alkalinity. It is in the aqueous film around the micro particles that the pH may alter and cause potency losses.

Consider temperature

Vitamin potency problems have long been known to be more prevalent during months of relatively high temperature than during the winter months.

Increases in temperature can speed up the rate of destruction, or conversely, slow down potency loss during colder periods.

Vitamin potency losses due to temperature effects are normally negligible for temperatures under about 15°C. At temperatures above 15°C some potency loss may start to be observed. Overseas workers have stated that the rate of potency loss will approximately double with each rise of about 15°C. For example, an additive which shows a potency loss of 10% per month during spring when the temperature is say 15°C, could be expected to loose potency at the rate of 20% per month during summer when the temperature is 30°C.

It is important to remember that temperatures inside feed bins or feed storage sheds etc. may be well in excess of 45 or 50°C during summer periods.

Although high temperatures are involved with pelleting, research has shown that generally there is little loss of potency because of the short time interval for which the pellets are heated. However, pellets may show vitamin potency loss after storage due more to the increased moisture content which occurs during the pelleting process.

Micro environmental factors which are considered to play an important role in vitamin stability are:

- The presence of mineral salts.
- The presence of oxidizing and/or reducing compounds.
- Micro ingredient particle size.

Presence of mineral salts

Many mineral salts can speed up micro ingredient reactions. Once again, the moisture content of the feed is important as most reactions occur in the liquid phase. Especially important then, are the water soluble mineral salts. Premixes and feed concentrates are the most vulnerable to this problem because of their concentrated form. The use of insoluble mineral salts (for example, carbonates and hydroxides) can alleviate much of this problem.

It is important when a combined mineral and vitamin premix is formulated, that likely reacting ingredients are not included in such a way that immediate potency losses occur. It is also extremely important that enough base material be used as a separating medium between micro ingredients.

Oxidizing and reducing compounds

Feedstuff ingredients such as ferrous sulphate, ascorbic acid, sulphites and bisulphites, oxidized fats, iodine, etc. can adversely affect sensitive micro ingredients.

Particle size

Micro ingredient particle size plays an important part in the stability of the ingredient concerned. It has been shown in many cases that there is a definite relationship between potency loss and exposed surface area per unit weight (that is, for certain ingredients the finer the particles are milled, the greater is the chance of destruction or loss of potency).

It is necessary therefore, when comparing micro ingredient sources, that the average particle size of the ingredient approaches the optimum for maximum stability. Unfortunately, little precise scientific information is available on the best particle size for many micro ingredients.

Consider the major vitamins

In general, there are two groups of vitamins —those which are fat soluble (A, D, E, K) and the water soluble group (the vitamin B complex).

From the preamble to this article, it will be recognized that the water soluble vitamins can be most easily destroyed if the moisture content of the feed increases. On the other hand, if the diet is tending towards rancidity then the fat soluble group would be most affected.

The water soluble group

Thiamin (vitamin B_1)

Thiamin occurs as a highly water soluble, white, crystalline powder (Thiamin hydrochloride). Stability decreases as the pH rises above 5·0. (Neutrality = pH 7·0. A solution is said to be acid if the pH is below 7·0 and alkaline if the pH is above 7·0). Thiamin is most sensitive to heat under neutral or alkaline conditions.

As most mixed feeds have a pH closer to 6·5 to 7·5, the feed formulator must expect some loss of potency especially in the presence of moisture and high temperature as found in the field.

Normally, poultry diets contain an adequate supply of thiamin and, therefore, supplementation is unnecessary.

Riboflavin (vitamin B_2)

Synthesized riboflavin occurs as an orange-yellow, crystalline product. It is only slightly soluble in water. It is reasonably stable to heat and oxidation but suffers potency loss under alkaline conditions and when subjected to light if it is in solution. Research workers have reported that riboflavin premixes are extremely stable, showing only 1 to 2% loss after 12 months storage. However, such conditions as the presence of reducing compounds such as ferrous sulphate and ascorbic acid etc. or alkalinity should be avoided.

Most poultry diets need added synthetic riboflavin.

Pyridoxine (vitamin B_6)

Pyridoxine in the synthetic form exists as pyridoxine hydrochloride. It is fairly stable to heat.

Pyridoxine is widely distributed in feedstuffs and, in general, a field deficiency is unlikely to occur.

Cyanocobalamin (vitamin B_{12})

Cyanocobalamin occurs in pure form as a dark-red, crystalline powder.

In multi-component premixes, cyanocobalamin can be gradually decomposed by high levels of choline chloride, reducing agents such as ascorbic acid (vitamin C) or by very acid conditions.

Normally field deficiencies are uncommon.

Nicotinic acid (niacin)

Few problems have ever been reported with niacin stability. Both nicotinic acid and nicotinamide are white, crystalline powders. Nicotin-amide has the advantage of not being acidic and is widely used instead of nicotinic acid where there could be serious incompatability problems with other micro ingredients.

Pantothenic acid

The calcium salt is the most commonly used form of this vitamin. Calcium pantothenate is a white, hygroscopic (absorbs moisture from the atmosphere) powder. High temperatures may cause a potency loss.

Stability of this product is not normally a problem in mixed feeds.

Choline

Choline chloride is the commercial vitamin and is marketed mainly as a 70% aqueous solution or as a dry premix on a grain carrier.

Choline chloride solutions are extremely stable and are quite stable in premixes and mixed feeds. The choline chloride premix on a cereal carrier is hygroscopic and coupled with the fact that choline chloride solutions are often slightly acidic, it can be seen that other more sensitive micro ingredients in the feed could be adversely affected.

Folic acid

Pteroylglutamic acid (folic acid) occurs as a yellow, crystalline powder. Both the powder and its solutions are sensitive to light. The available literature provides no data on the stability of folic acid in premixes or mixed feeds.

Ascorbic acid (vitamin C)

Ascorbic acid is a white, crystalline powder. In solution, it is strongly acid. It is a powerful reducing agent and is commonly used as an antioxidant in foods and pharmaceuticals. In normal water solutions, the ascorbic acid can be decomposed in a few hours just by oxidation due to air. These solutions are also sensitive to light.

Stability in meal-type feeds depends on the feed formula, moisture content, storage temperature and the type of vitamin C used. Overseas work shows potency losses of about 10% after 4 to 8 weeks of storage at about 25°C to 20 to 30% loss at about 40°C.

Ascorbic acid appears to be the most sensitive vitamin to feed pelleting operations.

The fat soluble group

Vitamin A

The commercial forms of vitamin A are yellow-orange, crystalline compounds (vitamin A acetate or vitamin A palmitate).

Both compounds are readily soluble in fats and oils. They are rapidly inactivated by ultra violet light (for example, in sunlight) and by oxygen present in the air. This decomposition can be accelerated by the presence of moisture, certain trace metal salts, high temperatures, and especially if the diet is tending towards rancidity.

Vitamin A is normally added to feeds in a stabilized gelatin beadlet form. Overseas work shows that under normal storage conditions, potency losses in mixed feeds average 5 to 10% per month at temperatures of between about 24°C and 38°C.

Vitamin D

Commercial vitamin D_3 (cholecalciferol) is insoluble in water but soluble in the usual organic solvents and in vegetable oils. It is produced by the irradiation of 7-dehydrocholesterol. In pure form, it occurs as white, odourless crystals.

Vitamin D_3 is destroyed by over exposure to ultra-violet light (for example, sunlight) and oxidation if the diet is tending towards rancidity. Most commercially-mixed feeds contain enough vitamin E and other natural and synthetic anti-oxidants to prevent total destruction of vitamin D_3.

Overseas tests have shown potency losses of from 0 to 10% per month over 6 months of storage under good conditions.

It would appear that testing for vitamin D_3 potency in the laboratory is a difficult process and results can be extremely variable.

Vitamin E

Vitamin E (alpha tocopherol) is a light yellow, oily liquid. It is insoluble in water but blends readily with vegetable oils. Alpha tocopherol acetate is the most widely used form of vitamin E and is mainly supplied in dry form on a cereal base. Vitamin E is easily oxidized in air.

Vitamin E potency is easily destroyed if the mixed feed is tending towards rancidity.

Pelleting may also destroy vitamin E, especially if the ration does not contain sufficient anti-oxidant to prevent accelerated oxidation under conditions of high temperature and moisture. D-alpha tocopherol acetate has been reported stable in mineral and premix mixtures for up to 3 to 4 months at about 45°C and in mixed meals for up to 6 months.

Vitamin K

Vitamin K is fat soluble, stable to heat, and susceptible to oxidation, alkalies, strong acids, and sunlight.

The most commonly used commercial feed product is menadione sodium bisulphite complex which is a white powder and is water soluble.

Heating up to 50°C would not appear detrimental to the commercial vitamin K potency.

Commercially used vitamin K is sensitive in premixes to minerals and moisture.

Some studies overseas have shown potency losses for commercial vitamin K in mixed feeds ranging from 6 to 20% per month at about 24°C.

