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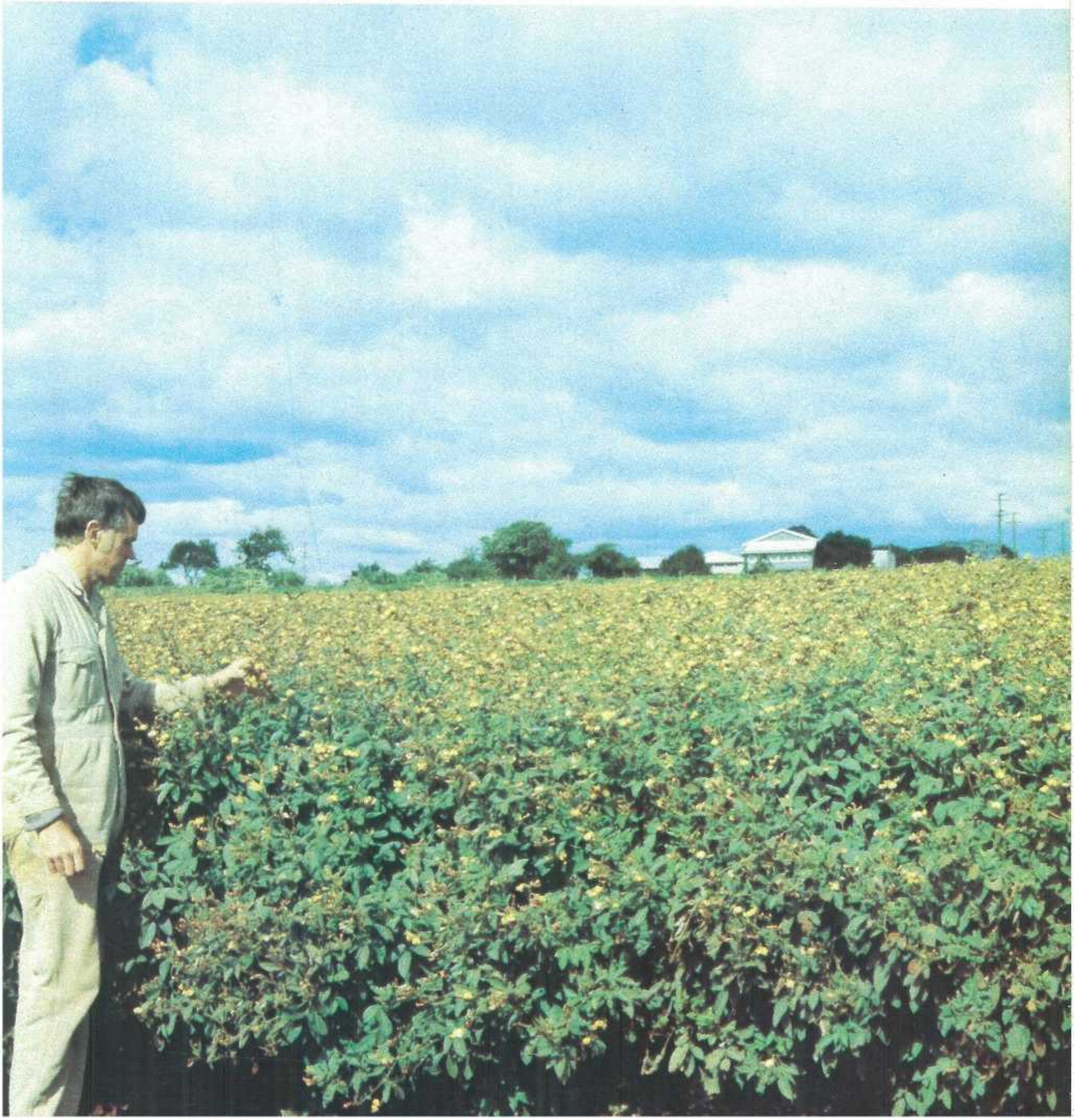

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COVER: A Royes pigeon pea crop grown at the University Farm, Redland Bay.

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Contents

page

Temperate pastures for the tropics and subtropics by L. J. Smith and others 482

Pigeon pea . . . a new crop for Queensland by E. S. Wallis and others 487

Shoeing horses by officers of Beef Cattle Husbandry Branch 493

Milking shed design and construction by J. D. Elrington 499

South Queensland grain sorghum planting guide 1979–80 season Compiled by S. R. Walsh .. 515

The Bentley cravat-an answer to self-sucking by J. Edmunds and J. W. Cooper 521

Bovine Tuberculosis free herds 522

Wattles in South-eastern Queensland with flowers in globular heads . . . part 1 by Beryl A. Lebler .. 524

Minor insect pests of macadamia—part 1 by D. A. Ironside xxxi

Cattle fencing by A. J. Boorman 529

Brucellosis tested swine herds 569

Aquatic plants of Queensland part 3–the duckweeds of Queensland by T. D. Stanley .. 570

Year of a massive armyworm problem by R. H. Broadley 573

Index 574

Foliar symptoms of manganese deficiency in wheat by N. J. Grundon xxxv

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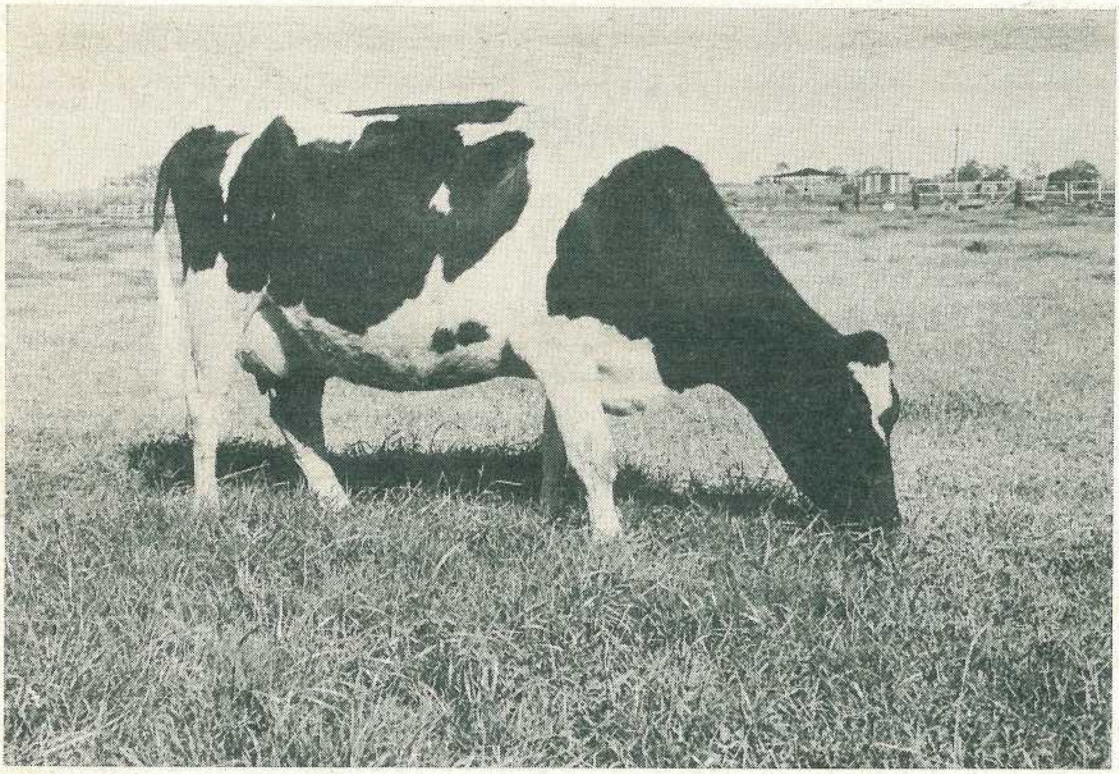
Temperate pastures for



by L. J. Smith, I. K. Buchanan, D. V. Kerr, Dairy Cattle Husbandry Branch and A. C. Bird, S. F. Spreadborough, P. B. McKeogh, Dairy Field Services Branch.

A Friesian cow grazing ryegrass at Ayr Research Station.

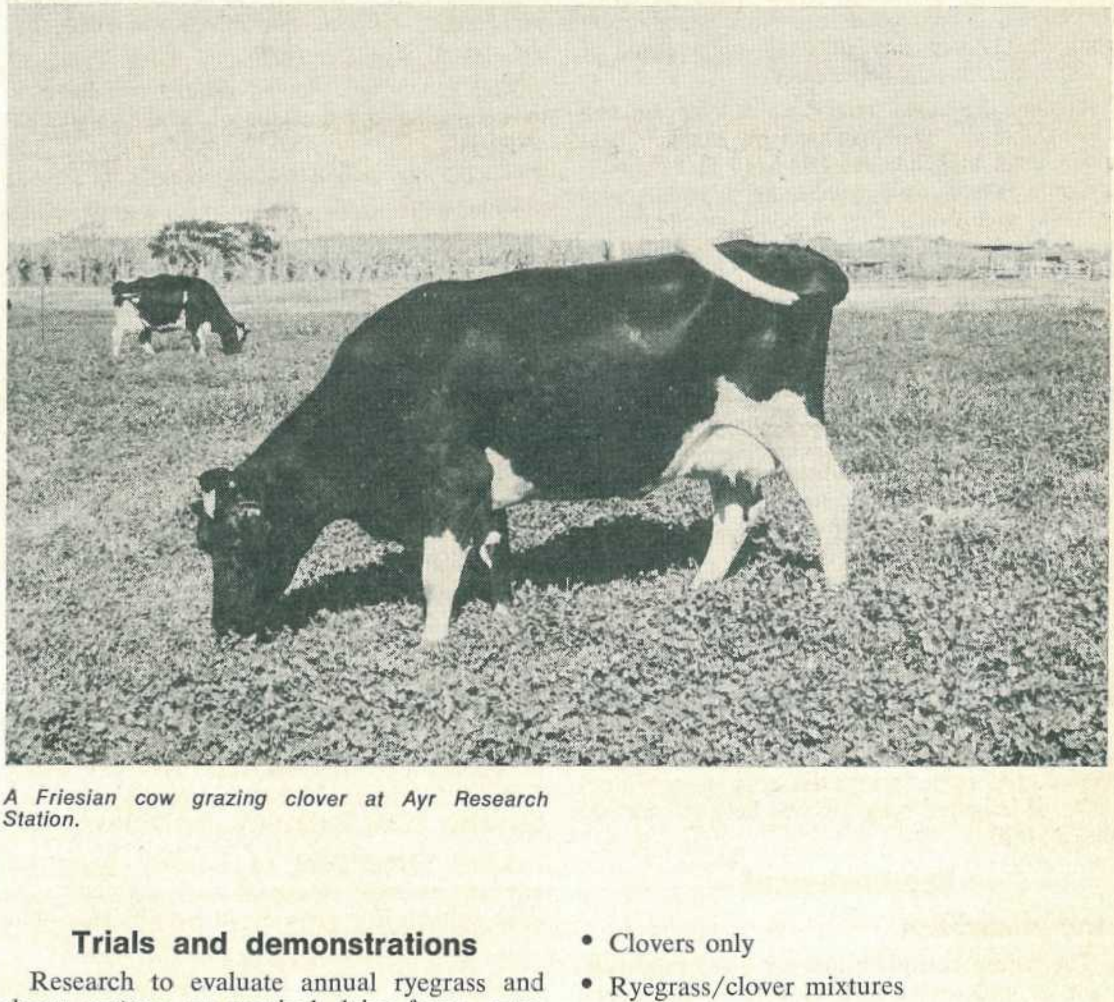
ANNUALLY-SOWN areas of irrigated ryegrass and clovers will produce 11 000 to 17 000 litres of milk per hectare from May to December.

This milk is produced at an average cost of 3·0 to 5·0 cents per L. These figures have been obtained from grazing trials at the Ayr Research Station and confirmed in commercial farm demonstrations in the Mackay region.

The growth pattern of tropical and subtropical pastures in Queensland is distinctly seasonal. Pastures produce high yields in the warm, wet season but growth is slowed considerably during the colder months. Milk production from April until the occurrence of spring rains is limited by this reduction in pasture availability. For farmers supplying whole milk, continuity of supply is important. They must therefore look to alternate feed sources to maintain production.

Annually sown areas of irrigated ryegrasses and clovers have the potential to produce high milk yields over this period and provide an economically attractive alternative to the use of concentrates or other winter cropping systems.

the tropics and subtropics



A Friesian cow grazing clover at Ayr Research Station.

Trials and demonstrations

Research to evaluate annual ryegrass and clover systems on tropical dairy farms commenced at Ayr Research Station in 1975. This work was requested by farmers in the Mackay region who were having difficulty supplying sufficient milk to the factory during the winter-spring period to meet market milk requirements.

Experiments at Ayr Research Station examined three types of irrigated temperate pastures:

- Ryegrasses only
- Clovers only
- Ryegrass/clover mixtures

Following the success of these pastures at Ayr, demonstration areas of ryegrasses and clovers were sown on two farms in the Mackay region in 1977. The farmers were Mr F. Brieffies of Blue Mountain via Sarina, and Mr L. Cameron on the Eungella Plateau. Both demonstration areas proved highly successful with milk production increasing substantially on both farms once grazing of the temperate pastures commenced.

On Mr Brieffies' property, 14 ha of mainly Tama and Ariki ryegrass, and 1·5 ha of Mt. Barker subterranean clover and Ladino white clover were planted in May 1977. Grazing with his milking herd of 150 cows commenced 6 weeks after planting. With these pastures, Mr Brieffies increased his milk production from 950 L per day in May to a peak of 1 500 L per day in September.

Around the same time, 3 ha of ryegrass and 1 ha of clovers were planted on Mr L. Cameron's farm at Eungella. His herd of 50 Friesian and Jersey cows commenced grazing the area in mid June. His production increased from 290 L per day in May, to 400 L per day in September. These lifts in production contrast with a decline in total supply to the factory over the same period.

In 1978, 10 ha demonstration areas were planted on the farms of Mr D. Bovey, Sarina Range, and Mr R. Burns, Eungella. In previous years, both farmers had maintained milk production throughout winter-spring by heavy grain feeding. With temperates, Mr Burns reduced grain consumption of his 140 cow herd from 4·0 t to 0·5 t per week. This represents a saving in grain over the period of approximately $8 000.

On Mr Bovey's farm, grain feeding (previously costing $30 per day for his 100 cow herd) was ceased once grazing of ryegrass commenced. Over the winter-spring period his total cost saving in grain was approximately $6 000. On both farms, the cost of providing 10 ha of irrigated ryegrass was between $3 000 and $4 000.

Establishment

Land preparation

The prime consideration for good establishment of ryegrasses and clovers is to reduce competition from existing pasture species during establishment. Thorough cultivation will generally ensure establishment and improve milk production. At Ayr Research Station, thoroughly cultivated areas have consistently outproduced minimally cultivated areas by 2 000 L of milk per ha over the period May to December.

Where thorough cultivation is not possible (for example, because of lack of time through late planting, erosion worry, or fear of damage to existing pasture species) minimal cultivation will give good production. However, seeding rates on minimally cultivated areas should be 25% higher than those on thoroughly cultivated areas. Sod seeding (no cultivation) is not recommended. This may be successful in some years when climatic conditions are right, but the risk of failure is high.

The following rules of thumb can be used to determine the amount of land preparation required:

- THOROUGH CULTIVATION—where it is possible, will reduce seeding rates and generally give better pasture and more milk.
- Areas planted in March or early April need to be thoroughly cultivated to reduce competition from pre-existing species.
- MINIMAL CULTIVATION—light discing or ripping will give good stands after mid April provided adequate seeding rates are used.

Varieties

Different varieties of ryegrasses and clovers produce best at different times of the year. It is for this reason that seeding mixtures are often recommended. Combining early and late varieties can lengthen the production life of the pasture.

For example, Tama and Wimmera ryegrass and the subterranean clovers (such as Mt. Barker or Clare) produce well early (May to September). Ariki ryegrass and the white clovers (such as Ladino or Haifa) produce best later in the season (August to December).

Local Department of Primary Industries' advisors are best equipped to recommend varieties suitable for growing in a particular area.

TABLE 1

RECOMMENDED SEEDING RATES FOR IRRIGATED TEMPERATE PASTURES.
(kg of seed per ha)

Pasture Type	Land Preparation	
	Thorough Cultivation	Minimal Cultivation
1. RYEGRASS	30	40
2. CLOVER		
—Subterranean Clover	15	20
—White Clover	5	6
3. MIXTURE		
—Ryegrasses	20	25
—Sub-clover	8-10	12
—White Clover	1·5	2

Management

Adequate irrigation and fertilizer inputs are the secret of success with intensive ryegrass/clover systems. Failure to provide either in the correct quantities can turn the system into a costly failure.

Irrigation

The frequency and amount of water required depends to a large extent on prevailing climatic conditions. During the cooler winter months 50 mm of irrigation each 10 to 14 days will usually prove adequate. As summer approaches, the frequency of irrigation needs to be increased. By December, irrigation may be required each 5 to 7 days.

Fertilizer

High production systems such as irrigated areas of annual ryegrasses and clovers need high levels of fertilizer input. In the North, fertilizer levels used have been:

AT ESTABLISHMENT they should receive 500 kg of superphosphate and 125 kg of muriate of potash per ha.

POST PLANTING—nitrogen is the other essential input. Within 3 weeks of planting, areas should receive 250 kg urea per ha. Thereafter, urea should be applied at the rate of 125 kg per ha per month.

Cutting trials at Ayr suggest that it may be possible to reduce levels of nitrogen fertilizer for pure clover stands. Nitrogen fertilizer on clover increased pasture yields during the first 2 months after planting but subsequent response to nitrogen was minimal. However, as yet, reduced levels of nitrogen for clover pastures has not been tried under grazing and consequently cannot be recommended. Farmers wishing to try clovers without nitrogen should initially do so on small areas only.

Soil type and fertility may restrict growth of clovers. Clovers will not grow well on very acid soils (with pH below 5·0), and phosphorus deficient soils may require higher levels of superphosphate at establishment. Molybdinumized superphosphate ('Mo-Super') may be necessary to stimulate rhizobial development for improved nitrogen fixation.

Grazing management

Intensive areas of ryegrass and clovers will stand heavy stocking. Trial areas at Ayr Research Station and on farms in the Mackay area have supported average stocking rates of seven cows per ha from June until December.

The first grazing after planting should be delayed for 4 or 5 weeks. At this stage, the pasture should be grazed lightly then allowed to recover for at least 10 to 14 days. Thereafter, with adequate water and fertilizer, heavy stocking rates can be maintained.

Both ryegrasses and clovers produce most milk when they are grazed reasonably heavily. Both species lose feed value rapidly as they age. If these pastures are not thoroughly grazed at least once every 3 weeks, then milk production will be lost.

Perenniality

Though some plants may persist through the summer, irrigated temperate pastures must be considered as an annual crop.

Costs of seed and pasture establishment form only a minor part of the total cost of this system. The high inputs of fertilizer and irrigation require that strong stands of the temperate pasture plants be present for success. Ryegrass and clover pastures should therefore be replanted each year.

Regeneration of the original tropical pasture will depend on the extent of land preparation and pasture species.

With minimal cultivation, kikuyu and couch or pangola pastures regenerate readily in summer. However, tropical legumes and tufted grass species such as Setaria may not re-establish satisfactorily. Also with more intensive cultivation, kikuyu or couch pastures will be less strong.

Problems

Fatalities have occurred in animals grazing irrigated temperate pastures. These problems can be minimized with a few precautions and planned grazing management.

Animals grazing ryegrass with high levels of nitrogen fertilizer may be lost by nitrate poisoning. The problem occurs when animals graze wilted pastures. Wilting results in very high levels of nitrates in the plant material and, when eaten, these cause de-oxygenation of the blood stream. The antidote for nitrate toxicity is to inject methylene blue into the jugular vein. However, prevention is better than cure as death is rapid, and may be the first symptom of the problem occurring.

Clovers are known to cause bloat in susceptible animals, though to date no problems have occurred with animals in trials or on demonstration areas. Incidence of bloat may be more frequent in cold, windy weather when animals may be more susceptible, and wilting of pasture can occur. If these conditions prevail, provision of an antifoaming agent such as 'Agral' in drinking water is probably the simplest means of control.

Temperate pastures should not be grazed when the animals are hungry, and animals should never be allowed to graze wilted pasture.

Alternatives

Grain supplementation

Concentrate supplementation has been the most popular method of lifting milk production. Grain has the advantage of being a readily available feed source which gives quick responses when fed. However, it is an expensive way of producing milk.

Experiments carried out at the Department of Primary Industries' Ayr and Kairi Research Stations have shown that it takes at least 1 kg of grain to produce 1 L of milk even during periods of low pasture availability. Thus if grain is landed on the property at $100 a tonne, each L of milk produced by grain will cost at least 10 cents. In contrast, trials and demonstrations with irrigated ryegrass and clovers have indicated that milk produced from these species costs between 3 and 5 cents per L.

Mollasses supplementation

Experiments at Ayr have shown good responses to molasses supplementation by cows grazing ryegrass and clovers. Animals supplemented with 3 kg of molasses per head per day produced an extra 2·4 L of milk per day compared with unsupplemented animals. With molasses costed at $40 per t landed on the property, milk produced from molasses will cost approximately 5 cents per L.

Fodder crops

In the past, oats has been the most popular winter fodder crop; and undoubtedly on farms without irrigation, it is still the best species for providing winter-spring feed. However, well established stands of annual ryegrass and clover grown with irrigation and adequate fertilizer will provide considerably more grazing and greater milk production than oats. Oats may provide slightly quicker feed, but this advantage is minimal especially when subterranean clovers are included in ryegrass/clover pastures.

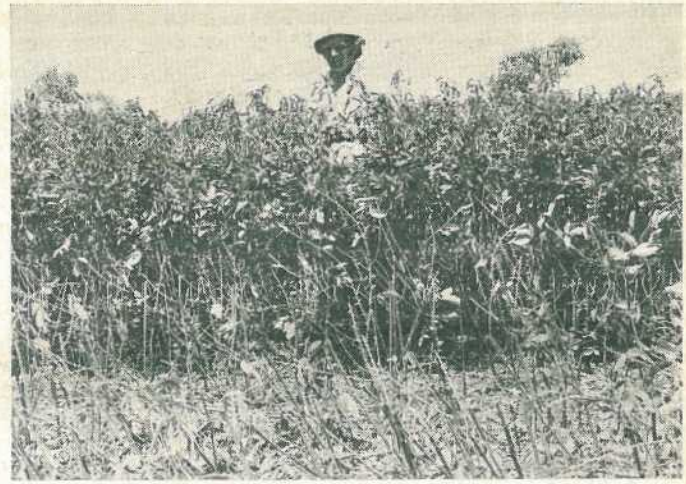
Tropical pastures

Proper maintenance of tropical pastures will reduce the amount of extra feed needed to maintain production through winter-spring. Adequate fertilizer will extend pasture supply further into autumn and irrigation will provide extra feed when growth is not restricted by low temperatures and frosts. However, during winter, irrigated nitrogen fertilized annual temperate pastures will produce more milk than similarly treated perennial tropical pasture.

In an experiment at Ayr Research Station, cows grazing ryegrass and clover pastures produced an extra 3 500 L of milk per ha compared with those grazing irrigated, nitrogen fertilized couch/pangola pasture.