Conclusions

- The potency life of any vitamin depends on many varied and interrelated factors.
- The most important factors affecting potency are temperature and moisture.
- Bagged feeds which are often stored for long periods prior to use are more likely to cause a vitamin deficiency problem.
- The need for sufficient base material to be added so that it becomes an efficient separating medium cannot be overstressed when premix concentrates are being considered.
- Only vitamin premixes which have been registered with the Standards Branch of the Department of Primary Industries and are correctly labelled should be purchased by producers who intend to mix their own feed.
- As a general recommendation, mixed diets should not be stored for longer than 1 month before total useage.
- Climatic differences throughout the State will cause different rates of potency loss on similar formulations.
- All diets in Queensland should have an antioxidant added as an initial preventative for vitamin potency loss.
- Containers of vitamin and/or mineral premixes should be stored in a cool, dry storage area which is shielded from direct sunlight and which is protected from severe heat radiation from iron roofs.

Top U.S. engineer to work in Queensland

DR Peter Bloome, Associate Professor of Agricultural Engineering with the Oklahoma State University will work in Queensland for 12 months.

The Minister for Primary Industries, Mr V. B. Sullivan, said, "Dr Bloome commenced duty in December with the Engineering Services Section of my Department in Toowoomba."

He has an excellent record in this relatively new branch of the engineering discipline.

His efforts in the extension field earned him the 1976 Engineering Achievement Award presented by the American Society of Agricultural Engineers. This was a notable attainment when it is considered the Society has over 7 000 members.

His first, and probably major project, during his stay here will involve a study of disinfestation of headers for the Wheat Industry Research Council.

Control of Johnson and Columbus grasses on irrigation channels and drains

by J. MARLEY, Agriculture Branch.

JOHNSON grass and, to a lesser degree, Columbus grass are expensive and difficult to control in cultivation.

When the cultivation is used for irrigated summer-cropping the difficulty is accentuated as both chemical and cultural control measures are more effectively applied in cultivation during the summer period.

The banks (above the permanent water line) of irrigation channels and drains are ideally suited to the lush growth of both grasses. Their growth is favoured by deep, fertile soils and good soil moisture conditions. Both are susceptible to prolonged flooding and will not persist below the water line of permanently or semi-permanently filled channels. Where these grasses are established, other plant species are quickly dominated. A proportion of the seed formed will fall into the channel and will be carried by the water flow to irrigated areas.

Also, the tall, dense growth of the species on banks of channels reduces accessibility.

The author applying a herbicide treatment to Johnson grass patches in a herbicide evaluation trial.

Description

Both Johnson grass (*Sorghum halepense*) and Columbus grass (*Sorghum almum*) are tall, perennial grasses with erect stems ranging in height from about 0·9 m to about 3·5 m. Both have broad, rather succulent, dark green leaves with a thick, pale mid-rib and large, open panicles carrying numerous spikelets. Both species produce underground stems or rhizomes from which fresh shoots rise to the soil surface.

The species are also very similar in panicle and spikelet characteristics. This makes positive identification between the two quite difficult. Generally, Columbus grass has taller and thicker stems, broader leaves, shorter rhizomes which curve upwards and are not invading and larger panicles and seeds. Johnson grass is a more serious weed because of its longer and more invading rhizome system and its production of a proportion of dormant seed.

The mature seed of Columbus grass germinates readily.

Both species grow actively from spring through to autumn. New growth arises from the rhizomes in spring.

Control measures are aimed at eradication of the rhizome system followed by control of subsequent seedling populations. With Johnson grass, successive germinations of seedlings may be expected for several seasons following eradication of the original stand.

Little has been published on control measures for Columbus grass. It is suggested that the control measures outlined for Johnson grass should also be effective for Columbus grass.

Control measures

(i) INITIAL CHANNEL FORMATION

Soil disturbance promotes the spread and intensification of a Johnson grass problem. Rhizomes are broken up and spread. Also, seedlings germinate and establish readily with the disturbance of soil and the removal of plant competition. Attention to post-emergence chemical control of seedlings during the early period following channel formation could prevent rapid development of mature infestations which are more difficult and expensive to control.

Seedlings of Johnson grass, if treated prior to rhizome formation, are susceptible to post-emergence applications of paraquat, dalapon, MSMA or low rates of glyphosate.

(ii) NON-SELECTIVE CHEMICAL CONTROL OF LARGE INFESTATIONS

A number of herbicides are registered for control of established Johnson grass. These include bromacil, TCA sodium chlorate, dalapon, MSMA and glyphosate.

Probably the most cost-efficient of these chemicals in eradication of established Johnson grass plants is glyphosate. Glyphosate is virtually non-selective and will kill or severely thin associated vegetation. Glyphosate has no residual soil activity and the application of this chemical must be followed, on death of the original stand, with a residual herbicide. This is necessary to control the subsequent germination of seedlings which can quickly reinfest the area.

Johnson grass growing on a fence line in the Warwick area.

Bromacil or diuron are suitable residuals for control of Johnson grass seedlings. Bromacil is preferred to diuron except in cotton areas.

The following programme is suggested:

- Burn or mow the standing vegetation in late December. This procedure is suggested so that glyphosate can be applied to Johnson grass at the early-flowering stage in autumn. Glyphosate is most effectively applied to Johnson grass at that growth stage and season. The dead material from the growth of the previous summer should support a fire in December.

- When the resultant Johnson grass growth commences flowering in late February or in March, apply glyphosate. Overall coverage of the plants including the heads is essential. Rate of application is 6 litres per hectare of Roundup (R) by boom-spraying. The volume of water is not critical provided overall coverage is achieved. For spot-spraying with high-volume equipment, 1 part of Roundup (R) in 100 parts of water is recommended.

  Rainfall within 6 hours of application will probably reduce effectiveness.
- When the aerial parts have died, and before the following spring, apply bromacil at 7 kg a.i. per ha or diuron at 18 kg a.i. per ha. Care must be taken that bromacil is not introduced into the area of water flow of the channel. Both of these chemicals should give season-long control of germination of annual broad-leafed weeds and grasses as well as those of Johnson grass and Columbus grass.
- Any re-growth from original rhizomes of Johnson grass or Columbus grass during the following spring should be treated as previously with glyphosate.
- A close watch should be kept on the treated area for several seasons. Any indications of re-establishment by seedlings should be prevented by immediate re-treatment with bromacil or diuron.

(iii) SELECTIVE CHEMICAL CONTROL

Selective control may be desirable where erosion of bare banks is a problem.

Repeated applications of MSMA are effective in the control of Johnson grass. Green couch (*Cynodon dactylon*) and Rhodes grass (*Chloris gayana*) tolerate repeated applications of MSMA. It is expected that where Johnson grass is associated with either of these latter species, repeated applications of MSMA will result in a dominant green couch or Rhodes grass sward.

The competition from such swards should prevent the subsequent establishment of Johnson grass seedlings when they emerge from previously dormant seed.

The suggested rate of MSMA applications is 4 kg a.i. per ha. Several applications may be required in each of two consecutive seasons. Each application should be made at early flowering of the Johnson grass. Temperatures above 25°C at application are required for maximum effectiveness.

(iv) MOWING

Repeated slashing may be possible and desirable in some situations.

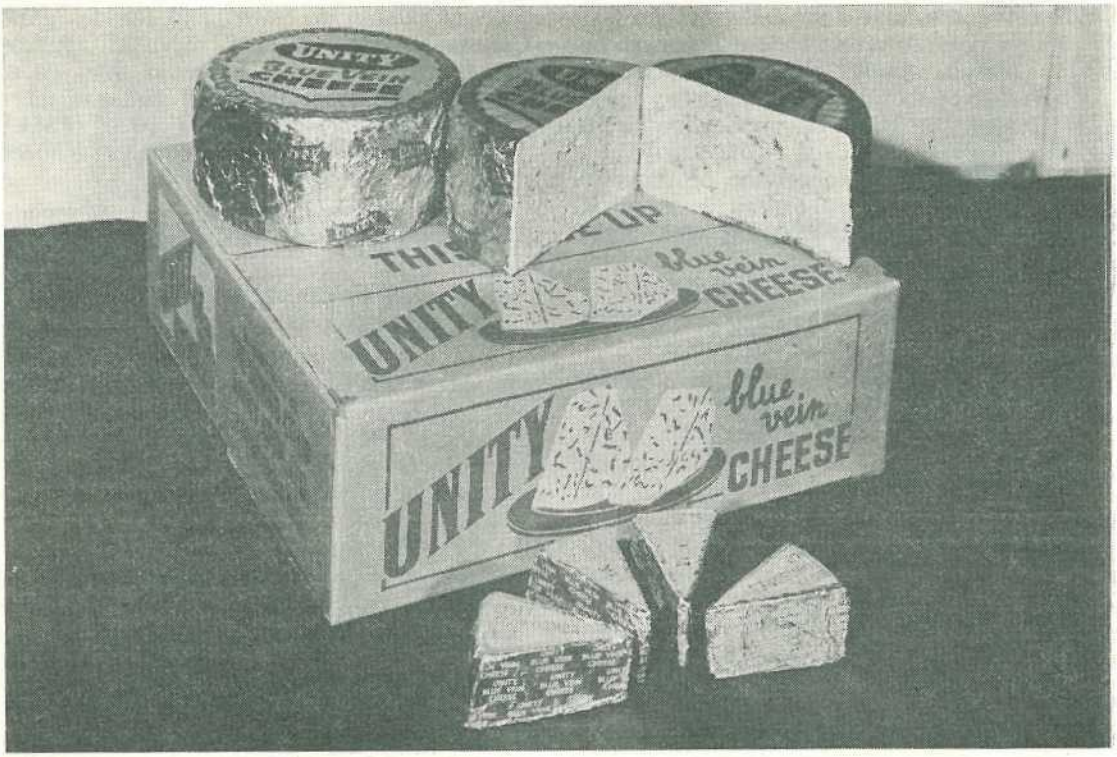
Johnson grass vigour is reduced by repeated slashing. This may be accompanied by increased vigour of a desirable, associated perennial grass species.