Intensive systems of annual ryegrass and clovers should not be considered on areas which cannot be irrigated.

Pigeon pea ... a new crop for Queensland



PIGEON pea (*Cajanus cajan* (L) Millsp.) is a short-lived perennial shrub legume. It is widely grown throughout the tropical and subtropical regions of the world.

India is the major producer with 1·6 million tonnes (1975) making up 92% of world production. The grain contains 22% protein and is used widely in India as a dry split pea for dahl preparation for human consumption. In the Caribbean region, the pea is consumed as a green vegetable. A canning industry exports green peas to expatriates of this region in the United States and Britain.

Pigeon peas have been grown in Australia as green manure crops in pineapple and banana plantations. Sporadic interest in pigeon peas as a forage crop has occurred but productivity is low.

In 1969, the University of Queensland's Department of Agriculture began a programme to evaluate pigeon pea as a dry season stand-over forage. Subsequently, this programme has identified high seed-yielding types and developed a production system for the frost-free areas in Queensland.

Market opportunities exist in the Middle East, Pacific Islands and some parts of South-east Asia for dry peas for human consumption and as a component in compound animal rations in Australia. These markets have yet to be developed and no firm indication of returns to growers is available.

by E. S. Wallis, P. C. Whiteman and D. E. Byth, Department of Agriculture, University of Queensland.

Photograph above. Undefoliated Royes pigeon pea.

The University of Queensland has released the cultivar Royes. This pigeon pea is considered to be the most suitable currently available for coastal areas in Queensland.

Royes was released to interested growers in 1978–79 to test the market potential of this crop plant. The seed is expected to be more widely available in 1979–80. Breeders seed will be held by the Department of Agriculture, University of Queensland.

The cultivar

Origin

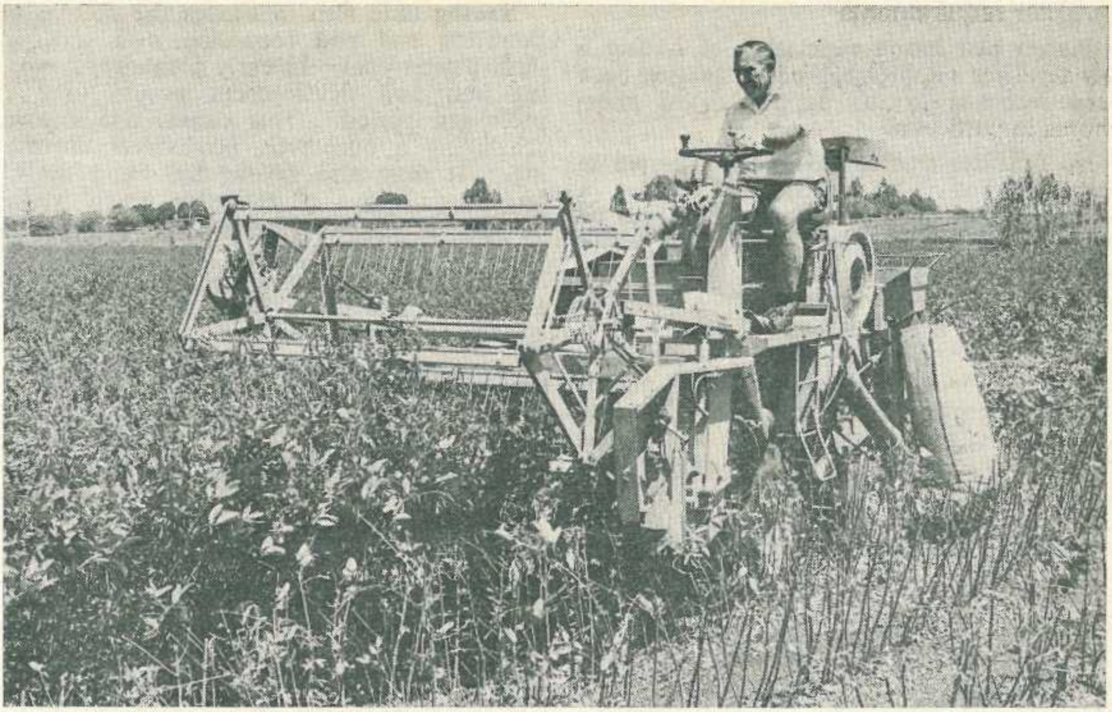
Royes was collected at the University of the West Indies, Trinidad by Mr B. Grof of the Queensland Department of Primary Industries and registered as Q8189 on 1 March, 1965. The seed sample was labelled '*Cajanus cajan* O.P. dwarf (4)'. The University of Queensland designated the accession as UQ50.

This accession was derived from a breeding program commenced by H. J. Gooding and continued by the late Dr W. V. Royes at the University of the West Indies, Trinidad. It has performed well in Queensland since 1970, and has been named by the University of Queensland in honour of Dr Royes.

Description

Royes is an erect perennial shrub. Plant height can vary from 0·5 to 4 m at flowering depending on the planting date. Leaves are trifoliate with oblong, green, pubescent leaflets. Flowering is basipetal with flowers borne in clusters. The terminal flowering structure is a corymb with markedly reduced internode lengths. The dorsal surface of the standard petal is light red in colour. Pods are borne in clusters and are light green with a tincture of maroon when mature and 8 to 10 cm long. Seed colour is greyish-white, 4 to 6 seeds per pod, and 12 to 13 grams per 100 seeds. The time to flowering is related to sowing date. For an early December planting, Royes flowers in about 110 days and averages approximately 2 m tall at Redland Bay. This cultivar is determinate in habit and has consistently shown good dry seed yield performance at various locations throughout South-eastern Queensland.

Defoliated pigeon pea crop.



Pigeon pea being harvested. The machine used is a Pamm seedmaster small plot header.

Apart from its relatively high seed yield, Royes has several characteristics of value in dry seed production:

- Pods are born at the top of the canopy. This does not occur in many other pigeon pea accessions and is an advantage when mechanically harvesting the crop as it reduces the amount of vegetative material passing through the header.
- A further advantage of this 'top podding' habit is in insect control. If spraying is required, the pods are readily accessible.
- The seeds are relatively large and white-coloured. This type of seed is preferred by the market.

Growing the crop

Location

Royes has a long vegetative phase. December plantings take 110 days to flower, so the major limit to suitable locations for growth is the occurrence of frost. Frost may kill the plant or at least cause heavy flower and pod loss.

Pigeon pea is reputed to be drought-resistant and capable of seed production in low rainfall situations. Experience at Dalby indicates that although some seed is produced in very dry years, the yield would not meet production costs. While adequate moisture is required if good yields are to be obtained, pigeon pea does appear to be better adapted to marginal rainfall areas than many of the other grain legumes.

Soil type

The major requirement is free drainage. Pigeon pea is killed by prolonged waterlogging and the soils must be well drained.

The crop is tolerant of lower fertility soils, but known soil nutrient deficiencies should be corrected before planting.

Seedbed preparation

All pigeon peas grow relatively slowly in the first 4 to 6 weeks. This coupled with the wide row spacings used in early plantings makes weed growth a potential problem. Consequently, it is important to attain a weed-free seedbed and early weed control after sowing.

Fertilizer requirements

Pigeon pea has a reputation of having a low fertilizer requirement but responses have been recorded to the application of phosphorus in particular.

No fertilizer studies have been reported in Australia but it is recommended that a standard basal dressing of superphosphate be applied. Any other known deficiencies should also be corrected. Fertilizer applications normally made for soybeans could probably be used as a guideline for the crop at this stage.

Zinc deficiency has been observed in pigeon pea plants grown in the Lockyer Valley over two seasons, even after a basal application of 8 kg Zn per ha prior to sowing. The deficiency was corrected by spraying with zinc sulphate solution. A basal dressing of zinc is recommended, particularly if growing on alkaline soils.

Rhizobium requirement

Pigeon pea belongs to the cowpea cross inoculation group. This means that a specific inoculant is not normally required for satisfactory nodulation. However, it is standard practice and cheap insurance to inoculate with CB756—cowpea, group I—prior to sowing.

Sowing time

Plant height and time to flowering in most pigeon pea cultivars are affected by sowing date as this exposes the crop to different daylength conditions during development. Early flowering is enhanced by shortening days so that planting after the longest day (December 22) will result in earlier flowering, less vegetative growth, and shorter plants.

The plant height of Royes decreases from approximately 210 cm when sown in October to 70 cm when sown in March. This reduction has important practical implications:

- Mechanical harvesting is only feasible in sowings made after mid December.
- Since late sowing results in smaller, less vegetative plants, more plants are required in late plantings than for earlier plantings in order to maintain yield. A basic rule of thumb is that the plant canopy should close across the inter-row before flowering if optimum yield is to be obtained.

Sowing time also influences the pattern of flowering and pod formation over time in most pigeon peas. In early plantings, flowering and pod development occurs over a prolonged period. This causes difficulty in scheduling a once-over, mechanical harvesting. It may also favour the build up of large populations of *Heliothis* which would necessitate frequent spraying. In late plantings, the flowering period and pod maturity is much more condensed so that fewer insect control measures are likely to be necessary and the optimal harvest time is easier to define.

Sowing date/density combinations

The choice of sowing date and density of planting **is the single most important factor affecting production of Royes pigeon pea.** As shown in table 1, higher plant populations are necessary for late sowings in order to compensate for the smaller plant size and to produce optimum seed yield per hectare.

The range of spacings and seed weights quoted in table 1 applies for early to late sowings within a particular month. For example, the appropriate weight of seed to be sown in January is 6 kg per ha, but by the end of January the sowing rate should be increased to 12 kg per ha. These figures are based on 100% germination and will have to be adjusted for the germination and purity of the actual seed involved.

A higher density of plants is required for irrigated crops. The limited information available suggests that approximately 200 000 plants per ha is optimum for irrigated crops sown in January and February.

The inter-row space of 75 cm has been chosen to enable inter-row cultivation for weed control. For sowings after late January, it is recommended that the inter-row space should be reduced to 50 cm and the intra-row spacing adjusted to maintain the designated plant population (table 1). Late January/early February sowings are recommended for Royes.

Weed control

During the relatively slow, early phase of crop growth, competition from weeds must be minimized. The crop subsequently forms a heavy canopy which will suppress most weed growth.

TABLE 1

RECOMMENDED SOWING DATE/DENSITY COMBINATIONS FOR DRYLAND PRODUCTION OF ROYES PIGEON PEA IN FROST-FREE AREAS OF QUEENSLAND

Cultivar	Month of Sowing					
	December	January	February	March		
(a) Metric						
plants/ha	35 000–50 000	50 000–100 000	100 000–150 000	250 000		
inter-row space (cm)	75	75	75	75	50	25
intra-row space (cm)	40–26	26–13	13–9	5	8	16
kg/ha seed (100% germination) ..	4·2–6	6–12	12–18	30	30	30

Little information exists on the effects of various pre and post-emergence herbicides on pigeon peas and no herbicides are currently registered for use in Queensland. Trifluralin has been used in Royes pigeon pea trials as a pre-emergent herbicide. Some phytotoxic effects have been noted at Redland Bay using 1·8 L of the commercial product Treflan per ha. Treflan applied at 0·9 L per ha, the rate usually used on light soils, had little effect on crop growth and did control weed growth. Paraquat has been used successfully in trials to control weeds during the early phases of growth, but care must be taken not to spray the pigeon peas directly.

Insect and disease control

To date, no disease has been observed to cause any significant damage to pigeon peas in Australia and the crop is basically free of disease problems. *Sclerotinia sclerotium* can cause some plant loss in wet coastal conditions but Royes appears to exhibit resistance to this disease.

It is rare to observe insect damage to pigeon peas prior to flowering. However, pod-boring insects (particularly *Heliothis*) attack the flowers and green pods of pigeon pea and can be a major problem in early planted crops which have prolonged flowering and pod formation. In later plantings, from mid January onwards, flowering of Royes is relatively well synchronized. It begins about the end of April and is condensed, so that if spraying is necessary, relatively few well-timed applications should control the insect problem.

Sprays used experimentally at Redland Bay have included methomyl, endosulphan, parathion and methimidaphos to control *Heliothis*. If not controlled, this pest can severely damage the crop.

Harvesting

The crop is ready for harvest when the majority of pods have lost the green colour and the seed is sufficiently dry. With Royes, this will occur in July-August depending on the planting date. The plant will still retain considerable green leaf and stem, and some pods will be immature. A considerable body of green material must pass through the header at harvest. However, provided plant height has been controlled by sowing date, normal headers can harvest the crop satisfactorily.

The seed will have to be dried and re-cleaned after harvest. Defoliation prior to harvest using paraquat has assisted harvesting of trial plantings by reducing the amount of green material passing through the header and improving the seed sample obtained.

Royes pigeon pea will ratoon and flower quickly if adequate moisture is available after a July-August harvest. This ratoon crop, which should be harvested in the following January-February, is capable of yields equivalent to the first crop. Further ratoon crops are possible in some environments provided the original plant stand is not greatly reduced.

If the harvest of the plant crop is delayed until September-October, the ratoon crop will not flower until the following autumn. This is undesirable as the land is occupied unproductively for many months and harvesting is difficult because of the excess vegetative growth.

If no ratoon crop is planned, the stubble can be grazed by stock. Stock appear to require a period to become accustomed to pigeon pea but, to date, no toxicity has been observed.

Seed yields

Yields from mechanically harvested stands at Redland Bay have reached 1 500 to 2 000 kg per ha from each of two harvests over a 12 month period (table 2). Redland Bay is a frost-free maritime environment south of Brisbane. Annual average rainfall at Redland Bay is approximately 1 250 mm mainly during the summer months. These crops received some supplementary irrigation in the early stages of crop growth. Fertilizer was applied to provide a non-limiting supply of major nutrients and weeds and insects were controlled as necessary.

TABLE 2

MECHANICALLY HARVESTED YIELDS OF ROYES PIGEON PEA AT REDLAND BAY, SOUTH-EAST QUEENSLAND

Sowing Date	Density (plants/ha)	Yield (kg/ha) 23–8–77	Ratoon Yield* (kg/ha) 25–1–78
9–12–76 ..	21 900	1 010	2 000
	47 600	1 710	2 000
	78 400	1 670	1 900
28–1–77 ..	47 600	1 130**	1 600
	88 900	910**	1 600
	111 000	1 250**	1 800

* Hand-harvested subplots.

** Harvested before completely ripe.

Acknowledgements

Support from the Rural Credits Development Fund of the Reserve Bank of Australia from 1973 to 1977 is gratefully acknowledged.

Since 1978, the project has been supported by the International Crops Research Institute for the Semi Arid Tropics (ICRISAT), Hyderabad, India.

Northern Australian agricultural research

The *Potential Contribution of Research to Agricultural Development in Northern Australia* has recently been published by the Queensland Branch of the Australian Institute of Agricultural Science.

This book points out that 81% of the 16·5 million hectares of arable land in Northern Australia is undeveloped.

If national productivity is to be increased by better use of the soil and water resources of Northern Australia, then technological limitations must be overcome by agricultural research.

This book describes the vital importance and the potential for this research.

It is available from: The Australian Institute of Agricultural Science (Queensland Branch), c/- Department of Agriculture, University of Queensland, St. Lucia, Q. 4067. The cost is $5.00 per copy.

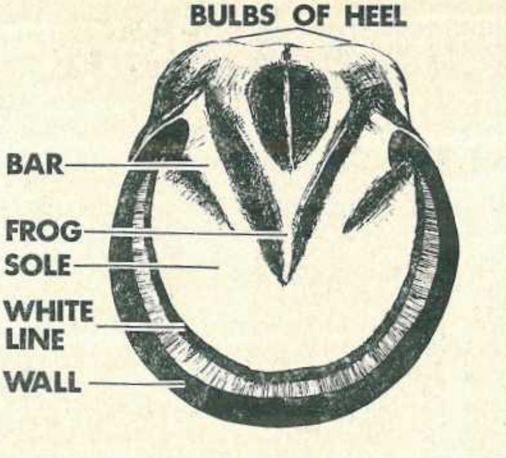


Diagram 1.

Shoeing horses is a skilled trade but in today's world the farrier is fast disappearing. Yet for both work and pleasure, shod horses are often necessary. This article has been prepared by a veterinarian to guide those who may have to shoe their horses.

Shoeing horses

by officers of Beef Cattle Husbandry Branch.

BLACKSMITHS willing and/or able to shoe horses are few and far between these days. However, many people still require their horses to be shod and many are being forced to do this job themselves.

The purpose of this article is to serve as a guide to the amateur farrier. For those still able to find a farrier to shoe for them, this article should provide the basis for a constructive appraisal of the work being done.

The horse's foot

Before plunging into the details of shoeing it is necessary to have some understanding of the basic anatomy and functions of the equine foot.

The foot of the horse consists of the hoof and the structures within. The hoof forms an outer, insensitive layer which protects the deeper and more sensitive tissues. These tissues, in turn, supply nutrients required for normal hoof growth.

The hoof is made up of three groups of horny tissue as illustrated in diagram 1—Wall and bars, sole, and frog.

The wall

This is the outer horny layer of the hoof. The bearing surface is arbitrarily divided into three parts (diagram 2)—the toe, the quarter, and the heels.

The wall grows down continuously from the coronary band at about 6 mm a month. It takes 9 to 12 months to grow a complete new hoof. The wall is thickest at the toe and

Some Steps In Shoeing A Horse

Figure 1. (from left): Rasp, buffer, farrier's knife, hammer, pincers, hoof cutters, nails.

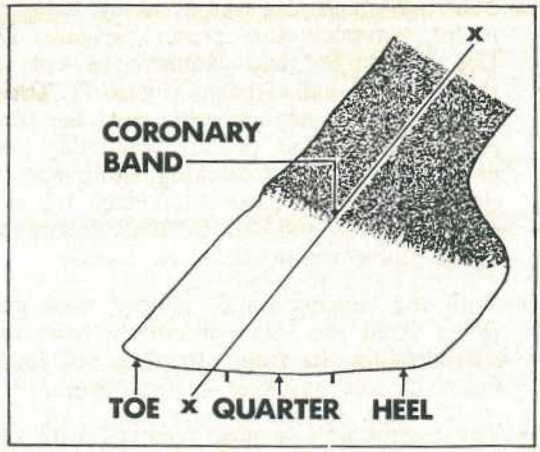


Diagram 2.

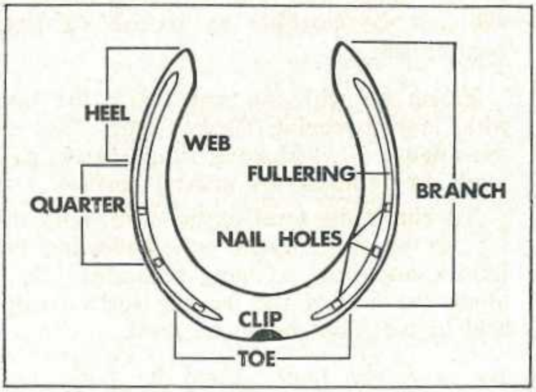


Diagram 3.

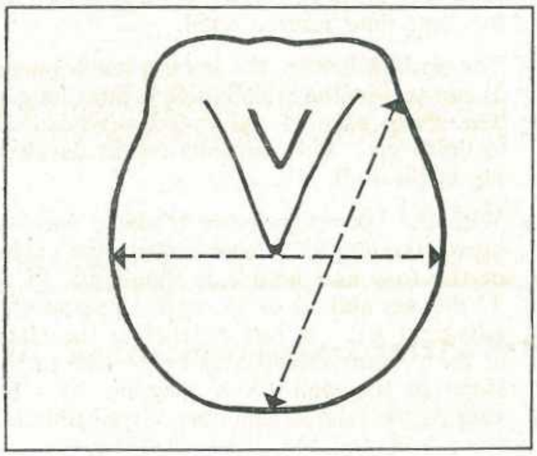


Diagram 4.

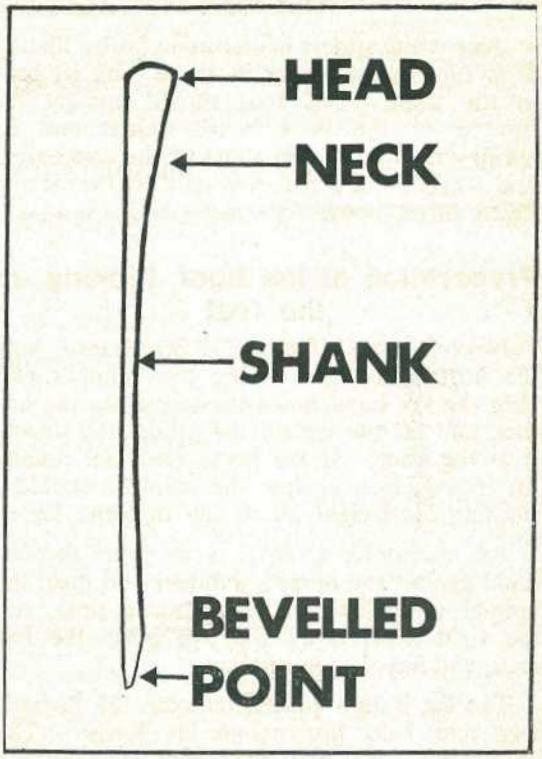


Diagram 5.

thinnest at the heels, the thinner wall allowing the heels to expand when the foot bears weight thus reducing pressure on the inner, sensitive layers.

The wall is the major weight-bearing structure of the hoof. The bars are a continuation of the wall as it bends inwards at the heels.

The sole

This consists of less dense, horny tissue than the wall. The shape of the ground surface of the sole is concave and is not designed to bear weight except for a 6 mm margin in the region of the white line. Excessive pressure on parts of the sole leads to bruising, often called 'corns'. The white line marks the junction of the sole and wall (diagram 1). It is visible on the bearing surface of the hoof and is an important landmark when driving nails into the hoof when shoeing.

The frog

This is the softest of the three horny tissues. It is roughly triangular in shape with its base at the heels. The frog should contact the ground as the hoof bears weight and its springy nature absorbs some of the concussion and transmits the forces evenly to the deeper layers of the hoof.

Preparation of the hoof. Picking up the feet

Near forefoot (figure 2). Stand level with the horse's shoulder facing the animal's tail. Run the left hand down the leg, grasp the fetlock and lift the leg off the ground by flexing it at the knee. If the horse does not readily lift its leg, lean against the animal's shoulder pushing his weight on to the opposite leg.

An alternative method is to place the left hand against the horse's shoulder and push the animal off balance. At the same time, run the right hand down the leg, grasp the fetlock, and flex the leg as above.

The leg is now placed between the farrier's legs and held just above his knees. The correct stance is with the knees together and the feet placed about 22-cm apart with the toes turned slightly inwards for balance.

To pick up the opposite fore foot follow the procedure as above using the opposite hand.

Near hind foot (figure 3). Stand level with the point of the hip facing the animal's tail. Place the left hand over the point of the hip. Run the right hand down the horse's leg and grasp under the fetlock. Lift the leg forwards, rest it on the knees and transfer the right hand to grasp the hoof across the sole. Take a step towards the rear of the horse carrying the hind leg so that it comes to rest on the thigh. The left hand can now be taken off the hip and the upper left arm is used to hold the hind leg in position.

In preparing the foot for shoeing, the following steps are taken:

- Observe the horse and its action before beginning work. Check that the horse is not lame and look for any unusual action, for example, brushing, forging and overreaching. It may be possible to correct some of these faults by corrective shoeing.
- The old shoes are removed by using a buffer, hammer and pincers (figure 1). Use the buffer and hammer to cut or straighten the nail clenches (figure 4). Then, starting under one heel nail, lever the shoe forwards with the pincers, loosening one nail at a time and working from side to side alternately (figure 5). Place the old shoe on the ground with the nails downward so the horse cannot tread on them.
- With the shoeing knife, remove mud and stones from the sole particularly from the clefts besides the frog. Remove any loose flakes of sole and tags of frog tissue.
- The excess wall is now removed with the hoof cutters (figure 6). Do not follow the level of the sole in the region of the quarters or too much wall will be removed and it will not be possible to prepare a level bearing surface.

Finish off with the rasp. Use the rasp with long sweeping strokes from heel to toe (figure 7). Rasping from side to side tends to produce an uneven surface.

To check the level of the wall, hold the leg up by the cannon bone, allowing the fetlock and hoof to hang naturally. Sight along the line of the bearing surface from heel to toe; this should be level.

- By now, the hoof should be fairly well prepared. Very little rasping of the outer face of the wall should be done except perhaps in flat-footed horses being shod for the first time after a spell.
- For unshod horses, the hooves are trimmed as above but the wall is left a little longer. The sharp edge of the wall is rounded off to finish up. This prevents cracks developing in the wall.
- With the hooves properly trimmed and the horse standing on a level surface, the angles of the fore and hind feet should be 45 to 47 degrees and 50 to 55 degrees respectively (diagram 2). A line parallel to the slope of the pastern should also be parallel to the slope of the wall (X-X diagram 2). By varying the relative amounts of wall trimmed from heel and toe, these requirements can usually be met.

Faults in preparation of the hoof

Uneven lowering of the wall. The wall should be level from side to side and from heel to toe, thus giving even contact all round with the shoe. An uneven hoof leads to excessive weight bearing on small areas of the wall and may predispose to sprained joints and consequent lameness.

Cutting out the bars. If this is done, the heels will contract and the frog will not touch the ground. Chronic lameness will result.

Excessive thinning of the sole. If this is done, the deeper structures of the foot may be damaged and bruising of the sole will occur more readily.

Rasping the outer wall of the hoof. This upsets the hoof angles and the horse's gait is altered. Moreover, the protective outer layer of the wall is lost, the wall dries out and cracks develop.

Preparation of the hoof is the most important step in shoeing the horse. If this is done properly, fitting the shoe is relatively easy, and a good job is assured.

Fitting the shoe

The parts of a horseshoe are illustrated in diagram 3. Shoes may be machine or hand-forged. Machine-made shoes are cheaper to buy, and fairly easily obtained but require more shaping to give a correct fit (figure 9). Hand-forged shoes are much easier to fit, but are dearer to buy and may be more difficult to purchase.

When ordering shoes, first prepare the horse's hoof then measure the distance from heel to toe and the width at the widest point (diagram 4). From these measurements, the blacksmith can make the correct-sized shoe. For buying machine shoes, add these two measurements together and check against the following table.

Width + heel-toe	Shoe Size
22 cm	1
25 cm	2
28 cm	3
31 cm	4

To obtain an exact fit, prepare the hoof then trace the pattern on cardboard. This can be given to the blacksmith to use as a guide in make the shoes. One pattern for the fore and one for the hind feet is sufficient.

The aim in fitting a shoe is to make it fit the hoof, not make the hoof fit the shoe.

Shoes can be shaped cold but for making major changes in shape they are best heated in the forge. Tools required for fitting the shoe are:

- Anvil, or shaped railway line or old cart axle.
- Heavy hammer 1 to 1·5 kg.
- Tongs.
- Heal cutter or cold chisel.
- Pritchel.

Having prepared the hoof, a shoe of approximate size is selected and tried against the hoof to see where alterations to its shape are required (figure 8). The shoe should follow the line of the wall all round, but may project 3 mm beyond the wall at the heels. The bearing surface should be level, that is, there should be no gaps between the wall and the shoe. A small amount of hoof may have to be removed at the toe to allow the clip to sit in firmly. A large recess should not be cut as this allows the shoe to ride too far back and pressure on the wall may lead to formation of a condition called 'seedy toe'.

The heels of the shoe should be flush with the heels of the hoof. If too long, the horse will stand on the shoe and pull it off. If too short, the heels of the shoe will soon press on the sole and the horse will develop corns and become lame.

The inner edge of the bearing surface should be hammered down to round off the sharp edge. This helps to prevent the pressure of the shoe on the sole of the hoof.

Finally, one should check the nail holes to see they have not been closed while shaping the shoe. They can be readily opened using the pritchel. Before the shoe is nailed on, the heels should be filed to a rounded finish so the horse will not injure itself on any sharp projections.

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Nailing on

For size 1 and 2 shoes use No. 4 nails and for size 3 and 4 shoes use No. 5 nails. When driving nails, it is most important to have the bevel on the tip of the nail facing inwards, that is, towards the frog (diagram 5). If the bevel faces out, the nail will go too deep and the horse will be pricked and will become severely lame.

Start nailing with heel or centre nails, usually on the inner branch of the shoe (figures 10 and 11). After the first nail, the shoe may shift slightly and need to be tapped back to its correct position. Drive one nail in each side alternately.

The nail should emerge 19 to 31 mm up the wall of the hoof. The nail is driven home firmly and the sharp point twisted off using the claw of the hammer (figure 12). It is desirable to have all nails emerging at about the same height, with perhaps a slight slope from the toe to the heel nail on each side.

The ends of the nails are now turned down at right angles by holding the head of the pincers under the cut end of the nail and giving the head of the nail several sharp taps with the hammer (figure 13).

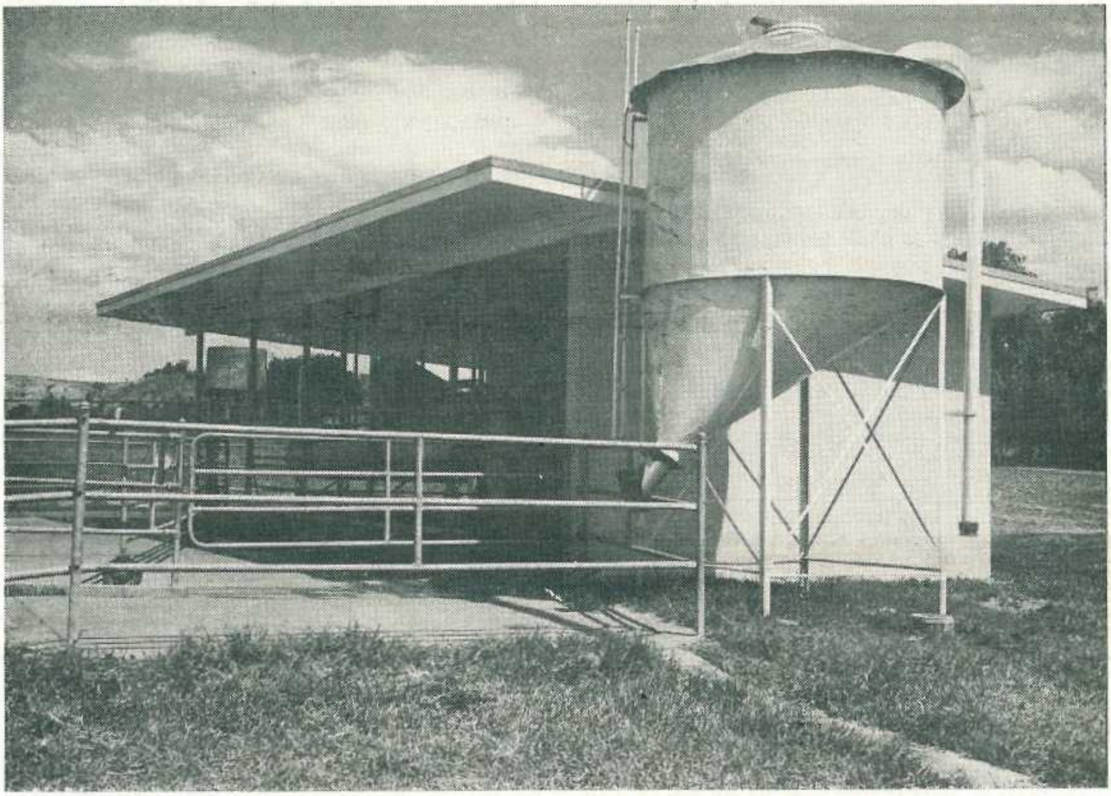
Having done this, the leg is brought forward and the file side of the rasp is used to square off the nail ends and clean up the broken wall under the exposed nail ends. One should not rasp grooves in the wall in which to seat the clenches.

Holding the pincers under the nail head, the clenches are turned down with the hammer and lightly bedded into the wall (figure 14). Figure 14 shows a fault in the preparation of the hoof or shoe. In this case the wall does not evenly meet the bearing surface of the shoe. The rasp is then used to smooth off the clenches and give the job a finished appearance (figure 15). Excessive rasping of the outer wall is to be avoided.

To finish off the hooves should be painted with a hoof dressing, for example, horse oil or Stockholm tar. These help to keep the hooves in good condition and prevent drying out and cracking of the wall.

Common faults

- Nails driven too shallow do not hold firmly and soon break out leaving a crack in the wall.
- Nails driven too high. These cause pressure on the sensitive tissues and the horse becomes lame. If the offending nail is quickly removed, no harm is done and the horse goes sound.
- Nails failing to emerge—probably put in with the bevel the wrong way round. Infection is introduced to the sensitive inner layers of the hoof and severe lameness follows.
- Allowing the shoe to slip back or to one side while nailing on. This gives an incorrect fit. The horse may stand on the shoe and pull it off.
- Using too many or too few nails. Six nails are usually sufficient. Seven or eight may be used in a size 3 or 4 shoe.
- Nailing into a crack. The nail will not hold so serves no useful purpose. It also tends to hold the crack open and cause it to run higher.



Milking shed design and construction

MILKING is the most regular and tedious chore on a dairy farm.

It would seem important then to provide a working area which is clean, efficient and comfortable for workers. The milking shed must be streamlined to milk the herd as quickly and easily as possible, with a minimum waste of workers' energy and patience.

This article highlights the points to consider in planning and constructing a milking shed for a particular farm and herd size. Discussions are restricted to actual plans and designs available from the Department of Primary Industries. Other designs are available from various building and construction firms.

by J. D. Elrington, Dairy Field Services Branch

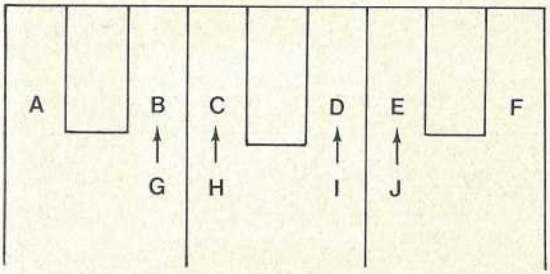
The milking routine

Milking equipment must be carefully planned to suit the herd size and the number of workers available for milking. It is most important to avoid over milking.

A milking machine should milk a cow in approximately 3 to 5 minutes. This does not allow an operator much time to do other things in the time between putting the cups on a particular cow and being there ready to take them off again when all the milk has been obtained. The number of jobs which can be done in this time depends on the facilities available and the amount of thought and capital spent on labour-saving devices.

Milking machines can be installed as single or double units. Single units refer to those providing one set of cups for two cows, while double units provide one set of cups for each cow.

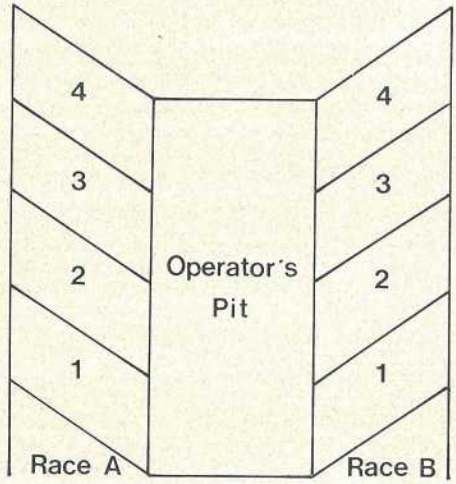
In walk-through bails, one man may be able to attend to three single or two double units if the cows are well trained and in full production and the milk room needs no attention. Even so, he will be very busy, as can be shown by a list of the jobs to be done in a 5 minute cycle in a three single unit bail.



Start: Put cups on cow (A).
Dip teats of cow (B) and put her out.
Put out feed for cow (G) and bail her up.
Transfer cups from cow (C) to cow (D).
Dip teats of cow (C) and put her out.
Put out feed for cow (H) and bail her up.
Return to first bail, start and wash cow (G).
Transfer cups from cow (E) to cow (F).
Dip teats of cow (E), put her out.
Put feed out for cow (J) and bail her up.
Return to second bail, start and wash cow (H).
Return to first bail ready to take the cups off (A), thus finishing the cycle.

Notice that there is no stripping and no leg-roping in the above cycle. When the cows are slack (when production has dropped), the operator should cut down his routine to take in two single or one double unit, so that he is back where he started inside 3 minutes with a few seconds to spare for rest. Note also that as lactation progresses, it takes progressively longer for 'let-down' to be induced. The let-down hormone acts for a progressively shorter period, and there is less milk to obtain.

In a herringbone bail, the same milking time applies per cow and per set of cups so if the cups are to be fully occupied, milking must be done very quickly. For example, if four cows a side are to be milked and 4·5 minutes is allowed for the cups to milk a cow, and 30 seconds are needed to change one set of cups from one side to the other, then the herd is milked by the machine at the rate of 48 cows an hour.



The operator (or operators) must, within 4·5 minutes of putting the cups on No. 1 cow in race (A),

(1) Attend to the other three cows in race (A).

(2) Dip the teats, empty out, bail up, start and wash race (B) cows.

(3) Put out feed for race (B) cows.

(4) Be ready to transfer the cups from the first cow in race (A) to the first cow in race (B).

This is difficult for one man to do in anything more than a four unit high line herringbone shed. Only a very active man with very good equipment could keep up this pace even in a shed as small as four units. The cycle is much easier and quicker in elevated herringbone milking bails.

In all planning, keep in mind this 3 to 4 minute milking time taken by the machine. If the farmer is to keep up with the machine, he cannot handle too many units or bails.

There is a grave risk of over-capitalizing by building too large a shed or purchasing a milking machine that is too large. Every minute of over milking time per cow could mean that an extra bail and unit have been built and purchased unnecessarily.

Plans recommended and not recommended

Generally, walk-through bails are considered to be obsolete even for small herds, so are not recommended. Elevated herringbone bails are considered to be a much better proposition, high line for small herds and low line for larger herds, for the following reasons:

- Elevated bails are easier to work in, as there is no stooping.
- Batch handling of cows is quicker and easier than individual handling.
- The average through-put time per cow in walk-through bails is much longer than in herringbone bails.
- Inspection of udders (and treatment if necessary) is easier in elevated bails.
- Herringbone bails may appear more expensive than walk-through bails. This could be a myth, especially if metal bails and the milking machine are taken into account. For a given herd and a given number of milkers, the herringbone should be a smaller shed than the walk-through and thus be competitively priced even without the purchase of a milking machine. In a package deal of building bails and machine, an elevated herringbone should always be cheaper than a walk-through.
- Milking time—a small herd which takes 45 minutes to milk in a walk-through dairy, may take only 30 minutes in a herringbone dairy.

If walk-through bails must be built, it is strongly recommended that doubled-up units be used. This not only reduces shed size, but also allows for better preparation practices before each cow is milked.

At this point, it should be noted that although one man can use four sets of cups in a herringbone shed, it does not follow that two men can keep up with eight sets. This is mainly because it takes longer to exit eight cows and enter eight fresh ones together than it does for four cows at a time.

Cow race position

If drainage is easy, the milker's alley should be set 76 cm into the ground, and the cows permitted to enter and leave the shed by a level path. The milker's alley should be excavated as much as drainage will permit and only on a very level site should the cows, if necessary, be raised to the maximum height of 76 cm above ground level. Even then it would pay to fill the site before construction so that cow entrances and exits are level.

Basic assumptions

To simplify discussions, subsequent figures are based on the following assumptions:

- Cows are in full production and take 4·5 minutes each to be milked by the machine.
- Each 'single' unit of a milking machine can milk at the rate of 12 cows per hour (4·5 minutes per cow and 0·5 minutes to change the cups).
- Each 'double-up' unit of a milking machine can milk at the rate of 18 cows per hour (because each set of cups is idle while cows are changed).

  Note: A high line herringbone shed can be doubled-up (for example, a three cows a side shed would have six sets of cups installed). Also note that a low line shed must have six sets of cups and is therefore automatically doubled-up even though it is called a three unit or three a side herringbone shed.
- Herringbone sheds have backing or forcing gates, and if producing milk for the liquid milk trade or for manufacture milk, have a bulk vat.
- Maximum milking time is 3 hours daily (1·5 hours twice a day) exclusive of the preparation time before milking starts, and the cleaning down time after milking finishes.
- Low line units milk at a 20% faster rate than high line units.

- Allowance has been made for the longer time taken to change cows in larger herringbone sheds.
- Each operator is active enough and has the facilities to be able to keep up with:
  Three single walk-through units
  Two double-up walk-through units
  Four single high line herringbone units
  Three units (three a side) low line units.
- Feeding concentrate in the bails during milking is done by some mechanical means such as press-buttons, levers, etc., from a bulk supply and not by hand.

When deciding on the number of units to build, start with these assumptions and then vary the number of units to suit individual needs.

For this reason the Department of Primary Industries provides a number of plans. There are three, four, five, six and eight unit high line herringbone plans for one, two and three man operations. So, if one man has to distribute feed by hand from a drum, he would probably be limited to a four units shed. If he had an assistant to look after the milk room, the feeds, and perhaps to assist in changing lines of cows, he could use a six unit shed. In this size shed, he would have no trouble keeping up with the machine, and conversely would not have excessively long rest periods while waiting on it.

Building site

Important points in selecting a site for a dairy are worthy of mention here.

- For a walk-through shed with level floors, the site needs to have:
  —the right textured soil for building and yard foundations.
  —sufficient north-easterly slope for good drainage.
  —allowance for space (adjacent to the milk room) for a bulk milk tanker.
  —available water and power supplies.
- For herringbone dairies of the style described later in the article, a different drainage system exists—the milk room and the milker's alley are drained underground. The milker's alley is 76 cm deep and the cows are on ground level so the drain is at least 1 m below ground level at the milker's alley. The site needs to drop 120 cm from the N.E. side of the building to a little beyond the edge of the cowyard for installing a straight underground drain with good fall. The cowyard may be built up to an easier grade if the builder desires, but this is not essential. The other factors—soil texture, road, water and power—are common to all sites.

Very seldom is a perfect site available, so a compromise is usually made remembering the cost involved in obtaining the ideal site.

Builders are especially urged to heed the architect's advice relating to black soil areas.

Notes for black soil areas

The detailed plans are based on good foundation conditions.

Black soil conditions should be avoided wherever possible (for example, by building on ridges away from watercourse flats).

If areas of black soil cannot be avoided, the following measures are recommended:—

- Bases of hardcore, gravel rubble or other non-expansive material should be provided to a minimum depth of 30 cm below all concrete slabs, even if this entails grading up for yards, entrances, etc.
- The use of concrete masonry is not recommended in black soil areas. All basic dimensions should be maintained, but timber-framed construction should be substituted.
- Where drainage is laid under concrete slabs, use cast iron pipes.

D.P.I. plans for milking sheds

The D.P.I. Dairy Division holds plans for the following buildings:—

Type of building	No. of units
Herringbone low line	three a side
Herringbone low line	four a side
Herringbone low line	five a side
Herringbone low line	six a side
Herringbone high line	three a side
Herringbone high line	four a side
Herringbone high line	five a side
Herringbone high line	six a side
Herringbone high line	eight a side
Herringbone high line	ten a side
Walk-through	two units
Walk-through	three units
Walk-through	four units
Walk-through	six units

When you order plans from the D.P.I., you will receive a comprehensive set of drawings and quantity sheets. To order plans, contact any D.P.I. dairy adviser or write direct to the: Director of Dairying, Department of Primary Industries, G.P.O. Box 46, Brisbane, 4001.

A fee of $5.00 is charged for the first set of plans plus $3.00 for each additional set ordered at the same time. The fee should be enclosed with the order if possible.

Greatly reduced ground plans of some dairies recommended by the D.P.I. are presented here.

Herringbone dairies

In the following herringbone plans, both high and low line, the milkrooms are on the side. These can easily be built on the end, but this location is considered to be inferior so plans for building are not available. Farmers who wish to relocate the milk room can make their own arrangements for modifications to the plan.

Low line Herringbone

The low line milking dairy results in a very open and pleasant working area as shown in plate 2. This area is wider by 300 mm than that in the same size high line dairy. A high line dairy should not be made wider because of the sideways pull of the downdroppers.

An example of plans for small low line herringbone sheds is the following (figure 1) one for a four a side low-line with a side milk room. The milk room for small herringbones is 4 000 mm square.