A roadside trial on the Darling Downs has demonstrated a spectacular decrease in Johnson grass intensity with an accompanying increase in paspalum (*Paspalum dilatatum*) growth through mowing at 8-weekly intervals during two successive growing seasons. Seeding of Johnson grass was prevented during the mowing phase.

Commercially, similar results have been claimed with the slashing of a Johnson grass—Rhodes grass association.

Chemicals

Active ingredient	Product	Manufacturer	Approximate cost of Product
glyphosate	Roundup (36% W.V.)	Monsanto	$87/5 litres
bromacil	Hyvar X (80% W.W.)	Dupont	$22.40/kg
	or Hyvar X–L (25% W.V.)	Dupont	$7.20/litre
diuron	Several (80% W.W.)	Dupont, Bayer, I.C.I., Lane, Chemical and Air Services,	$7.60/kg
	Flowable Diuron (50% W.V.)	Ciba Geigy	$4.20/litre
paraquat	Gramoxone (20% W.V.)	I.C.I.	$51.50/5 litres
MSMA	Daconate 8 (80% W.V.)	Ag Chem Pty Ltd	$23.25/5 litres
	Nocweed MSMA (50% W.V.)	Lane Limited	$22.85/5 litres



Queensland's blue vein cheese industry

BLUE veined cheeses are soft to semi-hard, white in colour with a network of blue or blue-green veins of mould, and with a rich, piquant flavour.

This type of cheese was first made in the Roquefort district of France, where it is still made by traditional methods. The original Roquefort type of cheese was made from ewes' milk and ripened in limestone caves.

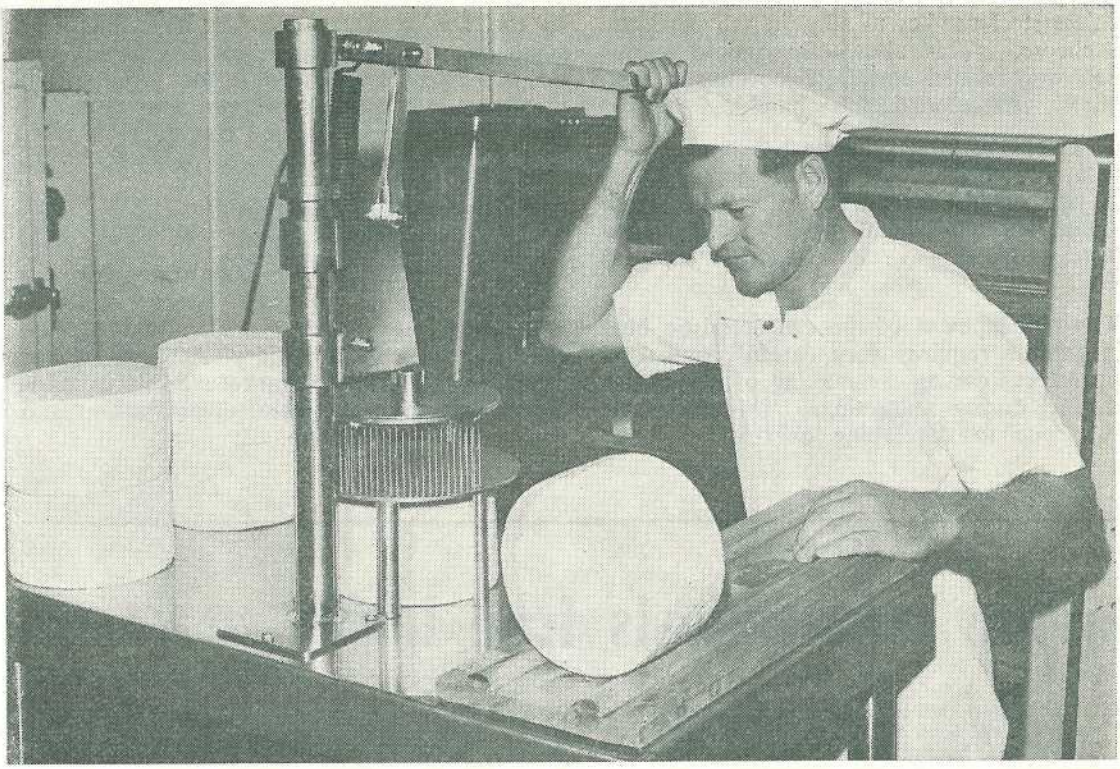
Several varieties of blue veined cheese are now manufactured around the world, including Roquefort and Bleu (France), Gorgonzola (Italy), Stilton (England) and Blue (U.S.A.). The variety manufactured in Australia is known as 'Blue Vein'.

by H. S. JUFFS, Dairy Research Branch and G. J. DENNIEN, Dairy Field Services Branch.

Production in Queensland

Commercial manufacture of blue vein cheese was commenced at the Toowoomba factory of the Downs Co-operative Dairy Association in 1960, with the guidance of the Queensland Department of Primary Industries and the support of Australian dairy industry research funds. Initially, 220 *l* of milk were processed each week. This yielded 12 cheeses—each about 3 kg in weight.

The production rate at Toowoomba was gradually increased over the years, a major expansion occurring in 1975 with the installation of a 3 500 *l* manufacture vat and additional ripening facilities. It is now possible



Piercing the cheese to stimulate mould growth.

for 120 cheeses to be manufactured daily, 5 days per week. Total production of blue vein in 1976 was 63 000 kg, compared with 13 500 kg in 1962. (1 kg of blue vein is obtained from approximately 9 *l* of milk).

Toowoomba blue vein is marketed throughout Australia under the famous 'Unity' brand. Small amounts are exported. The quality of the cheese is such that championships have been won at all major shows in Australia. The Gigarre cheese factory in Victoria was also a major manufacturer with their product 'Gigarre Blue'. However, they have recently stopped manufacture of blue vein and, at the present time, the Downs Co-operative Dairy Association is the principal Australian manufacturer of blue vein cheese.

How is it made?

Blue vein is made from high quality whole milk which is homogenized and pasteurized and pumped into a stainless steel vat at about 28°C. Lactic starter culture which will produce the clean acid flavour, and rennet (which is the active ingredient in junket tablets) are added. Spores of the blue mould are also added. The milk is allowed to stand for 1½ hours and during this time it sets into a firm curd.

The curd is then cut into small cubes and stirred gently. The development of the starter culture produces acid which firms up the curd and expels the whey. After approximately 2 hours, whey is drained off and the curd is placed in perforated cylindrical hoops.

The freshly-filled hoops are turned over several times at half hourly intervals and left at 20°C overnight without pressing to allow the pieces of curd to mat together to form a single block. The following morning, the hoops are taken off and dry salt is rubbed into the surface of the cheese. Salting in this manner is repeated daily for several days. Each block of cheese is then pierced with

stainless steel needles to allow air to penetrate the cheese. This allows the mould spores which were added earlier to develop and so form the characteristic blue mould.

To allow mould development throughout the cheese, it is held at 10°C for 4 weeks. For final ripening, it is held at 5°C. The cheese is marketed 16 to 20 weeks after manufacture, either as wheels or wedges wrapped in foil.

The development of the characteristic blue vein flavour requires very careful control of temperatures during the making of the cheese and also during marketing. This cheese is very prone to developing over-ripe flavours so the advice to prospective buyers is buy small quantities at a time, eat it, enjoy it, but do not attempt to store it for too long in the home refrigerator. If you must store it, make sure it is in a sealed container.

Successful diversification

The manufacture of blue vein is a highly skilled and traditionally a labour-intensive process and remains so. However, blue vein cheese has now been manufactured by the Downs Co-operative Dairy Association for 17 years and with the market steadily expanding, represents a successful diversification into fancy cheese production.

Bovine tuberculosis free herds (as at 8-12-77)