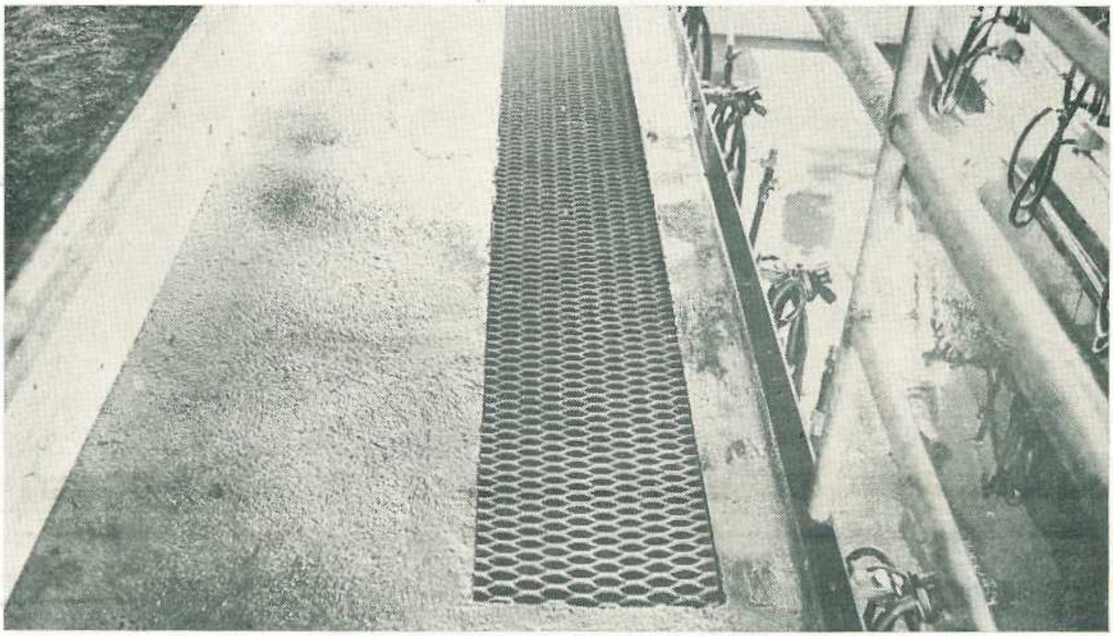
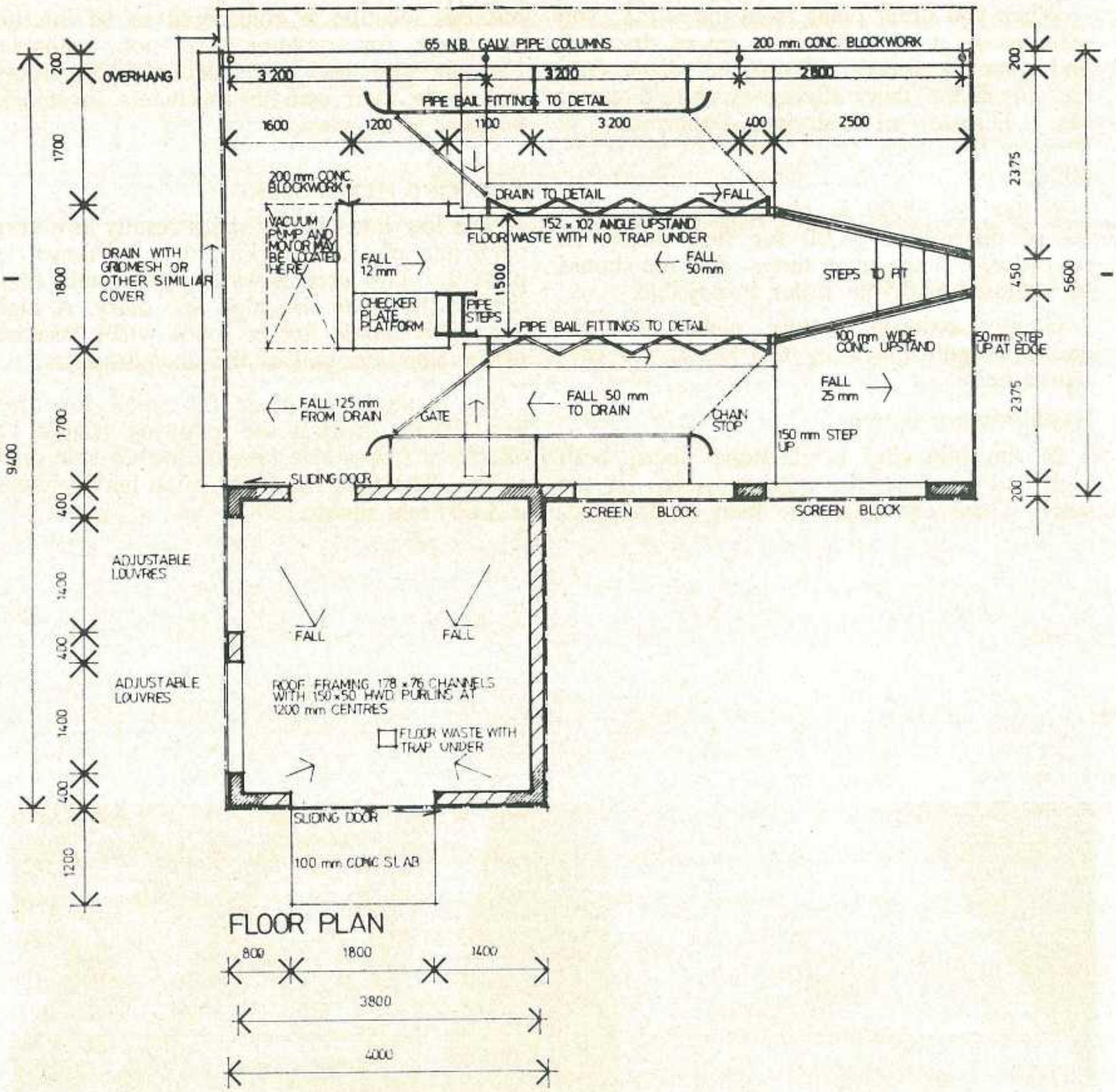


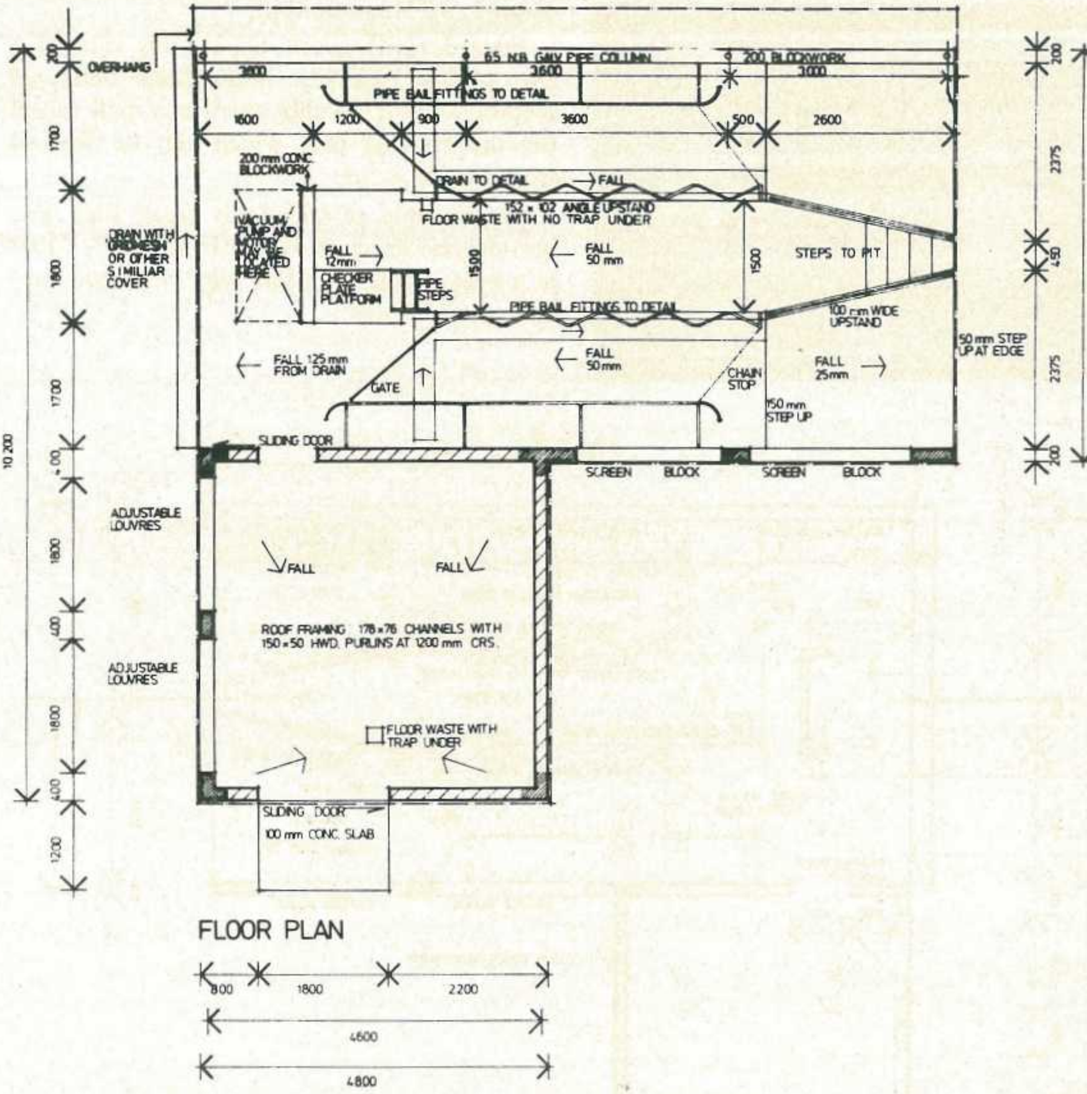
Plate 2.



FLOOR PLAN

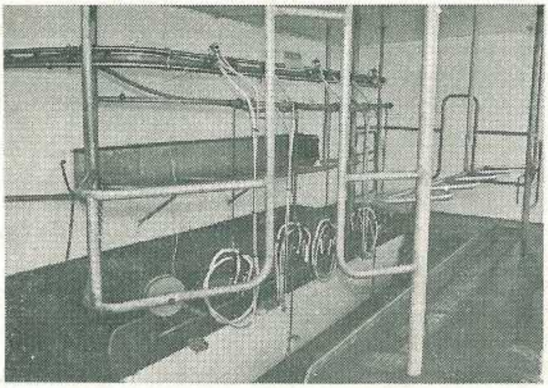
Working capacity (figure 1)

—	No. of workers needed	Herd size	Milking speed
Three a side low line herringbone	one	80 to 90 cows	55 cows/man/hr.
Four a side low line herringbone . .	two	90 to 130 cows	33 cows/man/hr.



Working capacity (figure 2)

—	No. of workers needed	Herd size	Milking speed
Five a side low line herringbone ..	two	130 to 160 cows	45 cows/man/hr.
Six a side low line herringbone ..	two to three	more than 150	



HIGH LINE HERRINGBONE

Plate 3 (left) shows the interior view of a five a side high line herringbone dairy. A feature to note in this shed is a pull wheel for the backing gate which can be worked from the pit.

An example of plans for small high line herringbone sheds is shown in figure 3. This is a four a side high line with the 4000 mm^2 side milk room.

Plate 3.

Figure 3

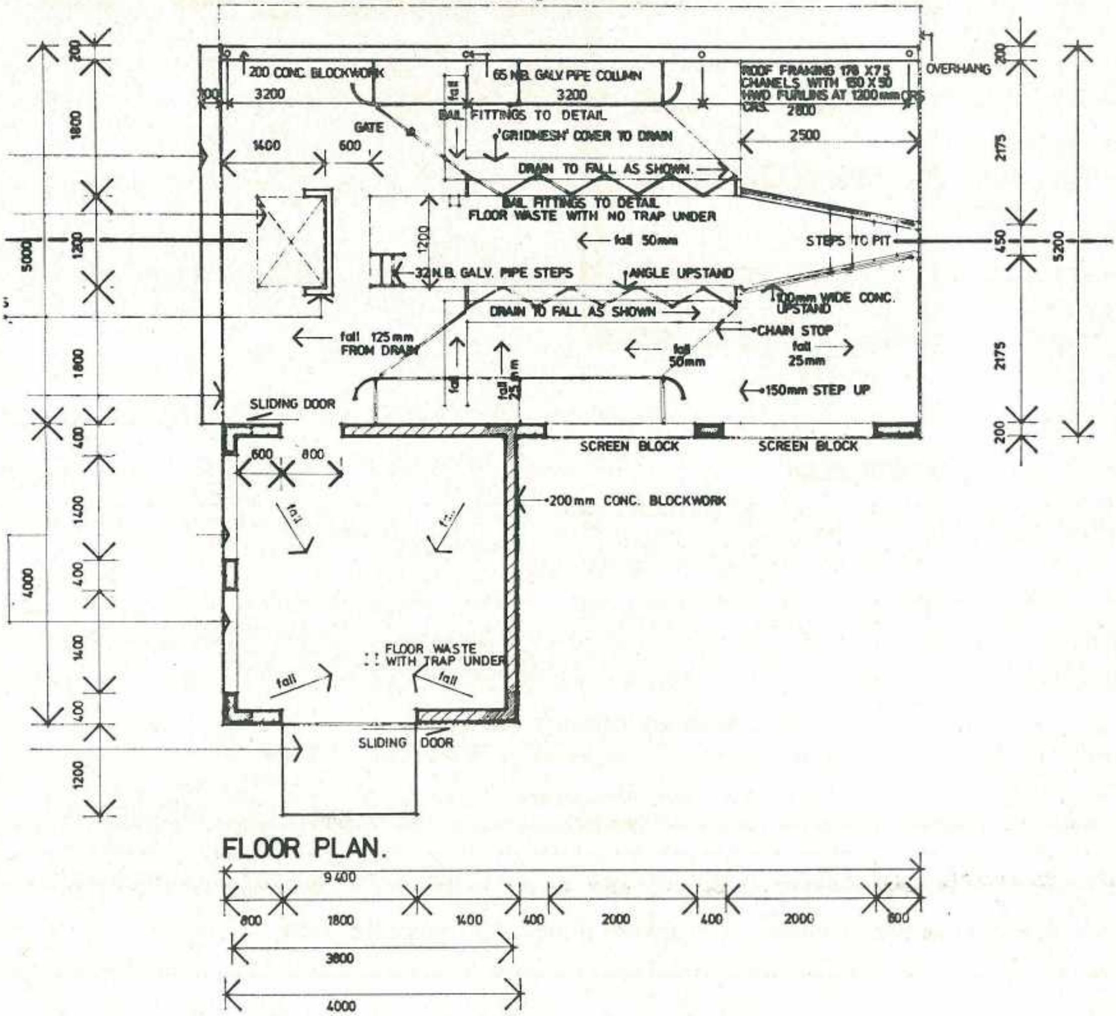


Plate 4 (right) shows the same five a side high line dairy as figure 3. The plan was modified so that the cows exit from the side because the farmer felt the need for more weather protection. The plan was also altered to place a feed room where the plan shows a milk room, with the milk room at the entrance end of the shed.

Figure 4 shows the plan for a larger high line herringbone shed. This shows a six a side high line with the 4800 mm² side milk room.

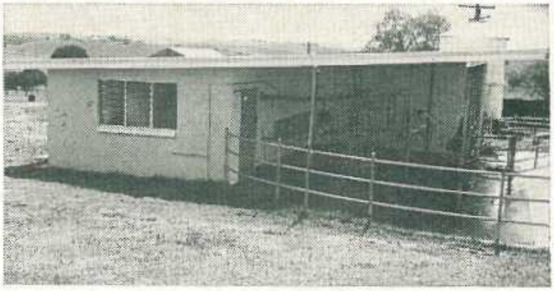
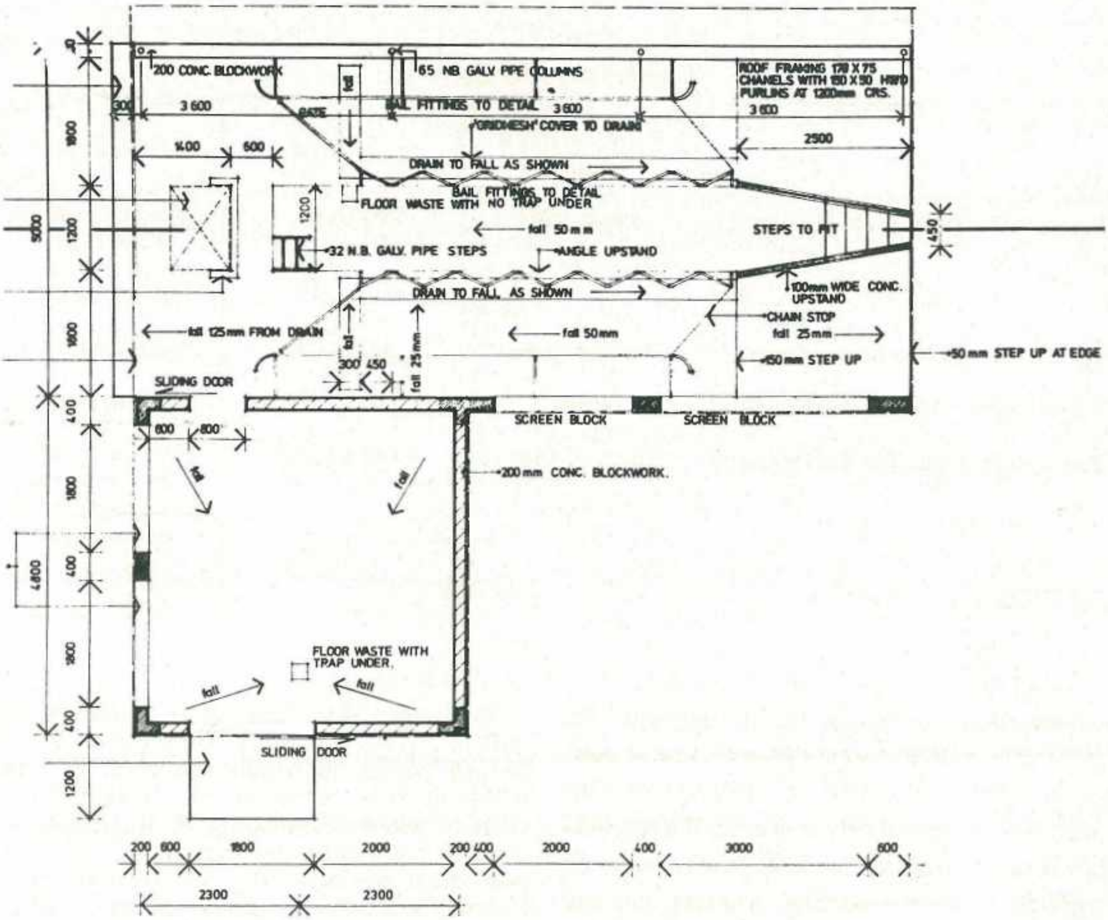


Plate 4.

Figure 4



Working capacity (figure 3)

——	No. of workers needed	Herd size	Milking speed
Three a side high line herringbone	one	up to 54 cows	36 cows/man/hr.
Four a side high line herringbone	one to two	50 to 70 cows	48 cows/man/hr. (one man) 25 cows/man/hr. (two men)

Working capacity (figure 4)

——	No. of workers needed	Herd size	Milking speed
Five a side high line herringbone ..	one to two	70 to 90	60 cows/man/hr. (one man) 30 cows/man/hr. (two men)
Six a side high line herringbone ..	two to three	90 to 110	25 cows/man/hr.
Eight a side high line herringbone	three	110 to 140	30 cows/man/hr.
Ten a side high line herringbone	three to four	140 to 180	35 cows/man/hr. (three men) 27 cows/man/hr. (four men)

Note that the longer the herringbone, the more time is needed to march each row of cows out and the replacements in. Preparation time must be correspondingly shortened if over milking is to be avoided, so more labour units are required to do the starting, washing and cup changing.

Remember that each set of cups can still milk 12 cows an hour, so if there are not enough people to handle the herd, the cups will have to be 'hung up' for a period in each cycle to avoid overmilking. If it appears that this will have to be done very often during the year, then obviously the correct thing to do is build a smaller shed and install a smaller machine.

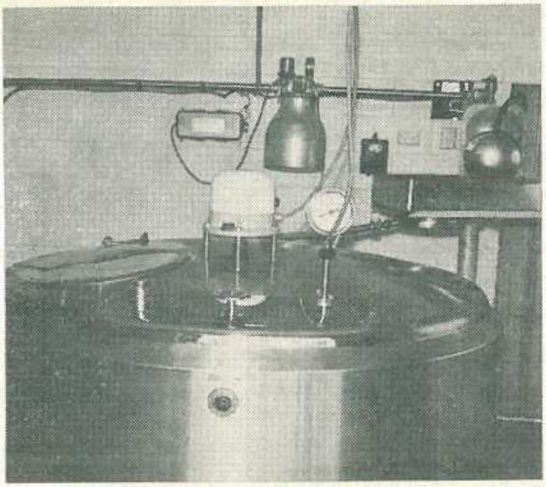


Plate 5.

The milk from a high line milking machine is nearly always exposed to the atmosphere in the milk room. Thus this room needs to be of a high standard of construction. Plate 5 shows a well-built, clean milk room.

Walk-through dairies

Plate 6 shows the interior view of a high standard walk-through dairy. Dairies such as this must upgrade the image of the dairy industry.

An example of plans for small walk-through dairies is the following one for a two unit bails and milk room (figure 5).

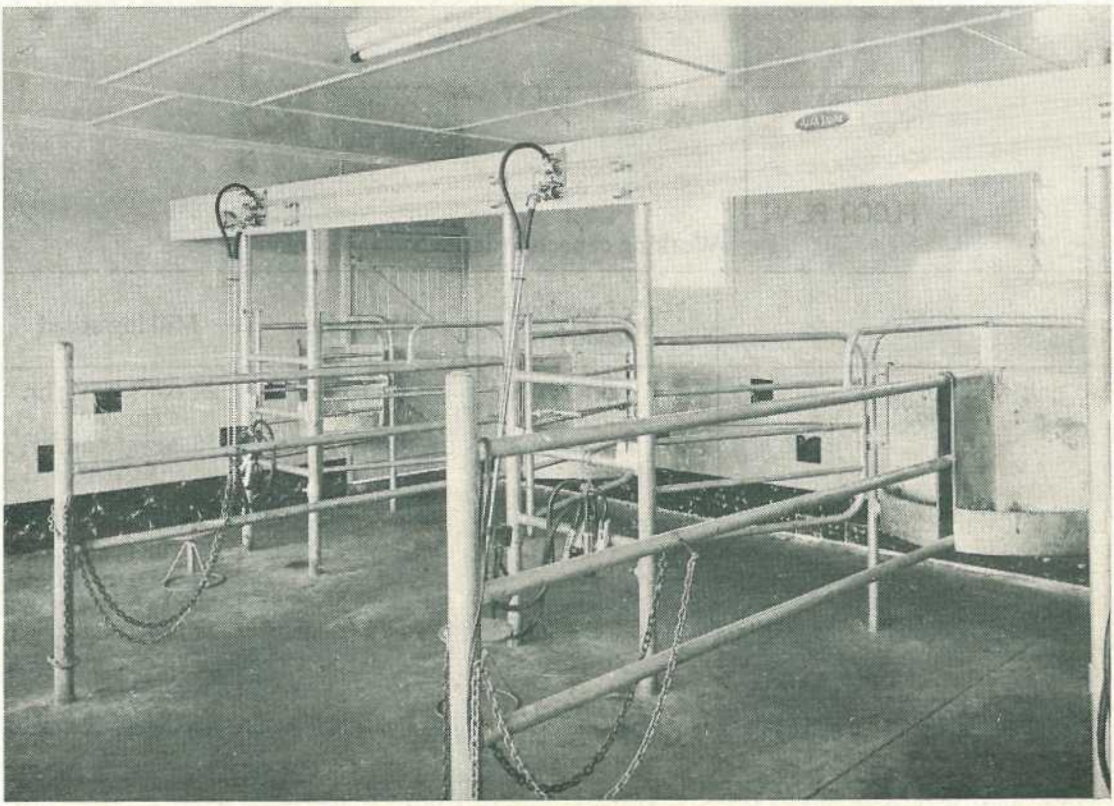
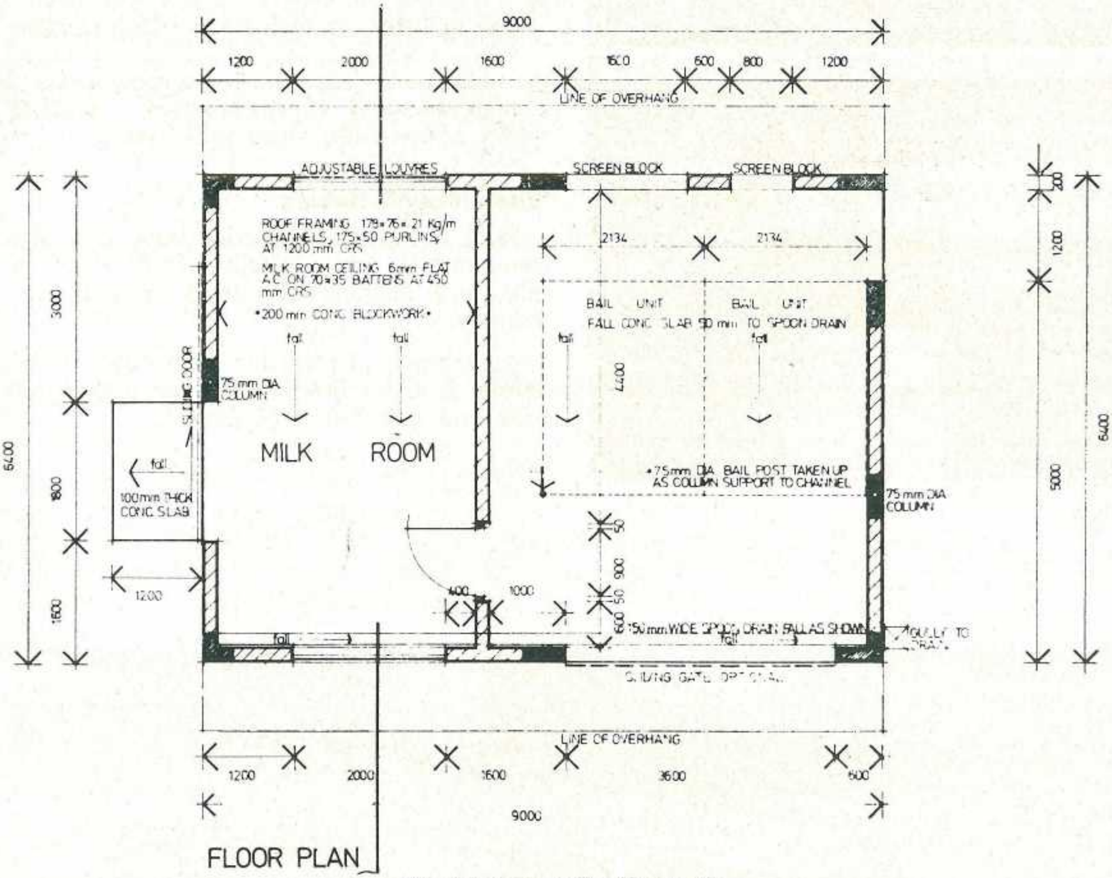


Plate 6.