C. P. Adams, Warwick Park, Pratten.	MG
J. H. Anderson and Sons, 'Inverary', Yandilla.	PH
Australian Estates, Eurella, Mitchell.	SG
Australian Estates, Wainui Station, Bowenville.	SG
W. H. Bowden, Brendale Braford Stud.	BF
Central Estates, 'Comet Downs', Comet.	SG
Cherokee Group, Tanby, via Yeppoon.	BM
B. L. and M. O. Christensen, 'Elavesor', Rosevale, via Rosewood.	PH
J. P. and M. M. Erbacher, Leafmore, Hodgsonvale.	GS
P. J. Evans, M.S. 28, Dragon Street, Warwick.	FS
B. Goddard, 'Inverell', Mt. Tyson.	AS
N. J. and H. M. Guppy, River Dell Friesian Stud, M.S. 852, Hodgsonvale.	FS
H. M. State Farm, Capricornia Stud, Etna Creek, via Rockhampton.	JS
H. M. State Farm, Numinbah.	AIS
H. M. State Farm, Palen Creek, via Rathdowney.	JS
G. T. and H. W. Hopper, Ellendean Guernsey Stud, Maleny.	GS
Klein Brothers, Kapleton A.I.S. Stud, Ma Ma Creek, via Grantham.	AIS
J. F. Lau, 'Rossallen', Goombungee.	JS
W. Leonard and Sons, Welltown, Goondiwindi.	PS
N. E. Lobley, Neloby, Mt. Pleasant, via Dayboro.	FS
R. G. McDonald, 'Buffelvale', M.S. 807, Mundubbera.	JS
C. R. and J. L. Marquardt, Cedar Valley A.I.S. Stud, Wondai.	AIS
W. H. C. Mayne and Sons, 'Gibraltar', Texas.	AG
H. J. and D. J. Morris, 'Gaiview' Stud, Clifton.	PH
E. I. and S. Pacholke, 'Sunnylawn', Braford Stud, M.S. 74, Clifton.	BF
Panorama Stud Pty. Ltd., 'Panorama', M.S. 765, Allora.	HF
R. S. and G. C. Postle, 'Yarallaside', Pittsworth.	JS
Q.A.C., Lawes.	AIS
Q.A.C., Lawes.	JS
Q.A.C., Lawes.	FS
Q.A.C., Lawes.	BM
D. G. Raff, Forres Angus Stud, Karara.	AG
H. N. Schelback and Co., Allanview A.I.S. Stud, Warwick.	AIS
J. N. Scott and Son, 'Auchen Eden', Ayrshire Stud, Camp Mountain.	AS
J. and S. C. Siebenhausen, 'Merriton', M.S. 195, Pittsworth.	AIS
E. J. Smith, 'Hillcrest', Borallon.	AS
Stanbroke Past. Co., Waverley Brahman Stud, St. Lawrence.	BM
N. L. Stiller, 'Vineveil', Guluguba.	PH, CN
University of Queensland, Veterinary School, St. Lucia.	DM
A. R. and D. G. Vonhoff, M.S. 918, Toowoomba.	FS
Westbrook Training Centre, Westbrook.	JS

KEY

Angus—AG
Ayrshire—AS
AIS—AIS
Braford—BF
Brahman—BM
Chianina—CN
Droughtmaster—DM
Friesian—FS
Guernsey—GS
Hereford—HF
Jersey—JS
Murray Grey—MG
Poll Hereford—PH
Poll Shorthorn—PS
Santa Gertrudis—SG

Bovine brucellosis free herds (as at 1-12-77)

J. H. and B. J. Amor, 'Carinya', Dulacca.	BF
Anderson Pastoral Co., 'Inverary', Yandilla.	PH
Animal Husbandry Research Farm, D.P.I., Wacol.	MIXED
F. R. B. Anning, 'Cardross', Grandchester.	CL
Australian Estates, 'Eurella', Mitchell.	SG
Australian Estates, 'Wainui', Bowenville.	SG
R. Barr, 'Eukey' Stud, Stanthorpe.	MG
A. V. Bauer, 'Warralea', Ipswich.	DM
G. W. Beck, 'Banbeck', Laidley.	DM
C. H. Beckingham, 'Cosme' Stud, Aspley.	JS, HF
Biloela Research Station, D.P.I., Biloela.	FS
C. E. Buchholz, 'Baron Downs', Maryborough.	SG
Burnett Downs Pastoral Co., Burnett Downs, Brigalow.	MG
J. A. and A. W. Butler, 'Coochin', Beerwah.	BF
R. B. and J. P. Cameron, 'Belconnen', McDougal Street, Warwick.	MG
M. P. Campbell, 'Tiaro Park', Tiaro.	BM
B. L. and M. O. Christensen, 'Elavesor' Stud, via Rosewood.	PH
G. E. Christensen, 'Double E', Moorang, via Rosewood.	SG
L. T. and T. J. Christensen, 'Coolaroo' Stud, via Rosewood.	JS
T. and W. Christensen, 'Omaha', Tarome, via Kalbar.	PH
J. R. and H. M. Ciesiolka, 'Trebon' Stud, Taylor Street, Toowoomba.	AIS
I. S. Conochie, 'Brookland', M.S. 461, Kalbar.	JS
Mrs E. B. Corden, Currajong Stud, 'Netherby', Warwick.	AG
D. B. and E. Crane, 'Keglsugl', Dayboro.	PH
V. R. and T. W. Crank, 'Gracelyn', Mt. Tyson.	AIS
Mrs M. Crombie, Old Hidden Vale Stud No. 49, Grandchester.	SG
D. Dance, 'Double D' Stud, M.S. 720, Millmerran.	MG
J. J. E. Davies, 'Glenwyn Park' Stud, Toowoomba.	HF
W. D. Davis, 'Wambo' Stud, M.S. 918, Toowoomba.	AIS
L. Delandelles, 'Cherokee' Stud, via Yeppoon.	BM
W. A. Dodd, 'Glengannon' Stud, Rosewood.	PH
Doro Park Friesians, 'Doro Park', Kingaroy.	FS
V. L. Duhs, Murray Grey Stud, Nambour.	MG
Fairymead Sugar Co., 'Marlborough' Station, Marlborough.	BM
Dr E. S. P. Ferguson, 'Coonoona', Wellcamp.	PH
D. J. Fogg, 'Den-Dia' Stud, M.S. 336, Toogoolawah.	AIS
Ford Holdings, 'Maraja' Stud, Caloundra.	BM
W. A. Freeman, 'Trevlac' Stud, Rosewood.	CL
A. W., E. M. and D. W. Frohloff, 'Trinity', M.S. 191, Cambooya.	FS
M. and G. M. Geddes, 'Rhodavale', Hodgson Vale, via Toowoomba.	FS
J. S. and E. J. Genge, 'Carinya', Miles.	SG
H. C., K. C. and I. E. Genrich, East Cooyar.	CL
B. Goddard, 'Inverell', via Pittsworth.	AS
H. A. Gordon, 46 Mellifont Street, Banyo.	MG
L. R. Granzien, 'Caboonbah', Kalbar.	JS
G. W. and A. L. A. Green, 'Woodridge', M.S. 371, Greenmount.	GS
J. C. Grigg, 'Bethonga', Stud, Wamuran.	BF
S. K. Guppy, 'Lynstarr', Nambour.	FS
M. F. Hemmings, 'Bileena', Warwick.	AIS
V. A. Henderson, 'Barkala' Stud, Greenmount Road, Cambooya.	HF
K. Henry and Sons, 'Tara' Stud, M.S. 465, Cambooya.	AIS
W. G. Henschell, 'Yarranvale', Brookstead.	HF
C. J. Hewitt, 'Judel' Stud, Delaney's Creek, via D'Aguilar.	FS
G. F. and N. E. Hoey, 'Coolalinga' Stud, M.S. 74, Clifton.	JS
A. T. Holt and Son, 'Karowara' Stud, Tamborine Mountain.	SG
H. W. Hopper, 'Ellendean' Stud, Maleny.	GS
M. E. and V. E. Hughes, 'Mivon', via Chinchilla.	HF
C. J. and M. E. Jackson, 'Jaffra', Fairy Bower Road, Gracemere.	BM
R. W. Johnston, 'Wallum Hills' Stud, Franks Lane, Wamuran.	SG
C. and D. I. Kajewski, 'Glenroy', Glencoe, M.S. 1049, Gowrie.	AIS
L. K. Kath, 'Kathleigh', M.S. 1049, Gowrie.	JS
Kerwee Pastoral Co., 'Argyle', Kingsthorpe.	SG
S. S. Knitter, 'Charnu' Stud, Forest Hill.	FS, JS
B. G. and R. M. Lamb, North Kolan, Avondale.	BM
K. J. and M. Lau, 'Rosallen', Goombungee.	JS
Lenorco Pastoral Co., Pierce Avenue, Caloundra.	CL
C. J. and W. T. Lewis, 'Medland', Toowoomba Road, Crows Nest.	HF
G. L. and A. E. Lobegeiger, 'Sunny Grove' Stud, Moorang, via Rosewood.	JS
Lobergeiger and Co., Wallaville.	BF
Lynn-Eden Braford Co., 'Warrigal', Columboola.	BF
R. J. P. Martin, 'Jacaranda' Stud, M.S. 546, Forest Hill.	FS
R. G. and M. Matheson, 'Mioko', Owanyilla, M.S. 221, Maryborough.	DM
R. G. and M. Matheson, 'Inabui', Eatonvale Road, Tinana.	DM
W. H. C. Mayne and Sons, 'Gibraltar', Texas.	AG
W. D. and M. M. McErlean, 29 Rowbotham Street, Toowoomba.	PH
D. D. and J. L. McGuckin, and I. D. and B. J. Francis, Five Mile Road, Tinana.	HF
R. C. Mogg, 'Raymount' Stud, via Nambour.	FS
P. Mort, 'Franklyn Vale' Stud, Grandchester.	BF
H. J. Murray, 'Greydale' Stud, Rosewood.	MG
A. and K. Niethe 'Lockrose', M.S. 546, Forest Hill.	DM
J. D. O'Sullivan, 'Navilloween', Greenmount.	PH
P. W. O'Sullivan, 'Navleigh' Stud, M.S. 371, Greenmount.	AIS
E. I. and S. Pacholke, 'Sunnylawn', M.S. 74, Clifton.	BF
Dr and Mrs R. H. Parker, 'Little Sussex' Stud, Charleville.	CL
P. A. and J. T. Paterson, 'Wheel Park', M.S. 852, Hodgsonvale, via Toowoomba.	FS
M. C., R. C. W., and I. M. Pearce, M.S. 582, Toowoomba.	JS
Pearson Bros., M.S. 1184, Murgon.	Commercial
C. W. Phillips, 'Sunnyview Park', M.S. 623, Warwick.	AIS
R. J. Pontifex, 'Roburn' Stud, Oakey.	FS

N. R. Potter and Sons, 'Acton Vale' Stud, Wellcamp.	PH, AIS
W. T. and E. A. Potter, Derrymore', Texas.	CL
D. A. Price and Co., 'Deloraine', Jimbour.	CL
H. D. N. and C. K. Quast, 'Lincolnfield', Beaudesert.	SM
D. G. Raff, 'Forres', Karara.	AG
A. A. and M. I. Ranger, 'Glenoyra', M.S. 222, Oakey.	AIS
K. R. and G. A. Reid, 'Goomeran', via Warwick.	HF
L. D. Russell, 'Courtleigh' Stud, Woodford Road, Peachester.	BM
G. G. Savage, 'Venvale', Ramsay, via Cambooya.	AIS
N. N. Schelback, 'Allanview', Warwick.	AIS
K. K. W. and V. J. Schodfeldt, 'Wyandah', Beaudesert.	SM
W. L. W. and D. J. Schossow, 'Teviot Brook', Boonah.	FS
E. I. Scott and J. S. Edwards, 'Auchenflower', via Forest Hill.	AS, FS
J. and S. C. Siebenhausen, 'Merriton', Pittsworth.	AIS
W. R. Slatter and Sons, 'Berryglen' Stud, M.S. 1605, Killarney.	MG
E. J. Smith, 'Hillcrest' Stud, via Ipswich.	AS
F. J. and H. R. Smith and Sons, 'Rubyvale' Stud, Nambour.	AG
J. Z. Smith, Alum Rocks, Amiens.	HF
Dr J. A. Stephenson, 'Sahwalid' Stud, Belli, via Eumundi.	SW
R. L. and V. M. Stumer, 'Lavron Nook' Stud, M.S. 484, Boonah.	FS
K. Sutton, 'Startwell', Wamuran.	BM
C. Thompson, 'Kingston', Dulacca.	BF
R. N. and C. M. Towner, 'Par Deux' Stud, Laidley.	DM
Mrs B. Tout, 'Berrima', Elbow Valley, Warwick.	AG
J. P. and V. Trier, 'Tamrookum Valley' Stud, Rathdowney.	BF
M. Vandoren, 'Glen-Aero' Stud, Applethorpe.	MG
P. and B. H. Van Popering, 'Brunetta' Stud, Coominya Road, Lowood.	JS
B. G. and B. Wells, 'Bundilla' Stud, Laidley.	MG
A. C. and V. J. Westphal, 'Alun' Stud, Roadvale.	JS
L. W. and N. E. Wilmot, 'Koetong' Stud, Applethorpe.	HF
R. S. Wilson, 'Calliope' Station, Calliope.	HF
O. J. and S. D. Woodcock, 'Kanara', Yelarbon.	BF
G. T. and H. E. Woods, 'Hazelwood', M.S. 906, Mapleton.	JS
J. R. and A. Woods, 'Jarmal', M.S. 16, Maleny.	DM
K. V. Wright, 'Wattle Vale', Boonah.	FS
Dr B. R. Yeates, 'Ugarapul', Boonah.	SG
G. S. Young and M. J. Cooper, 'Coograli', North Maleny Road, Maleny.	BF

KEY

AIS—Australian Illawarra Shorthorn
AG—Angus
AS—Ayrshire
BF—Braford
BM—Brahman
CH—Chianina
CL—Charolais
DM—Droughtmaster
FS—Friesian
GS—Guernsey
HF—Hereford
JS—Jersey
MG—Murray Grey
PH—Poll Hereford
SW—Sahiwal
SG—Santa Gertrudis
SM—Simmental

Use of symbol brands and earmarks

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

Stock foods . . . their manufacture and storage

QUEENSLAND is well recognized throughout Australia as being the fortunate possessor of a flourishing live-stock industry.

In addition, there is a complementary enterprise which works in close association and this is the industry which manufactures or processes stock foods and, in particular, prepared stock foods.

The term 'stock' deserves attention and this is defined in the Agricultural Standards Act 1952–1972 as 'any horse, mule, ass, cattle, sheep, goat, dog, cat, pig, domestic fowl, turkey, duck, goose, rabbit, pigeon, bee and any other animal or bird in captivity'.

The Department of Primary Industries is particularly concerned with stock normally raised on farms, such as cattle, pigs, sheep, dairy cows and poultry. The latter includes fowls for egg production as well as turkeys, ducks, geese and broiler fowls for meat production.

People deriving an income from the land, whether pastoralist, pig raiser or poultry farmer, accept the fact that animals must be properly accommodated and fed if a profitable livestock business is to be maintained. The more progressive farmers realized many years ago that the practice of allowing stock to graze freely and derive their nourishment the best way they could, only yielded poor returns; consequently this method has, in most cases, been phased out.

The equally futile gesture of feeding stock with such low-value salvage foodstuffs as cracked grains, pollard, bran, etc. and expecting good returns was accepted in earlier days but production from these types of ration bear no comparison with the results which can be obtained by the use of a properly designed and carefully prepared modern stock food.

The terms 'stock food' and 'prepared stock food' must be explained. The restraining influence of the Agricultural Standards Act 1952–1972 is of particular importance to the primary producer as it controls the registration, manufacture and marketing of agricultural requirements such as stockfoods, fertilizers, pest destroyers and veterinary medicines.

We are mainly concerned with stock foods and the term is defined in two parts. Firstly there is the normal stock food which is any chaff, grain, hay, prepared stock food, straw and any other material prescribed to be a stock food for the purposes of this Act. The term also includes stock foods prescribed to be low food value. The term does not include cultivated crops cut and sold as green feed, wet brewers' grains, arrowroot, bagasse, whey, skim milk, buttermilk, cornflour, factory wet waste, nor any material declared by the Governor in Council, by the order in Council or by the Regulations to be not a stock food under this Act.

by J. E. McDowell, Standards Branch.

The second term 'prepared stock food' is defined as 'any kind of meal or food for any stock prepared, whether in whole or part from one or more than one kind of grain or oils or nuts or juices or meats or other materials of a like nature and any condimental, patented or proprietary food for stock possessing or claimed to possess nutritive properties and any material of animal or vegetable origin produced in any process or process of treatment or manufacture not being the primary object of such process and any salt or any mineral food or supplement for stock and any material used or intended as a lick for stock or stock lick'.

What is involved in the manufacture of a prepared stock food? Before a prepared stock food can be manufactured or placed on the market for sale in Queensland, the firm concerned must submit an application to the Registration Section, Standards Branch, Department of Primary Industries, for appraisal. In the case of medicated stock food, the application (which should be accompanied by a specimen label) should show such information as the name of the preparation, the firm's title, nett weight, composition, guaranteed analysis, medication if any, and special instructions regarding storage and lastly the bag or package markings.

Research workers in various Government Departments have undertaken painstaking studies into determining the necessary levels of crude protein, minerals, and vitamins, which when fed to stock will keep them healthy. This research has been particularly relevant to the health of stock which are used for food production purposes.

In other words, standards for stock foods have been arrived at after proper study.

Here is a typical standard analysis of a poultry mash, described as a 'broiler starter mash' and suitable to be fed to table chickens from day-old to 8 weeks of age:

	Standard
(A) min. crude protein ..	20·0%
max. crude fibre ..	5·0%
max. salt	1·0%
max. phosphorus (P)	0·9%
max. calcium (Ca) ..	1·5%

(B) Each kilogram of food shall contain not less than—

8 800 international chick units vitamin A

880 international chick units vitamin D_3

6·6 milligrams of vitamin B_2 (riboflavin)

55 mg per kg manganese (Mn)

The approved label and bag markings are of particular importance to the purchaser as the label which should be conspicuously attached to the package should enable him to decide whether a particular commodity suits his purpose. In the event of the label becoming detached, mutilated or destroyed, the bag markings will still be a reliable means of identification. With bulk deliveries, the label accompanies the delivery docket or invoice.

Premixed concentrates particularly merit attention by 'do-it-yourself' farmers. These concentrates may be defined as mixtures of prepared stock foods with added minerals, vitamins or drugs. There has been a growing trend over recent years for the farmer to make use of such concentrates to manufacture his own stock foods, by diluting a set amount of the concentrate with mixed meals, grains etc.

The instructions regarding the dilution rate and mixing are designed to give a finished product which should provide the user with the means to obtain satisfactory results from basic materials which are readily available and only require specific supplementation.

These concentrates must be registered for sale in Queensland and a prerequisite is the inclusion of precise instructions on the label, giving the proper diluting ratios for the user to follow.

There has been considerable research effort by Government Departments designed to improve the quality and potential benefits of prepared stock foods by the incorporation of various additives.

These include such items as synthetic amino acids, drugs, antibiotics, growth promoting agents and similar preparations calculated to improve growth rates and to bring about more efficient feed conversion. For example, the increased use of non-protein nitrogen in the form of urea to improve the total nitrogen

content is finding wider application in the livestock industry, with particular regard to ruminants.

Stock foods containing the above-mentioned additives are required to have the details declared on the label in addition to the usual information. For example, stock foods containing drugs which are administered at therapeutic levels are described as medicated stock foods which will cure or control a specific disease.