Working capacity (figure 5)

——	No. of workers needed	Herd size	Milking speed
Two unit walk-through	one for single units	up to 36 (single units)	24 cows/man/hr. (single)
	two for double units	up to 54 (double units)	18 cows/man/hr. (double)
Three unit walk-through	one to two (single)	35 to 50 (single)	36 cows/man/hr. (one man) 18 cows/man/hr. (two men)
	two (double)	50 to 80 (double)	27 cows/man/hr. (2 men double)
Four unit walk-through	two (single) three (double)	50 to 70 (single) 80 to 100 (double)	24 cows/man/hr. (two men double)

Plate 7 shows an elevated two unit doubled-up walk-through dairy. Cows walk up the steps without any trouble. Exit is to a level 120 cm wide alleyway leading to a down ramp.

An example of plans for larger walk-through dairies is the one shown in figure 6 for a six unit walk-through.

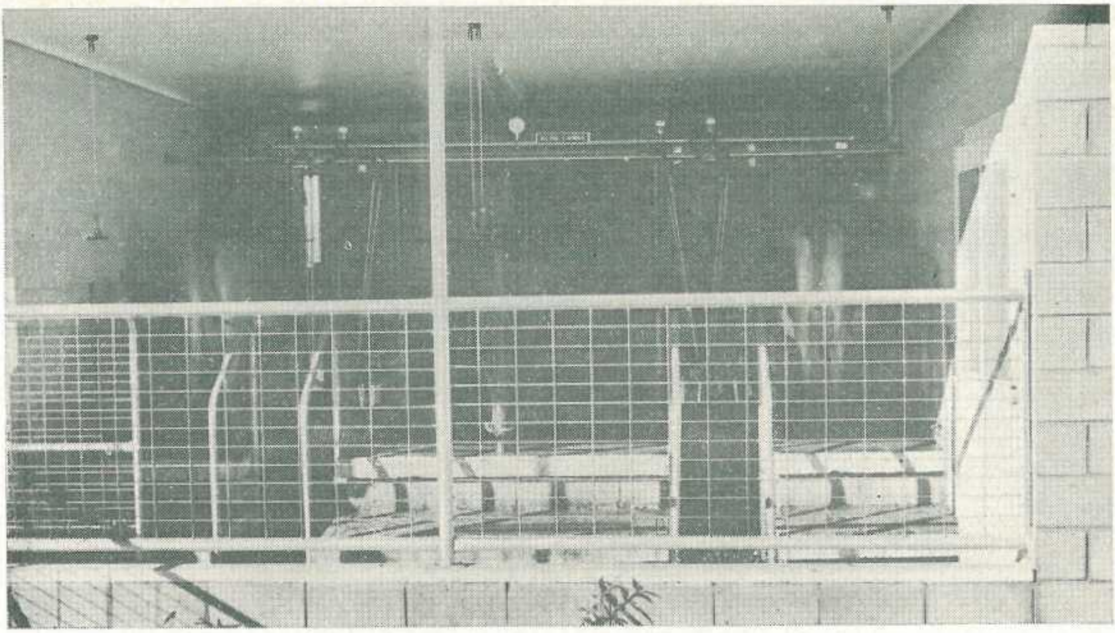
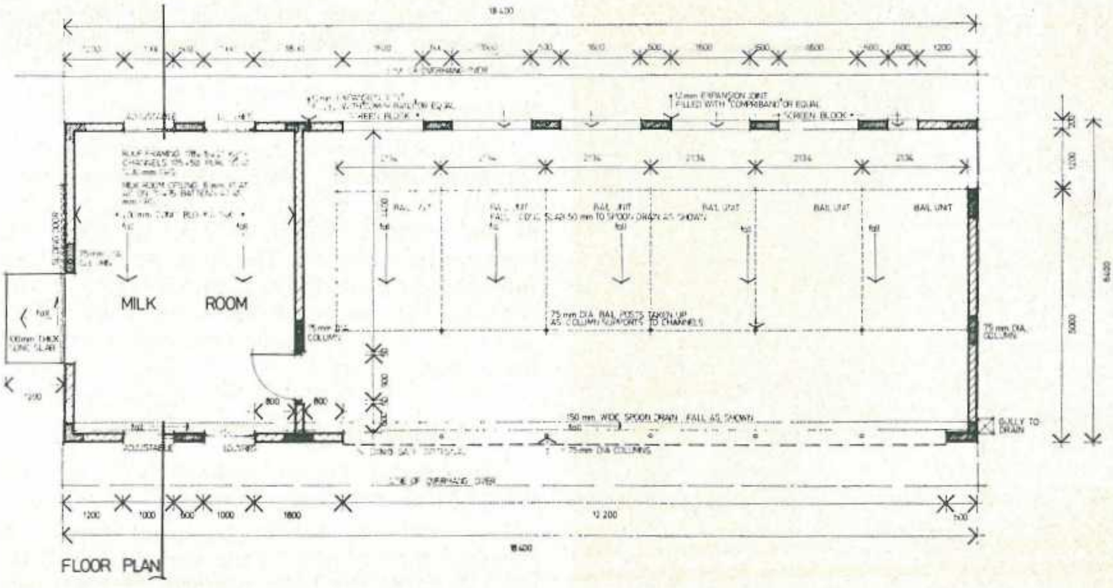


Plate 7.



Working capacity (figure 6)

——	No. of workers needed	Herd size	Milking speed
Six unit walk-through	three (single units)	72 to 108	24 cows/man/hr.

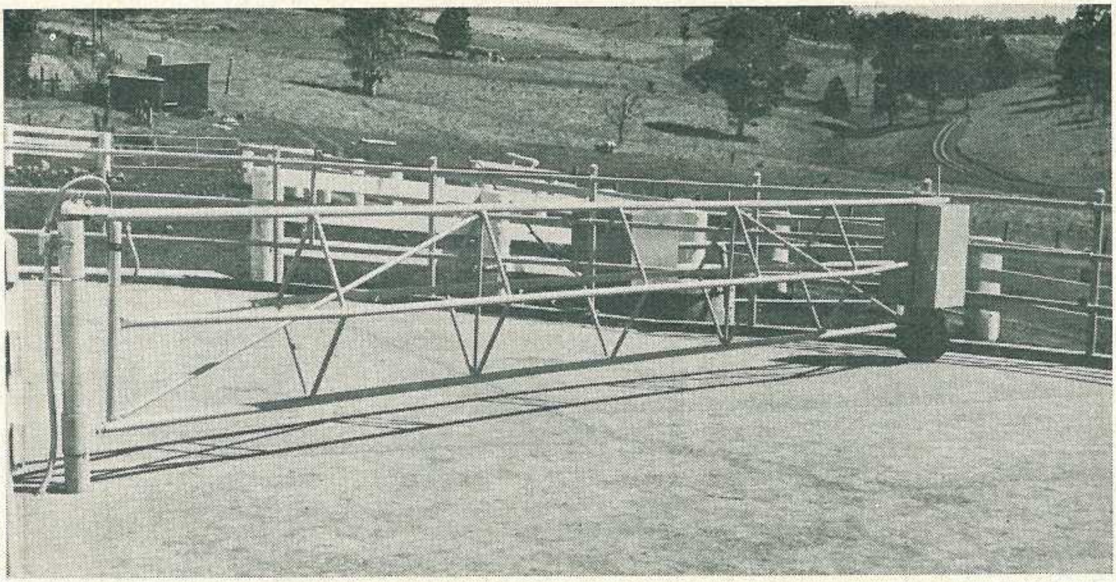


Plate 8.

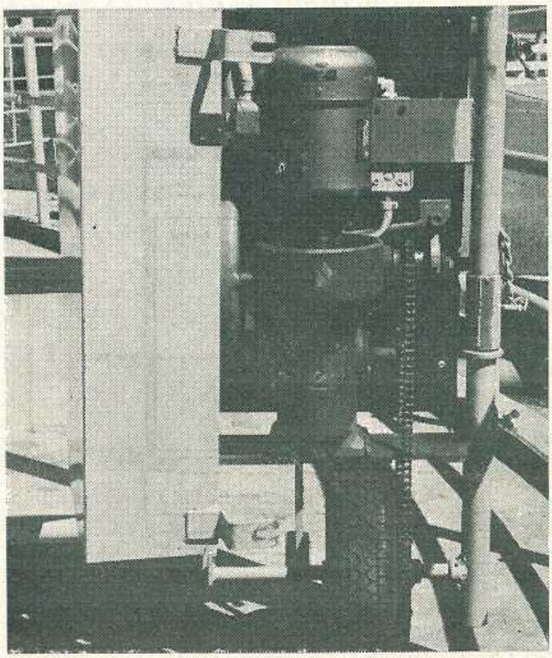


Plate 9.

Doubling up is not recommended unless the herd is well over 100 cows, but for larger herds only the herringbone design should be considered.

Rotary dairies

An article on milking sheds would not be complete without some reference to rotary dairies. Plans are available from the suppliers of the various rotary dairies, so there has been no need for the D.P.I. to produce them. Information is available from the D.P.I. Dairy Division head office at Newstead or from field dairy advisers for anyone contemplating building a rotary dairy.

Other important features

Many inventions and gadgets have made the milking task easier and quicker for workers.

One popular labour-saving device is a powered forcing gate in the yard to crowd the cows towards the bail entrance. In this case (plates 8 and 9), a cream separator was used as a reduction gear box.

Some farmers prefer their cow yards to be covered to protect cows and the workers from rain and hot sun. Plate 10 shows a covered circular cow yard.

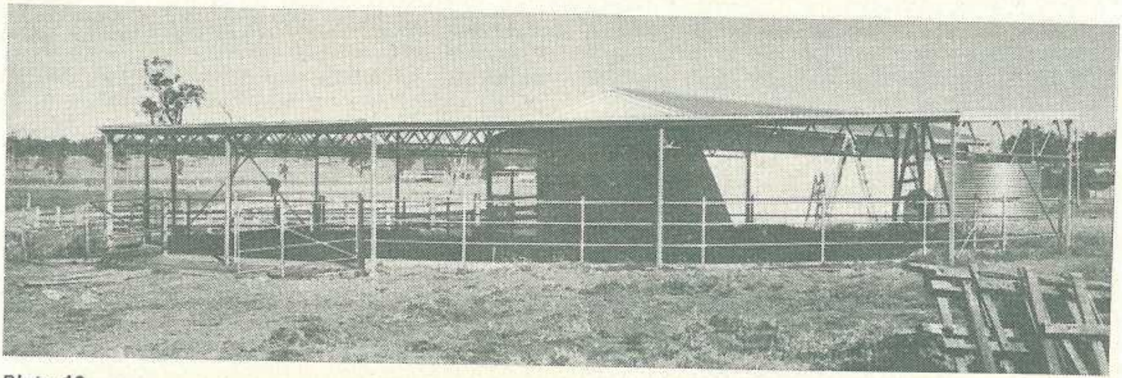


Plate 10.

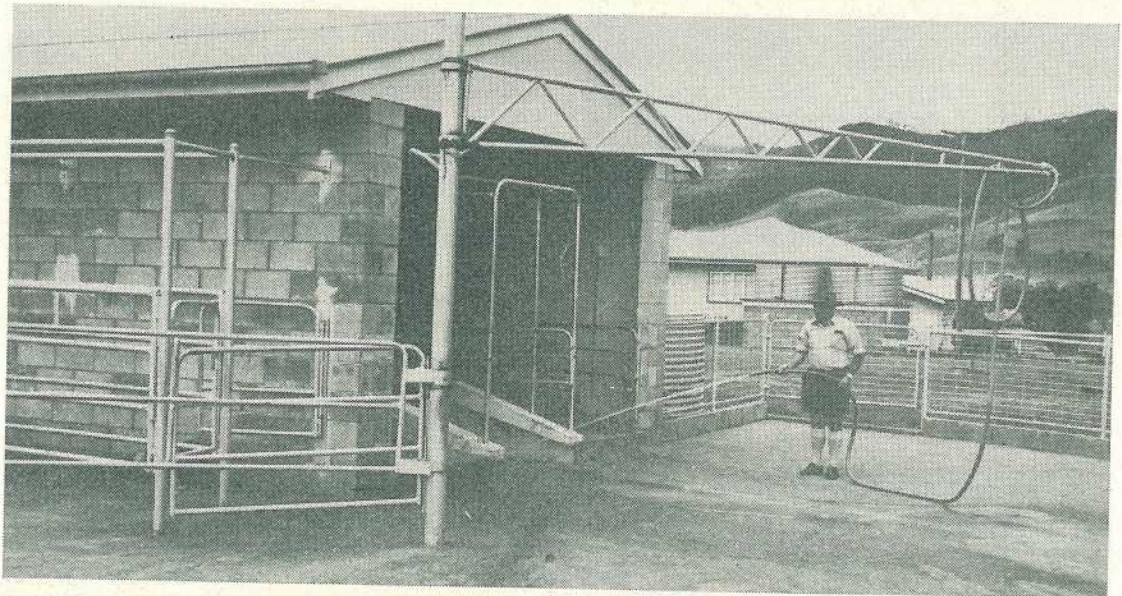


Plate 11.

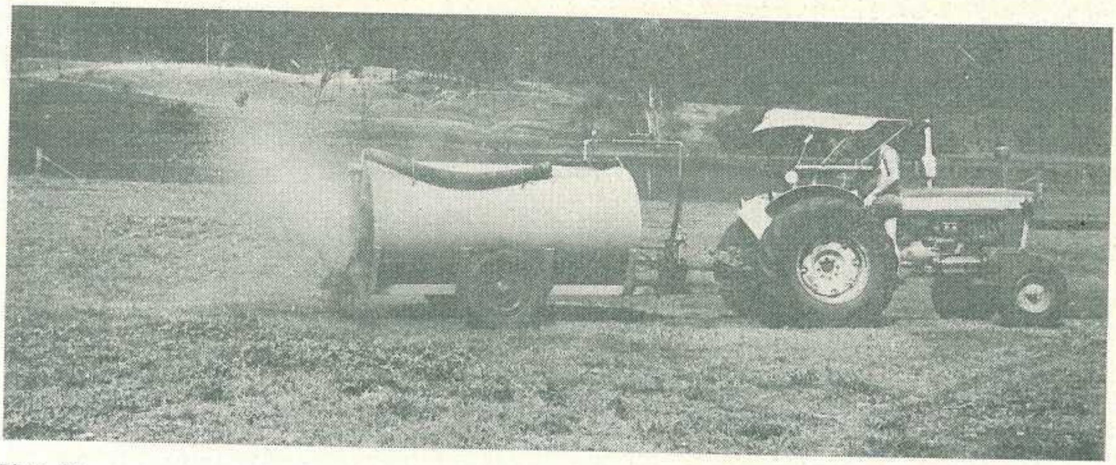


Plate 12.

78686—18

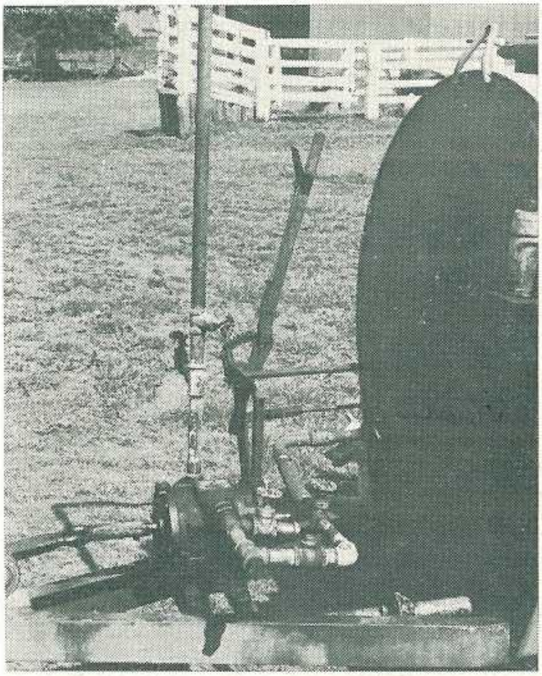


Plate 13.

Plenty of high pressure water should be available for hosing down the dairy after milking. Cleaning can take just as long as milking if equipment and water are inadequate. Plate 11 shows a dairy with good hosing facilities.

Waste disposal is often a problem on dairy farms. Plate 12 shows liquid manure being spread on to farm pastures. Plate 13 is a close-up of the vacuum pump and pipe mechanism of the manure disposal trailer. Manure is drawn into the tank by vacuum and blown out by air pumped into the tank via the exhaust pipe of the same pump.

The lever operates the rear valve—the spray is an old plough disc. Blockages do not occur with this system. Plate 14 shows the manure disposal tank being filled.

D.P.I. advice and services

If you are planning to build a new dairy, contact the nearest D.P.I. dairy adviser for plans, suggestions and assistance. Each adviser is in touch with many dairy farmers so is familiar with a range of building types, equipment and recent labour-saving devices.

The adviser can also check how your milking machines are working. This free test should be done at least once a year.

Plate 14.

South Queensland grain sorghum planting guide 1979-80 season

GRAIN sorghum hybrids recommended for planting in South Queensland in the 1979-80 season are listed in this guide. The hybrids have not been ranked in order of preference.

There are a number of hybrids offered for sale this season. Many have not been tested in Departmental trials and others have only been tested for a limited period; some are showing promise of high yields and desirable characteristics but could not be included in the planting guide until further testing has been completed.

The hybrids listed 'for trial' should be sown in smaller areas for evaluation under your conditions. It would be appreciated if farmers would advise their Agricultural Extension Officer of trial plantings as this will enable a wider evaluation of the performance of these hybrids to be made.

Some hybrids show a phytotoxic reaction to insecticides particularly monocrotophos which is used to control sorghum midge. The severity of the reaction to insecticides varies with the growth stage of the plant. A number of new hybrids released to the market have not been tested for their reaction to the insecticides and growers should be cautious when spraying. If in doubt, a small area should be sprayed first to test for any reaction or advice should be sought from the appropriate seed company.

Compiled by S. R. Walsh, Agriculture Branch

Open-headed hybrids are desirable in the more humid regions and in areas where sorghum head caterpillars are expected.

Planting rates

The established plant population for raingrown crops will vary from 75 000 to 100 000 plants per ha. The rate should be increased to establish about 250 000 plants per ha when crops are irrigated.

The planting rate will vary according to available soil moisture, time of planting, soil type and variety. Your Agricultural Extension Officer will provide further information.

Grain sorghum seed sold by major seed companies is of high quality, but seed size varies. Generally, it is in the range of 20 000 to 40 000 seeds per kilogram.

APPROXIMATE PLANTING RATE FOR GIVEN PLANT POPULATIONS

Plants/ha	Planting rate kg/ha
50 000	2·5 —3·0
75 000	3·75—4·0
100 000	5·0 —5·5
150 000	7·5 —8·0

Adjustments must be made for higher or lower populations and seed size. The efficiency of most planting machinery is also variable.

Lodging

Lodging is a major problem in many grain sorghum producing areas in Queensland. The most prevalent type is that which follows moisture stress during the grain filling period. Under such conditions, all grain sorghum hybrids will lodge. Lodging can also be associated with conditions other than moisture stress and hybrids relatively resistant to one type of lodging may be more susceptible to other forms.

Nevertheless, trial data and farmer experience have enabled classification of some hybrids as to their lodging resistance. Only lodging resistant hybrids are recommended for areas where lodging is known to be a problem. Other characteristics, particularly grain yield and disease resistance, determine the recommendations for areas where lodging is usually not important.

Lodging is not usually of importance in fully irrigated crops but can occur in well-grown irrigated crops which experience moisture stress during grain filling.

Crop maturity

The hybrids have been given maturity ratings. However, maturity is governed largely by temperature and to a lesser extent by day length. Hybrids which flower in 60 to 65 days when sown in October in south Queensland could be expected to flower in 50 to 55 days when sown in December. The slow and medium-slow hybrids may therefore react as midseason types when sown later in the season.

Head smut

Head smut, an important soil-borne disease, is favoured by cool soil conditions. It is common in early plantings in south Queensland. Highly susceptible (HS) hybrids should not be sown early in areas where this disease has occurred.

Sugar cane mosaic virus (SCMV)

All grain sorghum hybrids grown in Queensland are susceptible to the Johnson grass strain of sugar cane mosaic virus. Three types of symptoms occur depending on the hybrid and environmental conditions.

The mosaic (M) symptom is shown by most of the recommended hybrids and under field conditions, the grain yield of mosaic reactors is little affected.

Red stripe (R.S.) reactors show a conspicuous red striping when infected. Early infection may result in severe stunting and a substantial yield loss.

The red leaf symptom (R.L.) becomes evident when cool conditions follow infection and the mosaic symptoms change to red spots, streaks and areas of dead tissue. Substantial yield loss will result.

Rust

Sorghum rust occurs in most districts throughout the State but is more prevalent in late sown crops. Severe rust infection in highly susceptible hybrids has been associated with pinched grain and yield reduction. Premature plant death may also occur—predisposing the plant to lodging.

South Queensland grain sorghum planting guide 1979–80 season

A number of hybrids commercially available have not been fully tested in Departmental trials and are not included in the list of recommendations; many have shown promise under very limited commercial experience.