It is also well known that some antibiotics and drugs can be incorporated in stock foods to enhance growth promotion and to improve the efficiency of feed conversion. These additives are included at a non-therapeutic level (that is, below the rates required to cure or alleviate disease) and this important information must appear conspicuously on the label.

Included in other information which should appear on the labels of fortified stock foods is the expiry date of any sensitive additives (for example, drugs).

Directions concerning optimal storage conditions to avoid the possibility of deterioration are also important. The label should carry words after the following fashion—'if this medicated food is stored under proper storage conditions, the active drug constituent remains stable until . . . (insert expiry date)'.

If the active drug constituent is an antibiotic, the following words should appear on the label—'if this prepared stock food is stored under proper storage conditions the active drug constituent remains stable until . . . (insert date)'. It is naturally the responsibility of the manufacturer to see that the expiry date is clearly placed on the label prior to delivery.

Where stock foods are stored in bulk containers, they should be located in as cool a position as possible. In addition, the storage area should be absolutely waterproof and this precaution will minimize the risk of microbial activity which could cause breakdown and deterioration.

The most suitable storage for bagged preparations is a shed with adequate ventilation, preferably with the bags placed on pallets and arranged so that the air can circulate freely. This arrangement should also enable the premises to be swept effectively and kept tidy.

Basic construction should be such as to prevent the entry of rodents and every effort should also be made to prevent the premises becoming infested with insect pests such as grain moths and weevils. In addition, various batches should be stacked in proper sequence so that the oldest stock is used first.

It is a wise precaution to avoid storing pest destroyers, veterinary medicines, fertilizers and other farm chemicals in the same area with stock foods. Should some of these other concentrates leak or spill and then contaminate the contents of bags or packages of stock food, the farmer concerned could easily suffer losses by death or illness of his stock, assuming he were unaware that a mishap had occurred.

Good housekeeping involving the proper storage of stock foods will enable the farmer to enjoy the benefits of the many years of research which support the wide range of worthwhile stockfoods currently available.

Brucellosis tested swine herds (as at 8-12-77)

Aboriginal and Island Affairs Department, Cherbourg.	LW
P. and N. Batterham, Raby Park, Inglewood.	L, LW
R. A. and B. E. Bool, Rossvale Stud, M.S. 223, Nobby.	LW, L
D. J. Brosnan, Bettafield, Mt. Murchison, via Biloela.	LW, L
F. D. and E. C. W. Corney, Pagel, Tara.	LW
N. J. Cotter, Olarey, Goomeri.	LW
R. H. Crawley, Rockthorpe, Linthorpe.	B
G. F. and A. M. Dean, Home Creek, Wooroolin.	LW, L, B
E. Diete, 'Ettrock', Ingoldsby.	X
Mrs W. S. Douglas and Son, Greylight, Goombungee.	W
R. and L. M. Duckett, Fairview, Capella.	L, LW
C. P. and B. J. Duncan, Colley, Flagstone Creek, Helidon.	LW
J. A. and B. L. Duncan, Ma Ma Creek.	LW
Dunlop Meats Pty. Ltd., Coondulla Stud, 8 Malkara Street, Townsville.	L, LW
J. and L. Fisher, Lyndhurst, Bell.	L, LW
L. Fletcher, 'Par-en-eri', P.O. Box 143, Mundubbera.	LW, L
K. J. and B. D. Fowler, Kenstan, M.S. 195, Pittsworth.	L, LW
K. P. Fowler, Northlea Stud Farm, Hogg Street, P.S. 1436, Toowoomba.	L, LW
N. E. P. and M. P. Fowler, care of Kewpie Enterprises, Kingaroy.	L, LW, X
K. H. and B. Franke, Delvue, Cawdor.	LW
W. A. Freeman, Trevlac, Rosewood.	LW
E. F. and N. E. Geysing, Oakhurst, via Maryborough.	LW
D. F. and R. F. Goschnick and W. M. and K. J. Pearce, 'Echoes', Bancroft, via Monto.	LW
T. G. and E. A. Gosdon, Naumia, Dalby.	L, LW
D. G. Grayson, Wodalla, Killarney.	L, LW
A. H. and R. N. Grundy, Markwell Piggeries, M.S. 499, Toowoomba.	L, LW
H. M. Prison, Etna Creek, via Rockhampton.	LW
H. M. State Farm, Numinbah.	B, LW
H. M. State Farm, Palen Creek.	LW
G. R. Handley, Locklyn Stud, Lockyer.	B
Mrs M. Handley, Meadow Vale, Lockyer.	B
R. D. and B. M. Heness, 'Russley', Goomeri.	L
D. F. and R. K. Hinchliffe, Oakview, Milman, via Rockhampton.	L, LW
R. F. and V. D. Hudson, Rondel, Hogg Street, Wilsonton.	L, LW
K. B. and I. R. Jones, 'Cefn', M.S. 544, Clifton.	LW, L
C. and D. I. Kajewski, Glenroy, Glencoe, via Toowoomba.	LW, L
R. E. and M. D. Kajewski, 'Robmar' Stud, Acland.	L
A. R. Kanowski, Exton, Pechey, via Crows Nest.	LW
S. E. Kanowski, Miecho, Pinelands, via Crows Nest.	T
C. F. Kimber, M.S. 698, Biggenden.	L
E. R. Kimber, Tarella, M.S. 805, Mundubbera.	LW, B
I. E. and C. C. Kimber, 'Splenda View', Coalstoun Lakes, M.S. 698, Biggenden.	L
V. F. and B. L. Kruger, Greyhurst, Goombungee.	LW
V. and C. A. Kuhl, 'The Mounts', Boodue, M.S. 222, Oakey.	LW
R. R. and L. M. Law, 'Summerset', M.S. 757, Kingaroy.	LW, L
A. L. Ludwig, Beauview, Cryna, via Beaudesert.	B
Maranoa Stud Piggery, Mitchell.	L, LW
K. Mathieson, Ideraway, Gayndah.	LW
W. Neuendorf, M.S. 794, Kalbar.	B
G. R. and B. J. Patch, 'Kiara', Bell.	L, LW, X
L. A. Peters, Moonlight, Bongeen.	L
D. O'Connor, Rollingstone.	L, LW, X
T. O'Connor Enterprises, 32 East Street, Toowoomba.	LW
Queensland Agricultural College, Lawes.	B, LW
R. M. Radel, 'Turua Stud', Biggenden.	L
V. V. Radel, Braedella, Coalstoun Lakes.	LW
Research Station, Biloela.	LW
Research Station, Hermitage.	B
A. B. Robin, Blaxland Road, Dalby.	LW, L
G. Rosenblatt, Rosevilla, Biloela.	L, LW
A. F. and V. M. Ruge, 'Alvir' Stud, Biggenden.	LW
D. W. and L. J. Sharp, 'Arolla' Lavella, via Millmerran.	LW, L
N. O. and G. A. Smith, 'Miandetta', M.S. 162, Warwick.	X
R. A. H. and T. N. Smyth, Barambah Road, Goomeri.	LW
L. B. and L. J. Trout, 'Caminda', Crawford, via Kingaroy.	L, B
Wearmouth Piggeries, care of G. Varidel, Dalby.	X
Westbrook Training Centre, Westbrook.	B
L. J. Willett, Wongalea, Irvingdale, M.S. 232, Bowenville.	LW, L
K. Williamson, Cattermul Avenue, Kalkie, Bundaberg.	LW, L

KEY

Landrace—L
Large White—LW
Berkshire—B
Tamworth—T
Wessex—W
Crossbreed—X

How to store fruit and vegetables in the home

WITH today's ever-rising costs, householders need to reduce food wastage and make their budgets go further.

The household refrigerator makes it possible for consumers to maintain the quality of their fruit and vegetables and extend storage life by cool storage and freezing.

The best place for most fruit and vegetables is in the refrigerator. Low temperatures slow down the rate at which food deteriorates by slowing down both undesirable chemical changes and the growth of spoilage organisms. (There are some exceptions to this rule. Potatoes, sweet potatoes and onions do best at temperatures slightly higher than those of a normal home refrigerator).

A temperature of 4°C is the best temperature for a household refrigerator. To check the temperature, place a refrigerator thermometer at different locations in the refrigerator. These thermometers can be bought for a few dollars from most department stores.

In a self-defrosting refrigerator, the temperature is usually fairly uniform throughout. In refrigerators which must be defrosted manually, the chiller is the coldest area—apart from the freezer—and the crisper is the warmest. The temperature in the door shelves is usually several degrees higher than the rest of the refrigerator. Temperatures likely to be found in different parts of a domestic refrigerator set at the middle temperature range are shown in figure 1.

If the refrigerator is opened too often or if frost is allowed to accumulate in the freezer, the temperature in the refrigerator will rise. Overloading the refrigerator with food will also reduce its efficiency. Always allow space around food containers for air circulation.

When air circulates in the refrigerator, the cooler air moves downward and forces the warmer air near the bottom to rise. The moisture in this air then condenses on the cooling coils at the top of the refrigerator. This means that the cooler air moving downwards has a low moisture content which causes any unwrapped or uncovered food to dry out.

To prevent this drying out, wrap food in plastic. If plastic bags are loosely wrapped around the food or perforated with holes they will allow some air circulation which is desirable. Plastic film wrap is also suitable but this does not need puncturing since it lets some air in through the wrap itself.

The crisper is the best place for storing fruit and vegetables. Unless it is less than two-thirds full, produce stored in this part of the refrigerator does not usually need wrapping since the crisper is designed to have a high humidity.

Some fruit and vegetables suffer from chilling injury if stored for too long in the refrigerator. Water-soaked spots appear, the skin becomes pitted and the flesh softens. At the first sign of injury, these fruit and vegetables should be

by *PHILIPPA A. GOODRICK, Horticulture Branch.*

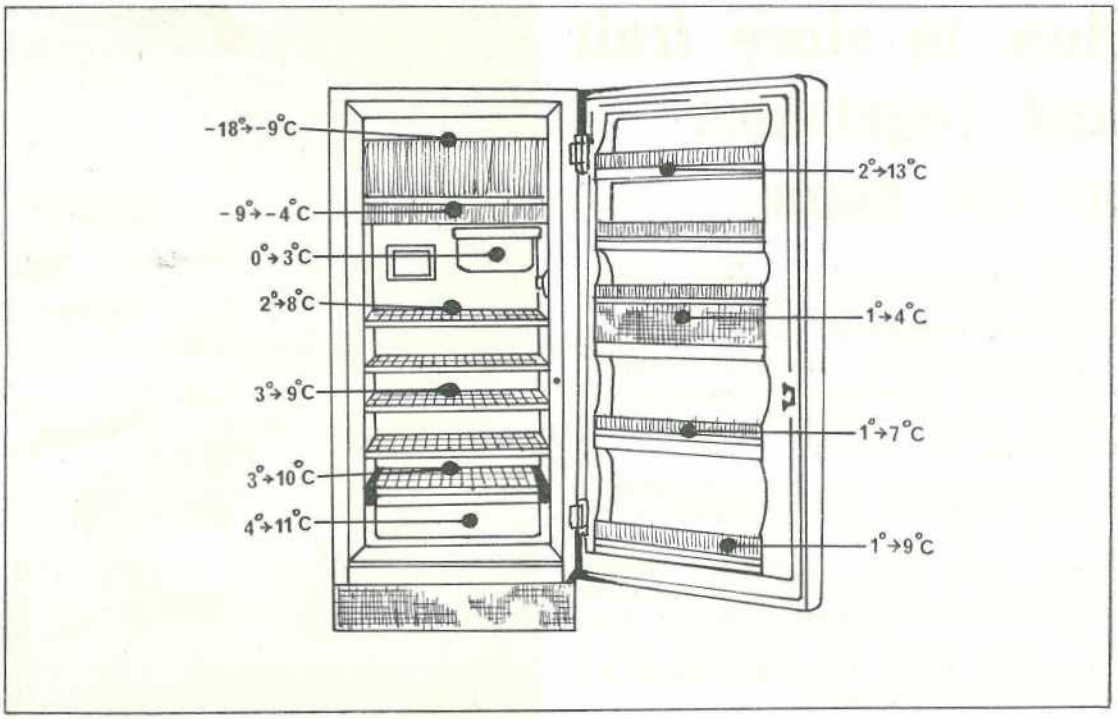


Figure 1. Temperatures likely to be found in different parts of a domestic refrigerator set at the middle temperature range.

removed from the refrigerator and used immediately or discarded. Vegetables which are susceptible to chilling injury are: capsicum, eggplant, cucumbers, zucchinis and chokos.

Other signs of overstorage are not always so obvious. Early season apples may look all right but the flesh will become dry and spongy when overstored. Overstored, unripe pears will not ripen normally. The flesh will either become dry and spongy or mushy. Citrus can look all right but it may have a musty flavour typical of over-ripe fruit. Carrots may develop a bitter flavour, but this can be removed by keeping them at room temperature for a few days.

So, when storing for long periods, it is a good idea to check your fruit and vegetables regularly and sample for internal signs of overstorage. Fruit or vegetables showing signs of rotting or breakdown should be removed before they affect the other produce.

Always handle your fruit and vegetables carefully because they are living produce and will bruise quite easily. Once they have been injured, spoilage organisms can enter the tissue and food will deteriorate quickly.

Certain varieties of fruit and vegetables are stored for some time before sale so it is not possible to predict accurately how long they will store in the home. The storage life usually ranges from a few days to 3 to 4 weeks depending on the variety.

Mushrooms and strawberries will usually keep for only 3 to 4 days in the household refrigerator. Strawberries are very prone to rotting and softening. Mushrooms will go dark although this will not affect their cooked flavour.

The following fruit and vegetables are suitable for short-term storage (up to 1 week) in the household refrigerator: apricots (ripe), asparagus, avocados, broccoli, cherries, eggplants, mangoes (ripe), nectarines (ripe), peaches (ripe), pears (ripe), sweet corn.

The next group of fruit and vegetables are suitable for medium-term storage (1 to 2 weeks): Brussels sprouts, capsicum, cauliflower, celery, cucumber, grapes, lettuce,

papaws (ripe), rockmelon, spinach, silver beet.

Long-term storage fruit and vegetables are: apples, citrus, beetroot, carrots, turnips, parsnips, potatoes, onions, cabbage.

For those housewives who have plenty of refrigerator space for storing their fruit and vegetables, and who plan to store them for lengthy periods, the common fruit and vegetables can be divided into two broad categories based on the temperatures at which they are stored commercially. Group 1 consists of: deciduous fruits (apples, pears, peaches, plums, apricots, cherries, and grapes); leaf crops (lettuce, cabbage, cauliflower, Brussels sprouts, silver beet, rhubarb and celery); root crops (turnips, Swede turnips, beetroot, carrots, parsnips and radishes); mushrooms; corn.

Group 1 fruit and vegetables are best stored as close as possible to 0°C without freezing, that is, in the coldest part of the refrigerator outside the freezer. In a one-door refrigerator with the chiller at the top and the crisper at the bottom, this will usually be the top shelves but the best way to make sure is to buy a refrigerator thermometer.

All ripe deciduous fruit except early season pears can be stored in the refrigerator. Early season pears do not store well when ripe and should be eaten immediately. Late season pears can be stored for a few days when ripe. Unripe pears can be stored in the refrigerator but must be removed to room temperature to allow them to ripen. Grapes store best in plastic film.

Do not store unripe peaches, apricots and plums in the refrigerator for longer than 2 to 3 days as the fruit will not ripen fully. Such fruit are best allowed to ripen at room temperature and then stored.

When storing leaf crops which are excessively dirty either wash and drain them thoroughly or remove the outer leaves. Store leaf crops in plastic bags or containers to reduce moisture loss. Root crop vegetables store best with the tops removed and in perforated plastic bags or plastic containers.

Corn is best stored unhusked and uncovered in the refrigerator. About 60% of the sugar in sweet corn is lost within 24 hours at room temperature, so corn is best used as soon as possible for the sweetest flavour.

The second group of fruit and vegetables consists of: citrus; tropical fruit (avocado, banana, custard apple, mango, monsteria deliciosa, passionfruit, persimmon, pineapple, and papaw); tomatoes; squashes; capsicum; eggplant; cucumbers; zucchinis; beans.

This group is best stored in the crisper area or the warmest part of the refrigerator since most of them are susceptible to chilling injury if stored for too long at too low a temperature.

Tropical fruit should only be stored in the refrigerator when fully ripe. They should be allowed to ripen at room temperature and then put in the refrigerator.

The skin of ripe bananas will turn black when placed in the refrigerator but this does not harm the eating quality of the pulp. The skin of passionfruit may also rot slightly but this will not affect eating quality either.

Green tomatoes should not be stored in the refrigerator as they will not ripen at refrigerator temperatures. Keep green tomatoes at room temperature away from direct sunlight until they ripen. They can then be stored at low temperatures.

Whole marrows, pumpkins and hard-shelled squashes need not be stored in the refrigerator but cut sections should be stored in plastic bags or plastic film in the refrigerator. Soft-shelled squashes such as zucchinis or button squashes should be stored in the crisper, or in plastic bags or containers in the general refrigerator area.

Potatoes, one of the exceptions to the rule of storing fruit and vegetables in the refrigerator, should be stored in a dry, dark place with good ventilation and away from any source of heat. Light causes greening which lowers eating quality. High temperatures hasten sprouting and shrivelling.

Dry onions are another exception. They should be stored at room temperature or slightly cooler in loosely-woven or open-mesh containers since they sprout and decay at high temperatures and high humidities.

Green onions (leeks, shallots, chives) are best kept cold and moist in the refrigerator in plastic bags.

Some ripe fruits such as apples and pineapples can cause tainting of other foods, especially dairy products. To avoid this, keep dairy products in closed containers or store them away from possible sources of tainting.

Have a beef fondue party

FONDUES were all the rage a couple of years back. It seemed that wherever you were asked, the hostess had a fondue of some type prepared for her guests.

It may have been one of the simple cheese fondues or a more elaborate cook-at-the-table affair.

In 1978, a fondue party is still a great way to entertain friends.

Try our Beef Fondue, or to give it the correct title, Fondue Bourguignonne. Our quantities can be adjusted to cater for as few as four, or as many as twelve, provided you have two fondue pots and burners, and 12 special fondue forks. Metal pots are necessary for this type of fondue, not the ceramic pot used for cheese fondues.

by Mrs Tess Mallos,
Australian Meat Board

Fondue Bourguignonne

185–250 g (6–8 oz) beef fillet per person
peanut or maize oil

Sauces: (Choose 3 or 4)
Bearnaise, tomato, horseradish cream (recipes follow)
Bottled or packet sauces such as mayonnaise, tomato, plum, etc.