REGION AND SHIRES	PLANTING TIME	RECOMMENDED HYBRIDS
Burnett		
Miriam Vale, Kolan, Gooburrum, Woongarra, Isis, Perry, part Biggenden, part Tiaro, Woocoo, Hervey Bay Shires	Sept.–Jan.	S: F64a MS: E57 *For trial:* MS: Dorado MQ: Goldrush
Monto, Eidsvold, Gayndah, Mundubbera, part Biggenden Shires	Nov.–Jan.	S: F64a MS: E57, Q5161, Sunlover I, Dorado, Leader M: Texas 610SR MQ: Yates 233, Goldfinger, Goldrush, Dorado E *For trial:* S: Big Red M: C43

REGION AND SHIRES	PLANTING TIME	RECOMMENDED HYBRIDS
South Burnett		
Kingaroy, Nanango, Wondai, Murgon, part Kilkivan, part Rosalie Shires	mid Nov.–Dec.	**All Soils:** MS: E57, Q5161, Sunlover I, Leader, SM8 M: Pride MQ: Goldrush
	mid Nov.–Dec.	**Non Lodging Soils** (additional varieties) S: Big Red MS: Yates 266, Dorado MQ: Yates 233, Goldfinger, Dorado E
Near North Coast		
Noosa, Widgee, part Tiaro, Maroochy, Landsborough, part Kilkivan Shires	mid. Nov.–end Jan.	S: Big Red MS: E57, Q5161, Sunlover I, Leader, Dorado M: Pride MQ: Yates 233, Goldfinger, Dorado E
Moreton		
Caboolture, Pine Rivers, Redlands, Albert, Beaudesert, Moreton, Esk, Kilcoy, Boonah, Gatton, Laidley Shires	Sept.–mid Jan. (Aug.–Sept. planting preferred)	**Irrigated and Rain-grown** MS: E57, Dorado, Leader M: Texas 610SR MQ: Yates 233, Goldfinger, Dorado E
Darling Downs		
Wambo, Chinchilla Shires	Oct.–Jan.	**Lodging Soils** MS: E57, Q5161, Sunlover I M: Pride MQ: Goldrush **Other Soils:** M: Texas 610SR, Pride MQ: Yates 233, Goldfinger, Dorado E *For trial:* M: SM8, Pacific 710
Pittsworth, Millmerran (east of Condamine River), Jondaryan, Crows Nest, part Rosalie Shires	Oct.-early Nov.	M: Texas 610SR, Pride MQ: Yates 233, Goldfinger, Dorado E
Millmerran (west of Condamine River)	Oct.-early Nov.	**Brigalow Soil** MS: E57, Q5161, Sunlover I, Dorado M: Pride MQ: Goldrush, Dorado E
Clifton, Allora, Rosenthal, Glengallan, Cambooya Shires	Oct.–mid Nov.	MS: E57, Dorado M: Texas 610SR, Pride MQ: Yates 233, Goldfinger, Dorado E *For trial:* S: Big Red M: SM8, Pacific 710
Stanthorpe Shire	Nov.–mid Dec.	MS: E57, Q5161, Sunlover I. Dorado MQ: Goldrush

REGION AND SHIRES	PLANTING TIME	RECOMMENDED HYBRIDS
Darling Downs—continued		
Inglewood Shire	Sept.–Oct.	S: F64a MS: E57, Q5161, Sunlover I, Dorado MQ: Goldrush *For trial:* M: SM8
All Shires	Oct.–early Nov.	**Irrigated** S: F64a, Big Red, Texas 671, Yates 275 MS: E55e, Dorado M: Texas 610SR, Pride MQ: Yates 233, Goldfinger, Dorado E *For trial:*
	Oct.–early Nov.	M: SM8, Pacific 710
Near South-west		
Waggamba Shire	Sept.–Oct.	MS: E57, Q5161, Sunlover I M: Pride MQ: Goldrush, Dorado E
	late Dec.–Jan.	MS: E57, Q5161, Sunlover I M: Pride MQ: Goldrush, Dorado E
Balonne Shire	late Dec.–Jan.	**Rain-grown** MS: E57, Q5161, Sunlover I M: Pride MQ: Goldrush, Dorado E
	late Dec.–Jan.	**Irrigated** S: Texas 671, Big Red, Yates 275 MS: E57, Dorado, E55e M: Texas 610SR MQ: Yates 233, Goldfinger, Dorado E
Murilla, Tara, Taroom Shires	late Sept.–Oct.	S: F64a MS: E57, Q5161, Sunlover I M: Pride MQ: Goldrush, Dorado E
	late Dec.–Jan.	S: F64a MS: E57, Q5161, Sunlover I M: Pride MQ: Goldrush, Dorado E
Bungil, Bendemere, Warroo, Booringa Shires	late Dec.–Jan.	MS: E57, Q5161, Sunlover I M: Pride MQ: Goldrush, Dorado E

KEY: S = Slow maturity; MS = Medium-slow maturity; M = Medium maturity; MQ = Medium-quick maturity; Q = Quick maturity.

For further information on varietal performance in your own district, consult your Agricultural Extension Officer.

Guide to grain sorghum characteristics

Compiled by Officers of the Department of Primary Industries

Seed Company	Hybrid	Mean Yield as % of Texas 610SR up to and including 1978–1979 Trials: Darling Downs		South Burnett		Time of Flowering		Height	Head	Grain Colour	Reaction to				Standability or Resistance to Lodging
		Yield %	No. of Trials	Yield %	No. of Trials	Sown Oct./Dec.	Sown Jan./Feb.				Head Smut Race 1	S.C.M. Virus	Rust (*Puccinia purpurea*)	Leaf Blight (*Drechslera turcica*)	
Asgrow ..	Dorado E ..	100	17	98	7	MQ	Q	MT	Semi-open ..	Bronze ..	R	Red Stripe	R	S	**
	Dorado A ..	105	13	112	3	M	M	MT	Semi-open ..	Bronze ..	R	M	S	S	*
	Dorado TX ..	N.A.	—	N.A.	—	M	MS	MT	Open ..	Yellow ..	R	M	N.A.	N.A.	N.A.
	Dorado ..	97	19	107	10	S	MS	S	Open ..	Bronze ..	R	M	S	R	***
	Topaz ..	N.A.	—	N.A.	—	VS	S	MS	Semi-compact	Red ..	R	M	N.A.	N.A.	N.A.
DeKalb ..	B17	80	11	N.A.	—	Q	VQ	M	Semi-open ..	Red ..	HS	M	HS	S	*
	C42t	94	20	99	7	M	M	S	Semi-compact	Bronze ..	R	M	HS	S	***
	C43	94	8	113	7	M	MQ	MT	Open ..	Bronze ..	R	M	S	S	**
	X5065 ..	N.A.	—	N.A.	—	M	M	MT	Open ..	Red ..	R	M	N.A.	N.A.	N.A.
	E55e ..	92	16	98	8	MS	M	MS	Semi-compact	Red ..	R	M	S	S	***
	E57	95	28	107	15	MS	M	MT	Open ..	Bronze ..	R	M	S	S	****
	F64a ..	85	16	99	7	S	MS	T	Open ..	Bronze ..	R	M	R	R	****
Northrup King	NK006 ..	N.A.	—	N.A.	—	Q	Q	MS	Open ..	Red ..	R	M	R	S	**
	NK150 ..	N.A.	—	N.A.	—	Q	Q	MS	Open ..	Bronze ..	R	M	N.A.	HR	*
	NK250 ..	N.A.	—	N.A.	—	MQ	MQ	M	Semi-open ..	Bronze ..	R	M	N.A.	N.A.	**
	NK280 ..	N.A.	—	N.A.	—	M	M	M	Semi-open ..	Light-red ..	R	M	N.A.	N.A.	N.A.
	NK330 ..	N.A.	—	N.A.	—	MS	MS	M	Semi-open ..	Bronze ..	R	M	N.A.	N.A.	N.A.
Pacific Seeds ..	Pac001 ..	82	11	N.A.	—	Q	Q	S	Open ..	Red ..	S	M	HS	S	**
	Nugget ..	107	5	98	5	Q	Q	S	Open ..	Red ..	S	M	N.A.	S	***
	Goldfinger ..	96	19	101	11	MQ	MQ	MT	Semi-open ..	Bronze ..	R	M	S	R	**
	Goldrush ..	94	18	97	11	MQ	MQ	MT	Semi-open ..	Red ..	S	M	HR	S	***
	Pac710 ..	105	7	N.A.	—	M	M	MT	Compact ..	Red ..	R	M	R	HR	**
	Sovereign ..	93	5	N.A.	—	MS	MS	MT	Semi-open ..	Red ..	S	M	N.A.	S	***
	Sundowner ..	N.A.	—	N.A.	—	MS	MS	MS	Semi-open ..	Bronze ..	S	R	N.A.	N.A.	***
	Pac303 ..	N.A.	—	N.A.	—	S	S	T	Semi-compact	Red ..	R	Red Stripe	S	S	**
	Tropic ..	100	4	N.A.	—	S	S	T	Semi-open ..	Bronze ..	R	M	S	S	**
	Monsoon ..	N.A.	—	N.A.	—	VS	VS	T	Open ..	Red ..	R	M	N.A.	N.A.	**

Key

Time to Flowering

Q = Quick
MQ = Medium Quick
M = Medium
MS = Medium Slow
S = Slow

Lodging Behaviour Ratings

* = Below Average
** = Average
*** = Above Average
**** = Very Good Standability

Height

VT = Very Tell
T = Tall
MT = Medium Tall
M = Medium
MS = Medium Short
S = Short

Head

Open
Semi-open
Semi-compact
Compact
(Compact heads dry less rapidly and are more susceptible to head Caterpillars)

Head Smut

R = Resistant
S = Susceptible
HS = Highly susceptible

Leaf Rust

HS = Highly susceptible
S = Susceptible
R = Resistant
HR = Highly resistant
(These classes are relative to each other, the dividing line being somewhat arbitrary)

Sugarcane Mosaic Virus Reaction

M = Mosaic
Red Stripe
Red Leaf
R = Resistant

N.A.: Information is not available or the variety has not been fully tested in Departmental trials. In the yield comparison columns, the 'Number of Trials' shows the number of trials in which both Texas 610SR and the particular hybrid both appeared. The greater the number of trials used to calculate the average, the greater the reliability of results.

Guide to grain sorghum characteristics—continued

Seed Company	Hybrid	Mean Yield as % of Texas 610SR up to and including 1978–1979 Trials: Darling Downs		South Burnett		Time of Flowering		Height	Head	Grain Colour	Reaction to				Stand-ability or Resistance to Lodging
		Yield %	No. of Trials	Yield %	No. of Trials	Sown Oct./Dec.	Sown Jan./Feb.				Head Smut Race 1	S.C.M. Virus	Rust (*Puccinia purpurea*)	Leaf Blight (*Drechslera turcica*)	
Pioneer ..	Gem ..	102	6	114	3	MQ	MQ	MS	Semi-open ..	Light-red ..	R	M	HS	S	***
	Pride ..	103	16	106	11	M	MQ	S	Semi-open ..	Bronze ..	R	M	S	S	****
	Leader I ..	96	19	110	12	MS	MS	MS	Open ..	Bronze ..	HS	M	R	S	***
	Sunlover I ..	96	16	108	12	MS	MS	MS	Semi-compact	Bronze ..	HS	Red Leaf	R	R	****
	Leader SR ..	100	5	115	4	MS	MS	S	Open ..	Bronze ..	R	M	N.A.	N.A.	***
	Solo	101	3	110	4	S	S	M	Open ..	Bronze ..	R	R	R	R	****
	Big Red ..	99	13	108	8	S	S	M	Semi-compact	Bronze ..	N.A.	M	S	S	**
Yates	Yates 233 ..	91	13	N.A.	—	MQ	MQ	M	Semi-open ..	Bronze ..	R	M	S	R	**
	Yates 212 ..	97	33	93	14	M	M	MS	Semi-compact	Red ..	R	M	S	S	**
	SM5	N.A.	—	N.A.	—	M	M	MS	Open ..	Bronze ..	R	M	S	R	***
	SM8	105	9	114	8	M	M	MS	Semi-open ..	Bronze ..	S	M	S	R	****
	SM9	N.A.	—	N.A.	—	MS	MS	M	Open ..	Bronze ..	R	N.A.	N.A.	R	**
	Yates 266 ..	93	19	104	12	MS	M	M	Semi -open ..	Bronze ..	R	M	S	R	**
	SM10 ..	93	9	117	4	S	MS	MT	Semi-compact	Bronze ..	S	M	R	S	***
	Yates 275 ..	95	8	N.A.	—	S	MS	M	Semi-compact	Red ..	R	M	S	HS	**
Hylan ..	626	94	33	95	10	M	M	M	Compact ..	Red ..	R	M	S	S	**
	610SR ..	100	All	100	All	M	M	M	Compact ..	Red ..	R	M	S	S	**
	Star	N.A.	—	N.A.	—	M	M	M	Compact ..	Red ..	S	R	R	R	**
	Trojan ..	N.A.	—	N.A.	—	MS	MS	M	Semi-open ..	Bronze ..	S	M	N.A.	N.A.	N.A.
	Q5161 ..	100	25	105	16	MS	MS	M	Compact ..	Bronze ..	HS	Red Leaf	R	HR	****
	4X8	N.A.	—	N.A.	—	MS	MS	M	Semi-open ..	Bronze ..	S	M	N.A.	N.A.	N.A.
	671	96	20	102	5	S	S	M	Compact ..	Red ..	R	M	S	S	**
Panorama ..	610SR ..	100	All	100	All	M	M	M	Compact ..	Red ..	R	M	S	S	**
	Q5161 ..	100	25	105	16	MS	MS	M	Compact ..	Bronze	HS	Red Leaf	R	HR	****
Open Pollinated Variety	Alpha ..	71	46	84	8	S	S	MS	Semi-compact	Red ..	S	M	HS	R	****

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Red Leaf
R=Resistant

N.A.: Information is not available or the variety has not been fully tested in Departmental trials. In the yield comparison columns, the 'Number of Trials' shows the number of trials in which both Texas 610SR and the particular hybrid both appeared. The greater the number of trials used to calculate the average, the greater the reliability of results.

The Bentley cravat—an answer to self-sucking

by J. Edmunds and J. W. Cooper, Dairy Cattle Husbandry Branch.

SELF-SUCKING is a vice in cows. It can be so complete as to divert all of a cow's milk production to herself.

Some years ago, the late Mr R. D. Bentley a field assistant working at Biloela Research Station in the Dairy Section encountered this problem. It was with an experimental cow being fed on a low diet treatment. After some development, a successful restraint was derived and the cow wore it while in milk for the next 4 years to the end of her useful life.

Plate 2 shows the Bentley cravat being demonstrated on a young Friesian cow, some years later.

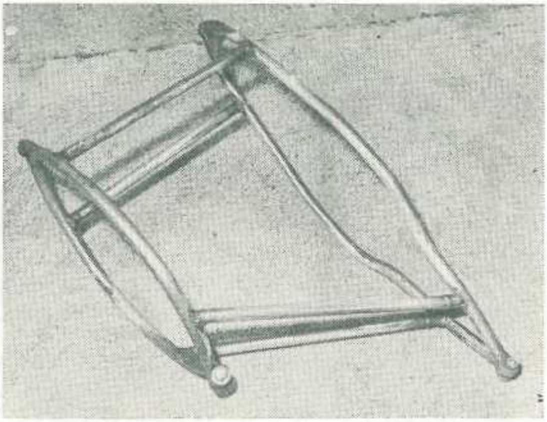


Plate 1. This photograph shows the cravat bolted together. It is made in halves, tailored to fit the animal. When worn, the animal cannot bend far enough to reach her udder. However, enough side to side head movement is retained to maintain balance and directional control. The measurements are quite critical, and are given for large breeds in figure 1.

Plate 2. The Bentley cravat in use.

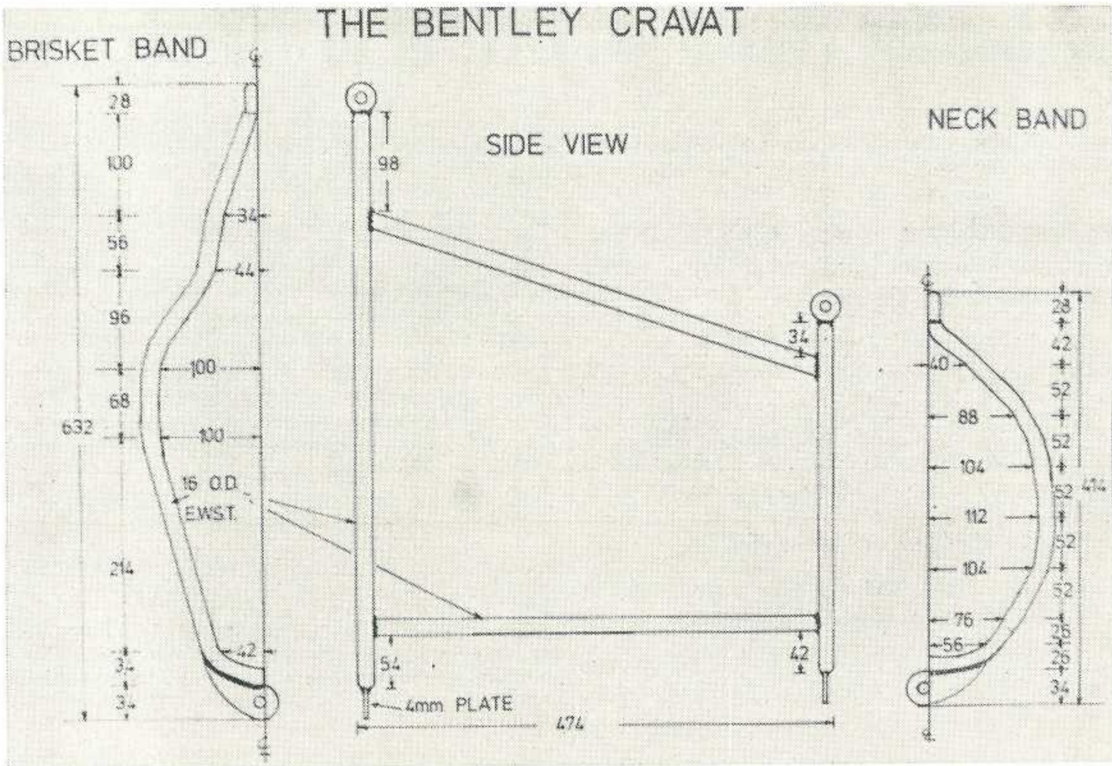


Figure 1.

Bovine Tuberculosis Free Herds as at 1-11-79

C. P. Adams, Warwick Park, Pratten.	MG
J. H. Anderson and Sons, 'Inverary', Yandilla.	PH
A. J. & M. A. Bell, Karingal, Millmerran.	PH
W. H. Bowden, Brendale Braford Stud.	BF
Cherokee Group, Tanby, via Yeppoon.	BM
B. L. & M. O. Christensen, 'Elavesor', Rosevale, via Rosewood.	PH
P. J. Evans, M.S. 28, Dragon Street, Warwick.	FS
B. Goddard, 'Inverell', Mt. Tyson.	AS
W. G. Henschell, 'Yarranvale', Yarrawlea.	PH, AIS
H.M. State Farm, Capricornia Stud, Etna Creek, via Rockhampton.	JS
Klein Bros., Kapleton A.I.S. Stud, Ma Ma Creek, Grantham.	AIS
W. Leonard and Sons, Welltown, Goondiwindi.	PS
R. G. McDonald, 'Buffelvale', M.S. 807, Mundubbera.	JS
C. R. & J. L. Marquardt, Cedar Valley A.I.S. Stud, Wondai.	AIS
W. H. C. Mayne and Sons, 'Gibraltar', Texas.	AG
E. I. & S. Pacholke, 'Sunnylawn', Braford Stud, M.S. 74, Clifton.	BF
K. J. & D. McPerrett, Creek Street, Bundamba.	MG
R. S. & G. C. Postle, 'Yarrallaside', 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
J. & S. C. Siebenhausen, 'Merriton', M.S. 195, Pittsworth.	AIS
E. J. Smith, 'Hillcrest', Borallon.	AS
University of Queensland, Veterinary School, St. Lucia.	DM
A. R. & D. G. Vonhoff, M.S. 918, Toowoomba.	FS

KEY

AG—Angus
AS—Ayrshire
AIS—AIS
BF—Braford
BM—Brahman
CN—Chianina
DM—Droughtmaster
FS—Friesian
GS—Guernsey
HF—Hereford
JS—Jersey
MG—Murray Grey
PH—Poll Hereford
PS—Poll Shorthorn
SG—Santa Gertrudis

Cotton survey shows skip row planting give better yields

A survey of dryland cotton producers in the Dawson-Callide and Bauhinia Downs areas has shown a marked yield advantage for skip row plantings over solid planted crops.

The survey was conducted by D.P.I. Agricultural Economist in Rockhampton, Mr Ross Lobegeiger. It involved a questionaire mailed to all 20 dryland cotton growers.

Mr Lobegeiger said crops that were solid planted rather than skip row planted have very poor yields.

On some properties, there was at least a 50% reduction in yield.

All low-yield crops were moisture stressed. Weeds were a problem with two crops that did not have pre-emergent herbicide treatments.

All high-yielding crops had very good subsoil moisture.

Even with good soil moisture and 75 mm of follow-up rain, the skip row crops on one property outyielded the solid plant crops by 100%.

Three of the four high yield crops were sprayed for insect control with three to five ground sprayings and two aerial sprayings.

Yield differences in this group between the sprayed and unsprayed crops averaged 68 kg per ha, which, at $1.18 a kg, meant an extra return of $80 per ha.

Yields over the 12 properties ranged from 277 kg per ha to 890 kg per ha. The average was 624 kg per ha.

Three properties were below 500 kg per ha and four properties above 740 kg per ha.

Gross margins (gross returns less variable production costs) and excluding cartage, would average $345 per ha, $626 per ha, and $892 per ha for each of the respective yield groups.

Seasonal conditions were generally very good for crop growth with most properties having reasonable sub-soil moisture before planting.

On six properties, cotton had been grown on the same area the previous year.

Four properties had grown sorghum on the area, and two were previously virgin cropping land.

Land preparation varied considerably with the type of implements used and the number of operations.

Disc ploughs, offset discs and scarifers were the most widely used implements.

The number of operations ranged from three to six with mostly one ploughing, two offset discings and one to two scarifyings.

The number of inter-row cultivations ranged from one to four, with two being the most common.

Trifluralin, a pre-emergent herbicide, was used on only six properties. Average yield was 703 kg per ha, compared with 544 kg per ha on the other six properties.

Four of the 12 properties did not use any form of insect control and their average yield was 568 kg per ha.

Two properties used aerial spraying only and the balance of the properties used two to three ground sprays and two to three aerial sprays.

The average yield of the crops sprayed was 652 kg per ha.

Aerial application costs varied from $3 to $5 per ha.

For the seven properties that paid cartage on their cotton, the cost ranged from 10 to 29 cents per bale per km. The average was 20 cents per bale per km.

Mr Lobegeiger pointed out that the survey was carried out for one particular cotton crop for which general growing conditions were excellent.

Long term average crop yields could be expected to fall in the range of the below-average group in the survey (250 to 500 kg per ha).

Copies of the survey report were available at D.P.I. offices in Central Queensland.