Accompaniments:
tomatoes
onion rings
gherkins and pickled onions
green and black olives
cucumber in sour cream
tossed green salad
crusty bread

Trim beef and cut into 2 cm (¾ in.) cubes. Arrange in an attractive dish, cover and chill until required. Remove from refrigerator 30 minutes before time to cook.

Pour oil into fondue pot—it should be no more than two-thirds full. Make sauces, keep hot sauces over hot water until required. Place cold sauces in matching bowls. Slice tomatoes, combine with onion rings in a bowl and pour on French dressing. Chill. Gherkins, pickled onions and olives can be placed in individual bowls or arranged on one or two serving dishes.

Wash cucumber, score skin with a fork and dice. Sprinkle with salt, leave 30 minutes and drain thoroughly. Mix with sour cream and place in a bowl. Chill. Prepare tossed salad. Slice bread and place in a bread basket or make garlic bread. Arrange sauces and accompaniments on the table, leaving hot sauces until just before guests are seated. Put fondue pot and burner in centre of table and dish of meat cubes nearby.

At each place setting have a medium sized plate or special fondue plate, and side plate for bread, a fondue fork and a table knife and fork.

Heat oil on table burner or you can heat it on the stove and place pot on burner when all is ready. Oil should be hot enough to brown a cube of bread in 1 minute—do not have it fuming.

Each guest spears a cube of meat with the fondue fork and places it in the pot to cook to taste. Forks are marked for convenience. When cooked to taste, the meat is dipped into a sauce then transferred to the plate with the table fork.

Guests can put their selection of sauces onto plates with selected accompaniments.

Bearnaise Sauce

¼ cup plus 1 tablespoon dry white wine
¼ cup white vinegar
1 tablespoon chopped parsley
1 tablespoon chopped spring onion
½ teaspoon dried tarragon
freshly ground black pepper
1 teaspoon cornflour
3 egg yolks
1 tablespoon boiling water
125 g (4 oz) butter
salt to taste

Place ½ cup wine, vinegar, spring onion, parsley, tarragon and pepper in a small saucepan and bring to the boil. Reduce to half original quantity. Mix cornflour with remaining wine and thicken the liquid. Cook 1 minute. Pour into basin or top of a double boiler and place over simmering water. Mix egg yolks with the boiling water and gradually stir into wine mixture using a wooden spoon or sauce whisk.

As mixture thickens, stir briskly until very thick and light. Add butter, 1 piece at a time, stirring in each portion before adding next lot. When all butter is combined remove sauce from heat and add salt to taste. Keep warm over a pan of fairly hot water. Cover with a plate. Bearnaise sauce does not have to be served piping hot—it is quite acceptable to serve it warm.

Note: If desired, flavouring herbs can be removed from wine mixture after reducing—it is all a matter of taste.

Tomato Sauce

1 large onion, finely chopped
2 cloves garlic, crushed
2 tablespoons oil
½ cup tomato paste
2 cups chopped, peeled tomatoes
1 bay leaf
2 tablespoons chopped parsley
1 teaspoon dried basil
¼ teaspoon dried oregano
½ cup red wine
1 teaspoon sugar
salt and freshly ground pepper

Saute onion and garlic in oil until onion is transparent. Stir in remaining ingredients, seasoning to taste. Cover and simmer gently for 30–45 minutes, stirring occasionally. Remove bay leaf and serve as it is, or place in a blender and blend until smooth. Serve hot.

Horseradish Cream

1 cup sour cream
2 teaspoons castor sugar
3 tablespoons horseradish relish
salt and pepper to taste

Combine ingredients until thoroughly blended. Chill until required for serving.

The Australian standard 250 ml measuring cup and level spoon measures are used in these recipes.

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Troublesome Queensland weeds

Lantana

(Lantana camara)

RAMBLING shrub often forming dense thickets; stems 4-angled with short prickles on the angles; leaves opposite, bright green above, paler beneath; mostly 6 cm long, margins slightly lobed; flowers in heads about 2·5 cm across, at first pale cream with dark yellow centre, later lilac or purplish, on stalks in leaf joints, fruits fleshy, purplish-black when ripe, about 8 mm across.

Lantana is common in coastal Queensland, taking possession of many gullies and hillsides, especially in richer soils. The 'common pink' form is described above. In another form, the flowers open yellow and turn orange. In a third form, the flowers open yellow and turn red. There are 29 different forms described as naturalized in eastern Australia. Some forms have been found poisonous to stock, particularly to cattle not accustomed to grazing in areas where the plant grows.

Control measures include mechanical removal followed by burning and sowing of pasture. For chemical control, dichlorprop and 2,4-D have both given good results. Dichlorprop is recommended for overall spraying at a strength of 0·3%, but 0·2% 2,4-D amine is also effective. For misting, a mixture of 60 to 75 ml of 50% 2,4-D amine to each litre of water is used. Thorough spraying is necessary. For basal bark spraying, a 1% solution of 2,4-D ester in diesel distillate is recommended and for cut stump treatment a 1% solution of 2,4-D amine in water. For basal bark and cut stump treatments, 2,4,5-T formulations are also effective.

St. Barnaby's Thistle

(Centaurea solstitialis)

ANNUAL with rosette of leaves followed by much branched clumps of stiff, erect stems; stem leaves alternate, softly hairy, the base produced into narrow wings along the stem; flower heads at the end of branches, about 2·5 cm across including the stiff, yellow, smooth spines spreading from the outside scales; flowers bright yellow.

This plant differs from Maltese cockspur chiefly in the more branched habit, the longer, more yellow spines on the flower heads and the bright shade of yellow in the flowers. It is not very abundant in Queensland but is seen in parts of the Darling Downs after winter and spring rains. In southern States, it is an important weed in wheat crops.

In the rosette stage it is susceptible to 2,4-D at 2·2 kg per ha.

Red Natal Grass

(Rhynchelytrum repens)

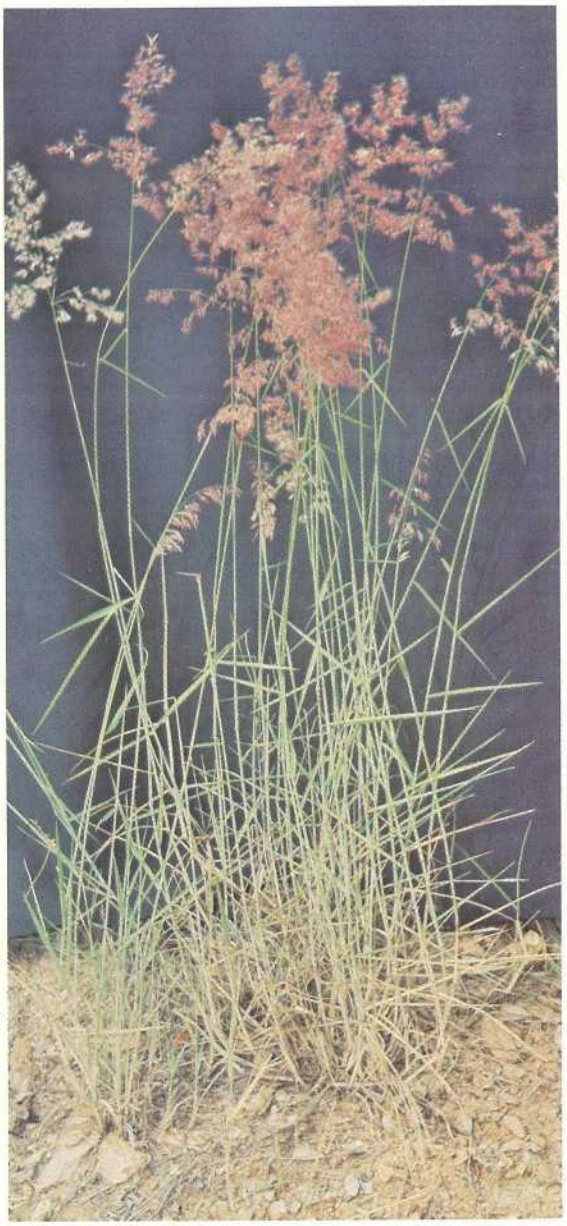
PERENNIAL with erect, slender stems forming rather open tussocks, leaves and stems pale green, sometimes with purple blotches; leaves 7·5 to 15 cm long, 3 to 4 mm wide, tapering towards the tip; seed-heads often partly enclosed in the upper leaf-sheath, erect with many 'seeds', usually shining, pale red or deep pink in colour, sometimes white; individual 'seeds', densely clothed with shining pink or pale red silky hairs, stripping readily from the seed-stalk.

Red Natal grass is now thoroughly naturalized in coastal Queensland and is found less commonly more than 100 miles (160 km) inland, particularly in the north. The plant is common on roadsides and similar disturbed situations and frequently takes possession of abandoned cultivation paddocks. It is particularly common on old banana and pineapple plantations. The grass is eaten fairly readily by stock if cut and chaffed up but the yield is low.

Where the land is wanted for crops, red Natal grass is easily killed by cultivation and it soon disappears in a well-managed pasture.

Compiled by officers of Botany Branch.

Expect trouble from these weeds



ABOVE LEFT. Lantana (Lantana camara)

LEFT. St. Barnaby's Thistle (Centaurea solstitialis)

ABOVE. Red Natal Grass (Rhynchelytrum repens)