Wattles in South-eastern Queensland with flowers in globular heads . . . part 1

by Beryl A. Lebler, Botany Branch

IN South-eastern Queensland, there are 42 native wattles with flowers in globular heads. Most are widespread but five occur in only a few localities and six are restricted to single localities. They vary in size from sub-shrubs less than 0·3 m high to rain-forest trees 30 m high.

The phyllodes of different species vary greatly in shape, size and texture. Some are terete or linear-subulate but the majority are vertically flattened, linear to ovate or oblong, triangular falcate or falcate. Some are pungent pointed. They vary in length from 0·2 cm to 15 cm. The texture ranges from stiff and leathery to soft and thin in a few species.

The phyllodes of some species have only one prominent longitudinal nerve while others have many. A few with only one main nerve have pinnate secondary nerves. Two wattles with two or more prominent veins have reticulate secondary venation and anastomosing venation is seen in only a few multinerved species.

The colour of inflorescences ranges from almost white to pale creamy-yellow and lemon-yellow to bright golden-yellow. Many wattles have little or no perfume, some have a faint sweet perfume and four are hightly perfumed.

Variation is also found in the pods. In most species, they are linear, thin and flattened usually with longitudinal seeds. Two have flat, oblong pods with transverse seeds.

These wattles can be separated into two groups, one with phyllodes not vertically flattened but more or less terete or linear-subulate and a much larger group with phyllodes flattened in a vertical plane.

Field Key to Wattles with Flowers in Globular Heads

A. Phyllodes not vertically flattened (± terete or linear-subulate)

1. Phyllodes less than 1·5 cm long 2
   Phyllodes more than 2 cm long 3

2. Phyllodes about 1 cm long, 5 to 7 in a whorl, recurved at the end. Heads bright golden-yellow .... *Acacia baueri*

   Phyllodes 0·4 to 0·8 cm long, crowded and scattered or in irregular whorls. Heads almost white .... *Acacia brunioides*

3. Phyllodes 2 to 8 cm long; terete but with 4 veins giving a 4-sided appearance. Heads pale lemon-yellow .... *Acacia quadrilateralis*

   Phyllodes 10 cm or more long, obscurely nerved. Heads deep buttercup-yellow .... *Acacia juncifolia*

B. Phyllodes vertically flattened

1. Phyllodes with 1 prominent vein.......2
   Phyllodes with more than 1 prominent vein.......27

2. Heads solitary and axillary.......3
   Heads in axillary racemes, sometimes condensed so that they appear to be in axillary clusters.......10

3. Stipules spinescent and spreading widely. Phyllodes 1 to 2 cm long, with an undulate lower margin. Heads bright golden-yellow on peduncles about 1 cm long....... *Acacia paradoxa*
   Stipules not spinescent.......4

4. Branchlets with yellowish, tuberculate, resinous ribs. Phyllodes linear and crowded, less than 0·5 cm long. Heads bright golden-yellow....... *Acacia resinicostata*
   Branchlets without resinous ribs. Phyllodes not linear, more than 0·5 cm long.......5

5. Phyllodes more or less triangular, broadest at the base and tapered gradually to a pugent point.......6
   Phyllodes sickle-shaped or obliquely truncate at base.......8

6. Heads with bracteoles with long points projecting beyond the buds; peduncles stout. Phyllodes up to 0·3 cm broad ending in a stiff, pungent point. Heads pale golden-yellow....... *Acacia saxicola*
   Heads without bracteoles projecting beyond buds; peduncles slender. Phyllodes less than 0·2 cm broad.......7

7. Phyllodes to 1·5 cm long, less than 0·1 cm wide. Peduncles 0·2 cm long. Heads relatively few-flowered, golden-yellow....... *Acacia brachycarpa*
   Phyllodes to 1·1 cm long, more than 0·1 cm wide. Peduncles less than 0·2 cm long. Heads with 20 to 35 flowers, pale cream....... *Acacia ulicifolia*

8. Phyllodes sickle-shaped or oblong-falcate, to 3 cm long. Margins thickened and with tuberculate teeth. Branches and phyllodes scabrous. Heads almost white....... *Acacia hispidula*
   Phyllodes broadly ovate obliquely truncate at base. Branches hairy. Heads pale creamy-yellow or bright golden-yellow.......9

9. Phyllodes asymmetrical, midrib excentric, produced into a hooked point. Margins thickened. Heads bright golden-yellow....... *Acacia uncinata*
   Phyllodes obliquely truncate at base. Lower edge straight and ending in a pungent point. Heads pale creamy-yellow....... *Acacia hubbardiana*

10. Bipinnate juvenile foliage retained often to the flowering and fruiting stage. Phyllodes blue-green, leathery, oblong to almost spathulate. Heads pale creamy-yellow....... *Acacia attenuata*
    Phyllodes only at the flowering and fruiting stage.......11

11. Heads clustered in axils on peduncles up to 2·5 cm long, or in condensed racemes less than 2 cm long. Phyllodes falcate-lanceolate and leathery. Heads pale cream and strongly scented....... *Acacia fasciculifera*
    Racemes more than 2 cm long.......12

12. Phyllodes glaucous or pale.......13
    Phyllodes green.......21

13. Tree to 4 m, minutely pubescent. Phyllodes mealy glaucous, ovate to oblong, to 4 cm long. Heads golden-yellow on racemes twice as long as phyllodes....... *Acacia podalyriifolia*
    Shrubs or small trees with glabrous phyllodes.......14

14. Branches pendulous; phyllodes pale or glaucous, straight or nearly so, oblong linear or lanceolate, to 15 cm long. Heads pale creamy-yellow in racemes of 3 to 8 heads .... *Acacia salicina*

Branches not pendulous; phyllodes linear to lanceolate, falcate-lanceolate or obliquely obovate and obtuse 15

15. Tree to 6 m. Phyllodes obliquely obovate, to lanceolate, assymetrical, to 18 cm long, 9 cm wide, upper margin sometimes with triangular projections terminating in glands. Heads lemon-yellow in racemes up to 8 cm long .... *Acacia bancroftii*

Phyllodes not obliquely obovate 16

16. Phyllodes falcate, gland slit-like at base of phyllode. Heads creamy-white, in racemes 5 to 6 cm long .... *Acacia falcata*

Phyllodes linear, oblong or falcate-lanceolate. Gland usually prominent, at least 0·5 cm from base 17

17. Young shoots and inflorescences with dense covering of golden hairs. Phyllodes falcate, to 3·5 cm wide, midrib closer to upper margin. Heads pale creamy-yellow .... *Acacia falciformis*

Young shoots and inflorescences glabrous or hairs not golden. Heads pale yellow or bright golden 18

18. Phyllodes linear or almost lanceolate, to 13 cm long and 0·6 cm wide. Racemes much shorter than phyllodes and at first enclosed in imbricate bracts. Heads pale lemon or cream, sweetly perfumed .... *Acacia suaveolens*

Phyllodes less than 10 cm long, 0·2 cm to 2 cm wide 19

19. Phyllodes linear or falcate-lanceolate leathery, to 13 cm long, 2 cm wide, gland about 1 cm from base. Heads pale creamy-yellow, not perfumed .... *Acacia penninervis*

Phyllodes linear or oblong-elliptical to obovate 20

20. Phyllodes up to 6 cm long, as narrow as 0·2 cm, widest above the middle. Heads bright golden-yellow, strongly perfumed. Racemes often longer than phyllodes .... *Acacia decora*

Phyllodes oblong-elliptical to obvate 2 to 3 cm long, midrib closer to upper margin. Heads golden-yellow with no perfume. Racemes much longer than phyllodes .... *Acacia buxifolia* subsp. *publiflora*

21. Phyllodes leathery, spreading or reflexed, with long hairs on stems and margins of phyllodes. Racemes much longer than phyllodes. Heads vivid golden-yellow .... *Acacia leichhardtii*

Phyllodes not reflexed. Long hairs absent from branchlets 22

22. Phyllodes thick and rather fleshy, with thickened margins, incurved-falcate or ovate-lanceolate or oblong, 3·6 to 5 cm long. Heads pale creamy-yellow .... *Acacia myrtifolia*

Phyllodes linear or oblong to lanceolate-falcate or linear-lanceolate up to 17 cm long 23

23. Tree to 9 m, phyllodes linear-lanceolate to 13 cm long, with obscure pinnate venation and at least one raised marginal gland about 0·5 cm from the base. Heads vivid golden-yellow .... *Acacia neriifolia*

Shrubs or trees to 7 to 8 m, phyllodes linear or oblong to lanceolate falcate. Heads not golden-yellow 24

24. Phyllodes slightly leathery in texture and pale midrib and margin and prominent pinnate venation, often with a secondary vein near the base, ending in a gland. Heads either almost white or pale creamy-yellow .... *Acacia penninervis*

Heads lemon-yellow, lime-yellow or pale creamy-yellow 25

25. Phyllodes linear to 17 cm long and 0·5 cm wide, with 1 or 2 inconspicuous glands. Heads pale creamy-yellow .... *Acacia adunca*
Phyllodes 10 cm long and 0·5 cm wide 26

26. Twigs glabrous or pubescent with short hairs. Cilia usually present on margins of phyllodes. Phyllodes to 5 cm long and 0·2 to 0·5 cm wide. Heads lemon-yellow .... *Acacia fimbriata*
Whole plant glabrous. Phyllodes to 7·5 cm long, and less than 0·2 cm wide. Heads lime to lemon-yellow .... *Acacia perangusta*

27. Phyllodes triangular-falcate to 1·6 cm long, lower nerve more or less straight, running into the apex, other nerves running on to the upper margins. Heads bright golden-yellow 28
Phyllodes falcate, oblong or broadly lanceolate. Heads pale creamy-yellow 29

28. Phyllodes 2 to 4 times as long as broad, glabrous or hairy like the branches. Peduncles usually shorter than the phyllodes .... *Acacia amblygona*
Phyllodes about as long as broad, with spreading hairs on nerves and margins. Peduncles as long as or longer than the phyllodes .... *Acacia pravifolia*

29. Phyllodes with 2 or 3 prominent nerves 30
Phyllodes with more than 3 prominent nerves 32

30. Phyllodes with 2 prominent nerves, falcate, oblong or lanceolate, 7·5 to 10 cm long, thin-textured, conspicuous marginal gland below the middle. Heads pale creamy-yellow .... *Acacia binervata*
Phyllodes with 3 prominent nerves 31

31. Stellate hairs present on young shoots. Phyllodes 9 to 24 cm long, 2 to 4 cm broad, prominent glands present on margins at ends of veins. Heads pale primrose-yellow .... *Acacia flavescens*
Plant glabrous. Phyllodes broadly lanceolate, much narrowed to each end, to 13 cm long and 6 cm broad. Heads almost white .... *Acacia bakeri*

32. Plants sticky, phyllodes less than 0·5 cm wide 33
Plants not sticky, phyllodes more than 0·5 cm wide 24

33. Phyllodes oblong, lanceolate or linear-lanceolate, about 3 cm long with numerous fine veins. Heads deep lemon-yellow in racemes with 2 or 3 branches .... *Acacia ixiophylla*
Phyllodes narrow linear, 5 to 8 cm long, usually ending in a small, hooked point. Heads lemon-yellow, solitary or in pairs .... *Acacia viscidula*

34. Twigs flattened and glabrous. Phyllodes oval elliptic or oblong, obtuse, 7 to 10 cm long, 1 to 4 cm wide, with about 9 prominent nerves. Heads rich, bright yellow .... *Acacia complanata*
Twigs angular or terete 35

35. Twigs pubescent. Phyllodes stiff, or very firm in texture 36
Twigs glabrous or young shoots minutely pubescent. Phyllodes either leathery or thin-textured 37

36. Phyllodes rigid, falcate-lanceolate, 10 to 15 times as long as broad. Heads almost white .... *Acacia baeuerlenii*
Phyllodes firm in texture, falcate-lanceolate, 6 times as long as broad. Heads lemon-yellow .... *Acacia venulosa*

37. Secondary venation inconspicuous, veins not anastomosing. Phyllodes leathery, pale or glaucous, curved, tapering to each end; 10 to 23 cm long, 1 to 2 cm wide. Heads in condensed axillary racemes like a cluster, straw-yellow in colour .... *Acacia harpophylla*
Secondary venation conspicuous and anastomosing 38

38. Twigs terete, with a glaucous bloom easily rubbed off. Phyllodes thin in texture, much narrowed at base. Heads small and dense, pale creamy-yellow in branched axillary racemes or panicles........ *Acacia implexa*

Twigs angular, green, some short white hairs usually present. Phyllodes thin in texture, falcate-oblong or almost lanceolate. Heads large and dense, solitary or in a branched raceme which can be glabrous, scurfy or pubescent. Heads creamy-yellow...... *Acacia melanoxylon*

Flowering seasons

Summer	December to February
Autumn	March to May
Winter	June to August
Spring	September to November

Flowering Times

Season	Almost White to Pale Creamy-yellow	Lemon to Pale Golden-yellow	Bright Deep Golden-yellow
Spring	*A. bakeri* *A. binervatea* *A. hubbardiana* *A. melanoxylon*	*A. blakei* *A. viscidula*	*A. granitica*
Spring to summer		*A. irrorata*	
Summer	*A. fasciculifera* *A. implexa*		*A. uncinata*
Autumn to winter ..	*A. attenuata* *A. baeuerlenii* *A. falcata* *A. salicina*	*A. adunca* *A. bancroftii* *A. cincinnata* *A. flavescens* *A. glaucocarpa* *A. leiocalyx* *A. quadrilateralis* *A. saxicola* *A. suaveolens*	*A. farnesiana* *A. julifera* *A. leichhardtii*
Winter	*A. falciformis*	*A. orites*	*A. brachycarpa* *A. podalyriifolia* *A. pravifolia* *A. resinicostata*
Winter to spring	*A. brunioides* *A. myrtifolia* *A. ulicifolia*	*A. concurrens* *A. floribunda* *A. fimbriata* *A. harpophylla* *A. ixiophylla* *A. perangusta* *A. sophorae* *A. venulosa*	*A. amblygona* *A. buxifolia* subsp. *pubiflora* *A. decora* *A. juncifolia* *A. leucoclada* subsp *argentifolia* *A. neriifolia* *A. paradoxa* *A. sophorae* *A. uncinata*
Flowering spasmodically throughout the year	*A. hispidula* *A. longissima*	*A. oshanesii*	*A. baueri*

Minor insect pests of macadamia—part 1

THE insects referred to here as minor pests are but a few of the many species known to feed on macadamias.

Some occur sporadically in large numbers and may cause severe damage when not controlled (for example, red-shouldered leaf beetle at flowering, lacebug in elevated areas, flower thrips during dry seasons and orange fruit borer in nurseries). Most, however, are unimportant on macadamias as they are present usually only in low numbers. Even when large populations occur, damage is rarely significant.

Predominantly flower pests

Redshouldered leaf beetle

The redshouldered leaf beetle (*Monolepta australis* (Jacoby); Family Chrysomelidae) is a native insect which occurs sporadically in plague numbers any time during the year but is most common during spring and summer, particularly after rain. The beetle may completely destroy the flower racemes. Young nuts and lush foliage are also attacked. Often, individual trees or groups of trees are heavily infested while adjacent trees are largely free of damage.

The beetles are about 6 mm long and 3 mm wide, light yellow with a cherry-coloured band across the base of the wing covers and a similarly coloured spot in the middle of each wing cover.

Lacebug

The lacebug (*Ulonemia* sp.; Family Tingidae) is a tiny insect which sometimes attacks the tender foliage and flower racemes of macadamias grown in elevated areas. The adults and nymphs feed by sucking the plant sap and extensive damage to the flowers can result in poor nut set.

by D. A. Ironside, Entomology Branch.

The winged adult is light to dark brown and 3 to 4 mm long. Its nymphs are wingless, oval in shape and vary in colour from yellow to reddish-brown.

Black citrus aphid

The adults of the black citrus aphid (*Toxoptera aurantii* (Boyer de Fonscolombe); Family Ahpididae) are black, soft-bodied insects, about 2 mm long. They feed by sucking plant sap and severe infestations may cause death of infested flower buds and distortion of young foliage. The insect occurs mainly during winter and spring, but is of little importance as natural enemies usually give satisfactory control.

Flower thrips

Flower thrips (*Scirthothrips* sp.; Family Thripidae) are tiny, slender, yellow to light brown insects with rasping and sucking mouthparts. During dry seasons, heavy infestations can cause severe damage to flowers, young nuts and new growth. Feeding causes brown or bronze discolourations, stunting of damaged tissue and even death of severely infested racemes.

Hairyline blue butterfly

The larva of the hairyline blue butterfly (*Erysichton lineata lineata* (Murray); Family Lycaenidae) is the most common of a number of lycaenids which attack the flower buds. It destroys the flowers by eating a neat, round hole in the bulbous end of each bud. Heaviest infestations normally occur during autumn and winter.

The slug-like larvae are 10 to 11 mm long when fully grown and vary in colour from light green to pinkish-brown depending on the food source.

Flower looper

The flower looper (*Gymnoscelis subrufata* Warren; Family Geometridae) is the most common of numerous looper species which

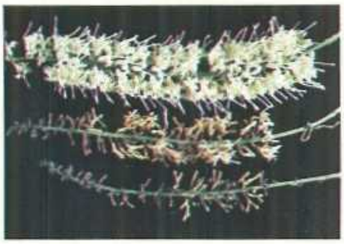
Minor insect pests

Redshouldered leaf beetles on a macadamia leaf.

Macadamia flower buds infested with redshouldered leaf beetle.

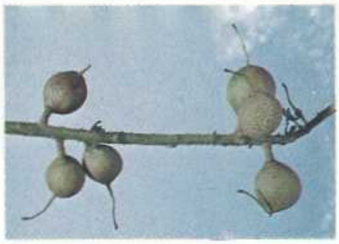
Redshouldered leaf beetle damage to new growth on macadamia.

A colony of lacebugs damaging a flower raceme.



Macadamia flowers damaged by the lacebug. The upper raceme is undamaged.

Macadamia flower racemes infested with black citrus aphid.



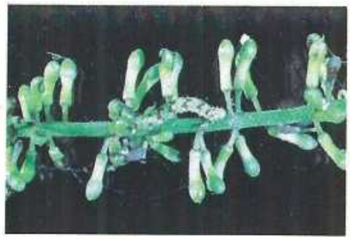
Young macadamia nuts (10 mm diam.) showing damage by flower thrips.

Terminal leaves showing damage by flower thrips.

Eggs of the hairyline blue butterfly on flower buds of macadamia.

Mature hairyline blue butterfly larvae on flower buds.

# of macadamia—part 1



Flower looper and its damage to flower buds.

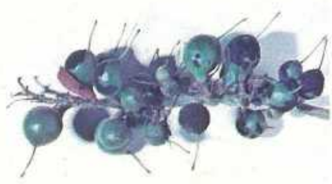
Photographs by D. A. Ironside, Entomology Branch

Yellow peach moth larvae on a piece of macadamia nut husk.

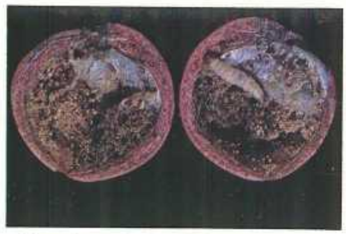
Macadamia nut damage by yellow peach moth larva.

Larva of Cornelian butterfly and its damage to a macadamia nut.

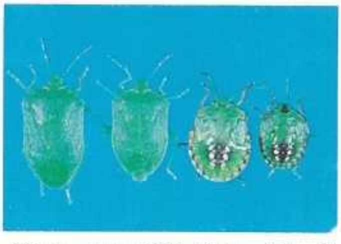
A mature larva of the pencilled blue butterfly.



Pencilled blue butterfly larva and its damage to macadamia nuts.



Kernel grub in a destroyed nut.



Green vegetable bug; left to right; adult female and male, and two nymphal stages.

Redbanded thrips damaging a macadamia nut husk.

Macadamia nuts damaged by greenhouse thrips.

feed on macadamia flowers. Its eggs are deposited mainly on the flower buds and the larvae feed on the bulbous end of the buds. When fully grown, the larva is about 15 mm long, light green in colour with brown, wedge-shaped marks along the body. It is most active on autumn and winter flowers.

Predominantly nut pests

Yellow peach moth

The larva of the yellow peach moth (*Dichocrocis punctiferalis* (Guenée); Family Pyralidae) resembles that of the macadamia nut borer but grows slightly larger and the dark spots on the body are larger and more oval. It causes similar damage to the macadamia nut borer but has a preference for nuts in clusters.

Cornelian butterfly

The larva of the cornelian butterfly (*Deudorix epijarbas diovis* Hewiston; Family Lycaenidae) tunnels into the nut and eats out the kernel, a single larva being capable of destroying several nuts. Infestations occur on developing nuts mainly from November to March. The stout-bodied slug-like larvae grow to about 35 mm long and are purplish-brown with orange and green markings.

Pencilled blue butterfly

Larvae of the pencilled blue butterfly (*Candalides absimilis* (Felder); Family Lycaenidae) attack flower buds, lush foliage and newly set nuts. Most damage results from feeding on the young nuts. When fully grown, the slug-like larva is about 16 mm long and its colour varies from green to red depending on what it has been feeding on.

Kernel grub

The moth of the kernel grub (*Cataremna* sp.; Family Pyralidae) deposits its eggs on nuts in the field prior to harvest. This insect can gain access to the kernel only when the shell has been previously damaged by other insects such as nut borer or spotting bug, or when a nut has an open micropyle. Numerous creamy-coloured larvae may be found in a single nut. They soon destroy the kernel and, when fully grown, pupate in the nut.

Green vegetable bug

Large numbers of the green vegetable bug (*Nezara viridula* (Linnaeus); Family Pentatomidae) are sometimes found on macadamias. The adult and nymphal stages (except for the first stage nymph) feed on macadamia nuts at all stages of nut development. However, the injury is not usually recognized until the nuts have been shelled when spotting of the kernels becomes evident. Feeding sites are mostly localized, circular and characterized by a dry, cottony, discoloured depression.

Redbanded thrips and greenhouse thrips

Redbanded thrips (*Selenothrips rubrocinctus* (Giard)) and greenhouse thrips (*Heliothrips haemorrhoidalis* (Bouché); Family Thripidae) at times build up to large numbers on nuts, extensively damaging the outer husks. Adults of both species are slender, black insects about 2 mm long. The immature stages of the redbanded thrips are easily distinguished by their light yellow colour and a bright orange band. Infestations are sporadic.

Cattle fencing

FENCING is one of the most expensive and essential items of property development.

This article describes the materials used, specifications and construction of fences and associated structures such as gates and grids.

Electric fencing is not included. K. F. Howard's bulletin 'Permanent Electric Fencing for Cattle and Sheep' provides a detailed guide to this topic and is available from the Queensland Department of Primary Industries. Electric fencing is substantially cheaper to construct than any other form of fencing, but does require more frequent attention. It should always be considered before embarking on new fencing or reconditioning old fences. But where it is considered unsuitable then some form of the fencing described in this article should be selected.

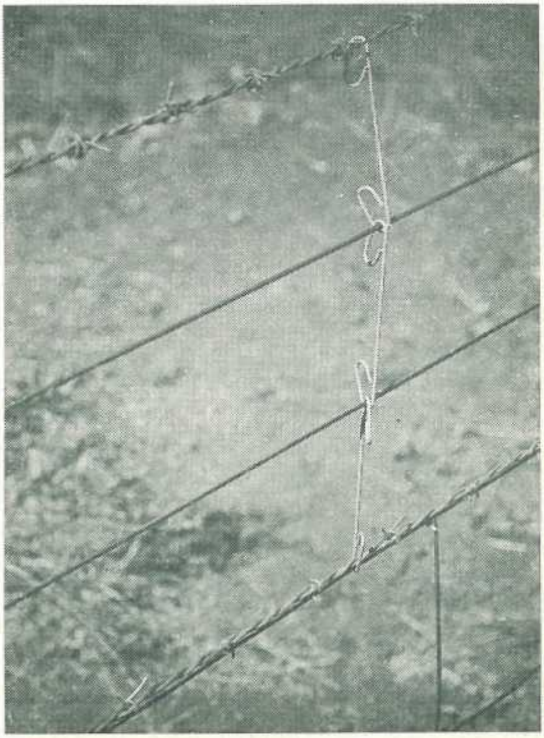
No fence is completely stock proof. The purpose of this bulletin is to provide some guidance in selecting the most suitable specification, to assist in calculating costs and materials, and to describe methods of construction that will give adequate stock control at a reasonable cost.

Types of fences

1. In this section conventional, suspension and fabricated fencing will be discussed. The situation for which each is most suited, quantities of materials and the merits of each will be outlined. Also, a basis for comparing the various fences on cost will be given.

2. Suspension fencing uses fewer posts, and is therefore substantially cheaper in materials and labour than conventional fencing. The wire is strained to a high tension over a long distance, and between the strainer posts can run freely through the intermediate post. The following situations are not suitable for suspension fencing and a conventional fence is preferable:

- Very broken country.
- Areas where heavy growth of twining legumes tends to pull down fences with long spans between posts.
- Country where large soil movements (which cause posts to lay over) occur.
- Areas where heavy concentrations of cattle occur, such as at watering points in large paddocks.
- Short length of fencing (anything under 200 m).



Coupling clips can be used to connect single wires to fabricated fencing. This prevents excessive sag in long spans of suspension fencing.

by A. J. Boorman, Beef Cattle Husbandry Branch

Conventional fencing

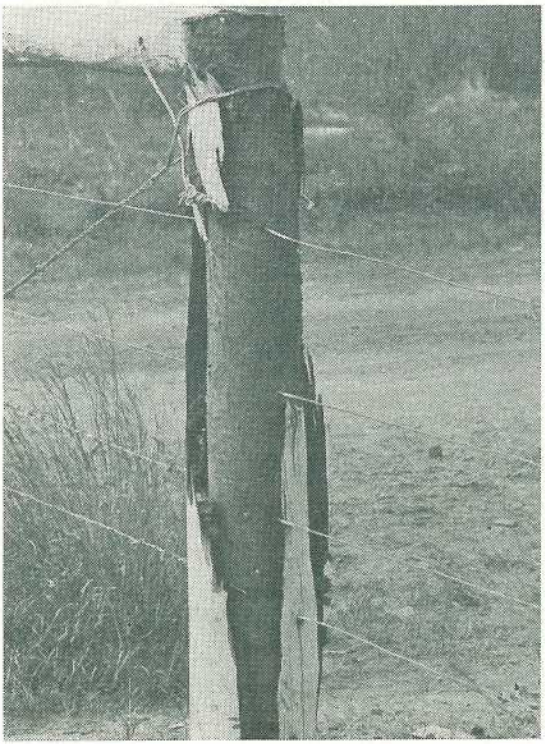
POSTS

3. The common post spacings in conventional fences are 3·6 m, 5·5 m and 6·4 m (see table 1 for number required per km). 6·4 m is quite adequate in most situations. Only very heavy stock pressure or very broken country necessitates closer spacing.

4. Both 1·65 m and 1·8 m steel posts and wooden posts are commonly used in conventional fences. Heavier posts can be spaced further apart (see paragraph 42).

WIRE

5. Conventional fences for cattle are usually made with either three or four wires, either all barb or a combination of barb and plain. Four barbed strands are usually unnecessary. Barbed wire should be 2·5 mm or 1·6 mm. For plain wire use 2·5 mm. 4·0 mm plain is not necessary. A four strand fence with two plain wires provides the most economical and stockproof fence. Three strands may be sufficient for large paddocks lightly stocked or where soil type and topography necessitates close post spacings. 4·00 mm plain wire is seldom used in cattle fences today.



Selection of fencing materials requires careful consideration.

Suspension fencing

6. The suspension fence as it is generally known in Queensland has two features which distinguish it from conventional fences. These are the distance between posts and the droppers inserted between the posts. In all other respects (that is, in the type and number of wires used, the tie wire and in the height the posts stand out of the ground) it resembles a conventional fence.

7. The outstanding feature of the suspension fence is its flexibility under pressure. In addition, it sways and whips for some distance from the point of impact. This extreme sensitivity to pressure seems to make cattle reluctant to come in contact with it.

8. When the top wires of the fence are moved out of line, the bottom ones move in the opposite direction, thus moving against whatever is applying the pressure at the top. The reverse situation also applies. When the pressure is released the span of fencing takes on a savage beating action. The panels on either side also sway and whip.

9. If cattle try to crawl under the fence they have to lift the weight of all the wires in the fence. This and the whippiness of the fence is a strong deterrent.

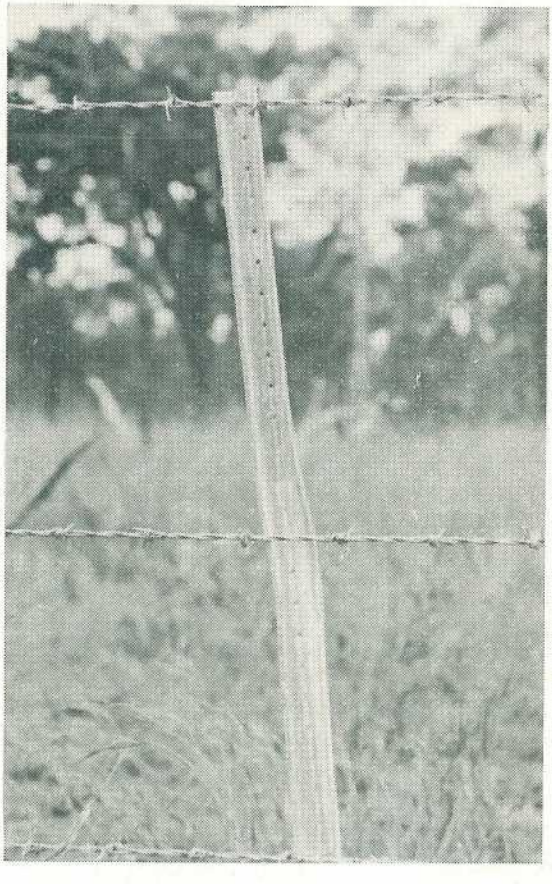
10. Wind-blown weeds (rowly-powly in Queensland) tend to work under the fence instead of piling up against it. This should be a distinct advantage.

11. However, if maintenance is not adequate with suspension fences, wire sag can be a problem (see paragraph 166).

POSTS

12. The most common post spacing with plain and/or barbed wire fences is 30 m. A substantial number of fences, however, are also built with 20 m panels. In the U.S.A. distances up to 45 m have been used.

Above and right. Waratah high tensile steel fence droppers are easier to see than wire droppers but more difficult to straighten when damaged.



13. In selecting a post spacing, remember that closer spacings make the fence more rigid and that this decreases the flexibility and whipping qualities of the fence and may make it less effective. Minimum post spacing on level ground should be 30 m (see table 1 for number of posts required per km).

DROPPERS

14. Many types of droppers are used. Their main purpose is the same whatever the design: to maintain spacings between wires.

15. A distance of 6 m to 7.5 m between droppers, depending on post spacings, should be adequate if the wires have been strained to give a final tension of 1.33 kilo-newtons (see table II for number of droppers required per km).

WIRE

16. Suspension fences on cattle properties are usually made with either three or four wires.

Fabricated fencing

17. Fabricated fencing, particularly ring lock and hinged joint, has been used for many years in sheep fences. It has been used for a shorter period in sheep and cattle fences. Its use on cattle properties is comparatively recent in Queensland.

18. This type of fencing is easily damaged by cattle especially bulls. It may also be damaged by emus and kangaroos. These animals usually try to go over the top selvedge. This causes crushing of the fence.

19. Fabricated fencing is susceptible to pig damage but when used in cattle fences it is less susceptible than when used in the combination sheep and cattle fencing which must have its lower wires close to the ground. Bulls will fight through a fence and can tear up long lengths of fencing. This type of damage and the type of damage caused by high speed impacts such as when a heavy animal hits the fence at speed are difficult to repair.

20. The major problem of fabricated fencing occurs when undulating or broken country must be traversed. The wire can be fitted to moderate curves but with sharp curves, gullies or ridges etc. one side of the wire will be slack. Some slackness can be taken up but if too much slackness occurs it may not be possible to take up sufficient to make the fence stock proof. In this case, single wire fencing is the only reasonable alternative (see appendix V for notes on overcoming problems with fabricated fencing).

21. Fabricated wire does not appear to offer any advantages over plain or babbed wire and because of the problems associated with its use it is not justifiable unless or until it is cheaper to buy and erect than plain or barbed wire.

Posts

22. Post spacings with fabricated fencing vary from 3.6 m to 30 m. On cattle properties the most common post spacings are 20 m and 30 m, but where sheep and cattle are run together post spacings of 15 m and 20 m are common.

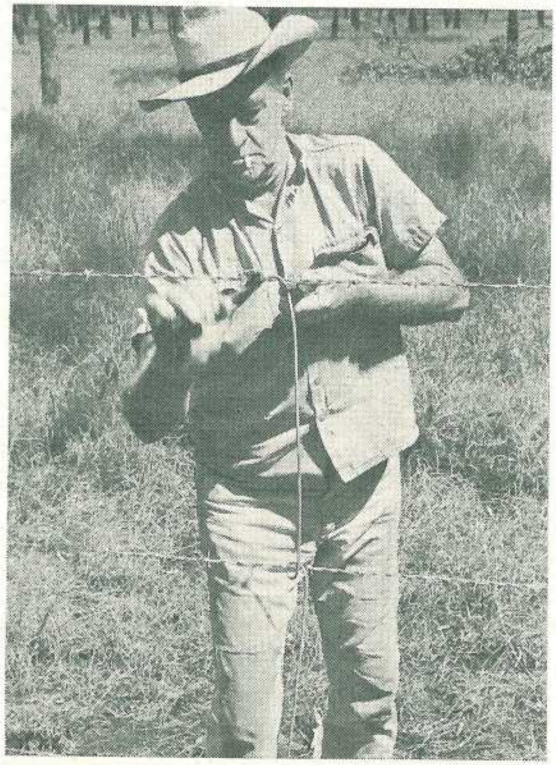
23. If conventional post spacings are used either 165 cm or 180 cm steel posts can be used but once post spacings get to 15 m or more only 180 cm posts are satisfactory.

Couplings

24. Where wide post spacings are used the fabricated wire is combined with either plain or barbed wire. Couplings can be used to connect the two types of wire. The couplings are made commercially in a range of sizes. They maintain the spacing between the two fence components and thus help to prevent stock penetration.

Wire

25. Fabricated fencing wire for cattle is available in a number of designs (table VIII). All hinged joint has 2.5 mm line wires while ring lock has either all 2.5 mm line wires or a combination of 2.5 mm and 2.8 mm line wires. Vertical wires are woven between the line wires to produce the final product.



Bill Hassal of 'Medowbank', Mt. Garnet, makes his own droppers modelled on the lightening dropper.

26. Where fabricated wire is used in a suspension fence it is important to remember, as with single wire fences, that it is the flexibility and whipping qualities of a suspension fence that makes it effective. Flexibility and whippiness is enhanced by long, even panels and minimum post spacings on level ground should be 30 m.

Fencing costs

27. The aim of this section is to give a basis for comparing conventional post and wire fences with suspension fences on cost. Information is presented in tabular form. The costs used are current as at January 1978 and presumably will date quickly. Graziers and managers can quickly update costs by using the physical data in the tables and altering prices as appropriate.

28. In preparing the tables, it was assumed that the number and type of strainers used per kilometre would be the same for each type of fence and therefore strainers are not costed. The type of strainer needed at a particular position varies with position in the fence (end assemblies are different to corner assemblies and line strainers) and also with the soil type. Thus strainer costs depend on location, and cannot be standardized.

TABLE I

NUMBER OF LINE POSTS REQUIRED PER KILOMETRE AT VARIOUS SPACINGS ASSUMING THAT A STRAINER IS USED EVERY 500 M.

Spacings m	No. of line posts per km
3·6	275
5·5	180
6·4	154
15·0	65
20·0	48
30·0	31
45·0	20

TABLE II

NUMBER OF DROPPERS REQUIRED PER KILOMETRE OF SUSPENSION FENCE WHEN LINE POSTS ARE SPACED AT 20 m, 30 m AND 45 m

Post Spacing m	Dropper Spacing m	No. of Droppers per km
20	6·6	100
30	6·0	132
30	7·5	99
45	7·5	110

TABLE III

COST OF BLACK VARNISHED STEEL LINE POSTS PER KILOMETRE OF FENCE WITH POSTS AT VARIOUS SPACINGS, ASSUMING STRAINERS ARE USED AT 500 m INTERVALS

Post Length	Post Spacing	Number of Posts per km	Cost per kilometre		Total
			Posts A	Labour B	
cm	m		$	$	$
165	3·6	275	371.25	123.75	495.00
180	3·6	275	408.38	137.50	545.88
165	5·5	180	243.00	81.00	324.00
180	5·5	180	267.30	90.00	357.30
165	6·4	154	207.90	69.30	277.20
180	6·4	154	228.69	77.00	305.69
180	15·0	65	96.53	32.50	129.03
180	20·0	48	71.28	24.00	95.28
180	30·0	31	46.04	15.50	61.54
180	45·0	20	29.70	10.00	39.7)

A. Costs are ex Brisbane, are current as at January 1978 and are $1.35 each for 165 cm posts and $1.485 each for 180 cm posts.

B. Costs quoted by contractors are current as at January 1978 and are 45c each for 165 cm posts and 50c each for 180 cm posts. Costs include carting from a " dump " on the fence line to the position for driving the post.

TABLE IV

COST A OF THREE TYPES OF DROPPER PER KILOMETRE OF SUSPENSION FENCE WITH POST AND DROPPERS AT VARIOUS SPACINGS

Post Spacing	Dropper Spacing	Number Droppers per km	Lightening Droppers					
			Three Wire (61 cm)			Four Wire (91 cm)		
			Cost of Droppers B	Labour Cost C	Total Cost per km	Cost of Droppers D	Labour Cost E	Total Cost per km
m	m		$	$	$	$	$	$
20	6·6	100	18.55	10.00	28.55	25.10	10.00	35.10
30	6·0	132	24.49	13.20	37.69	33.13	13.20	46.32
30	7·5	99	18.36	9.90	28.26	24.85	9.90	34.75
45	7·5	110	20.41	11.00	31.41	27.61	11.00	38.61

Post Spacing	Dropper Spacing	Number Droppers per km	Spiral Twist Droppers					
			4 mm Standard Wire (1 015 mm)			2·5 mm H.T. Wire (1 015 mm)		
			Cost of Droppers H	Labour Cost I	Total Cost per km	Cost of Droppers J	Labour Cost K 3 Wire Fence	Total Cost per km
m	m		$	$	$	$	$	$
20	6·6	100	32.70	10.00	42.70	26.62	10.00	36.62
30	6·0	132	43.16	13.20	56.36	35.14	13.20	48.27
30	7·5	99	32.37	9.90	42.27	26.35	9.90	36.25
45	7·5	110	35.97	11.00	46.97	29.28	11.00	40.28

Post Spacing	Dropper Spacing	Number Droppers per km	Waratah H.T. Steel Fence Droppers		
			96 cm Dropper		
			Cost of Droppers F	Labour Cost G 3 Wire Fence	Total Cost per km
m	m		$	$	$
20	6·6	100	36.60	20.00	56.60
30	6·0	132	48.31	26.40	74.71
30	7·5	99	36.23	19.80	56.03
45	7·5	110	40.26	22.00	62.26

A. Costs are current as at January 1978.
B. Purchase price ex Brisbane, $18.55 per 100.
C. Installation cost, $10 per 100.
D. Purchase price ex Brisbane, $25.10 per 100.
E. Installation cost, $10 per 100.
F. Purchase price ex Brisbane, $36.60 per 100.
G. Installation cost, $20 per 100.
H. Purchase price ex Brisbane, $32.70 per 100.
I. Installation cost, $10 per 100.
J. Purchase price ex Brisbane, $26.62 per 100.
K. Installation cost, $10 per 100.

TABLE V

Cost per Kilometre of various Wire Combinations

Wire Combinations	Number of Coils or Rolls	Price for Coil or Roll A	Cost per km for Wire	Labour Cost, Running, Straining and Tieing per km	Total Cost per km
		$	$	$	$
4 x 2·50 mm barbs	10	27.00	270.00	50.00	320.00
4 x 1·60 mm barbs	8	21.70	173.60	50.00	223.60
3 x 2·50 mm barbs	7·5	27.00	202.50	37.50	240.00
3 x 1·6 mm barbs	6	21.70	130.20	37.50	167.70
2 x 2·50 mm barbs 1 x 2·50 mm plain	5 0·67	27.00 32.75	156.94	31.25	188.19
2 x 1·60 mm barbs 1 x 2·50 mm plain	4 0·67	21.70 32.75	108.74	31.25	139.99
Ringlock Range Cattle 1 x 1·60 mm barb	2 2	76.55 21.70	196.50	98.50	295.00
Ringlock Station Country 1 x 1·60 mm barb	2 2	92.23 21.70	227.86	127.00	354.86
Hinge Joint 5/67/30 1 x 1·60 mm barb	5 2	40.10 21.70	243.90	127.00	370.90
Hinge Joint 6/70/30 1 x 1·60 mm barb	5 2	46.80 21.70	277.40	158.30	435.70
Ringlock Cattle	5	55.82	279.10	145.80	424.90
Hinge Joint 6/90/30	5	61.90	309.50	145.80	455.30
Ringlock Strongline All Stock	5	57.38	286.90	180.60	467.50

A. Price ex Brisbane.

29. To compare the cost of two fences with different specifications take the relevant information from the tables. For example compare a three wire fence using two x 2·50 mm barbed wires and one 2.50 mm plain wire with 165 cm steel posts 3·6 mm apart with a four wire suspension fence using 2.50 mm barbs with 180 cm steel posts 30 m apart and 91 cm four wire lightening droppers 7·5 m apart. The comparison would be made as follows:

Conventional fence

Total Cost of posts per km ..	$495
Total Cost of wire per km ..	$118.19
Total fence cost per km ..	$683.19

Suspension fence

Total Cost of post per km ..	$61.54
Total Cost of droppers per km	$34.75
Total Cost of wire per km ..	$320.00
Total fence cost per km ..	$416.29

30. As the materials prices are ex Brisbane an allowance would have to be made for freight. This will raise the actual cost, but the relative cost will remain the same and therefore the comparison is still valid.

Choice of materials

Posts

31. Posts can be either timber or steel. Timber posts may be either hardwood or softwood.

Timber posts

32. Species of hardwood suitable for use as posts are found in many areas of Queensland. The best guide to the durability and peculiarities of the timbers in any area is local knowledge.

33. Peculiarities include such things as the necessity to cut some species longer than is needed for posts and then let them season because they split during drying. After splitting has finished, the ends are cut off before the post is used. Another peculiarity of some species is that they are only durable in the soils in which they grow.

34. Not all hardwood species are suitable for posts and of those which are used some are not as durable as others. The species listed in table VI include some of those commonly used.

35. Softwoods, except for Cypress, need to be treated to withstand termites and rotting. Such treatment will give the posts a longer life than some untreated hardwoods.

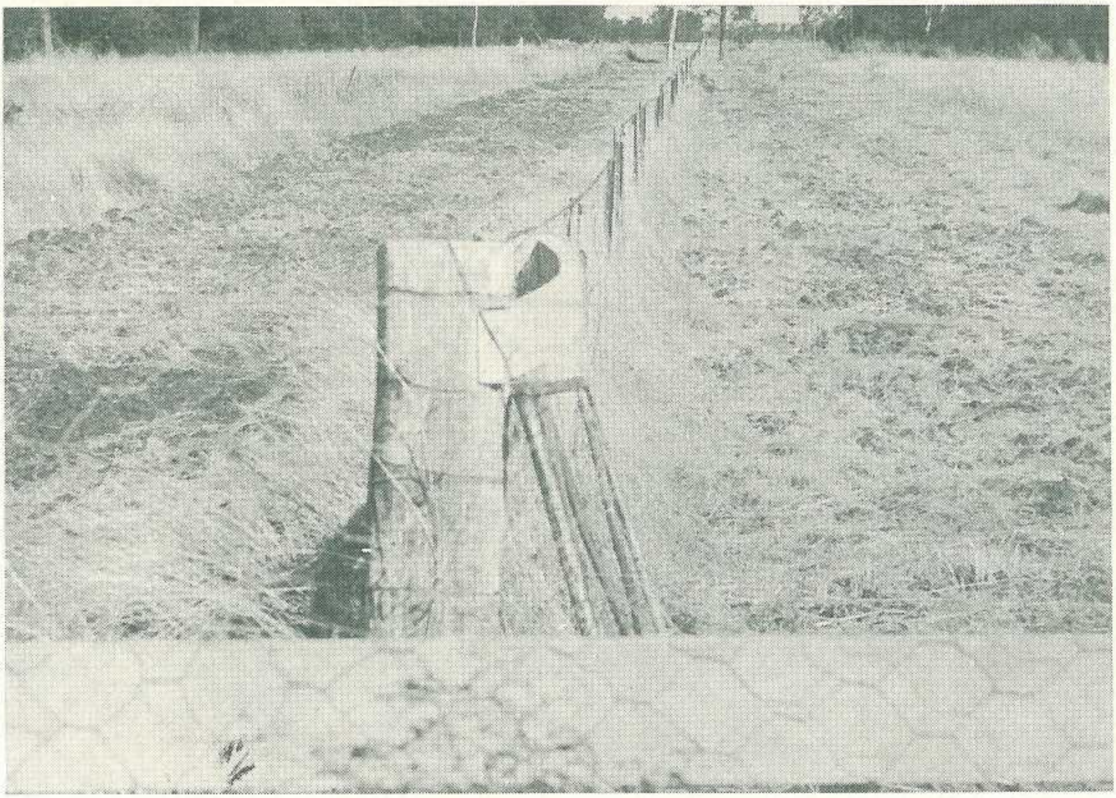
36. The hardwoods listed in table VI can be used without preservative treatment if heartwood is used. These timbers are normally used as split or sawn posts from large diameter trunks. If round posts are cut from saplings they must be treated, as the sapwood from even durable timbers will decay or suffer insect attack. Details of timber treatment are given in appendix 1.

TABLE VI

TIMBER SPECIES CLASSED AS 'VERY DURABLE' WHOSE HEARTWOOD IS SUITABLE FOR SPLIT POSTS.

Common or Trade Name	Botanical Name
Group 1. Very hard, heavy and strong.	
Ash, Hickory	*Flindersia ifflaiana*
	Eucalyptus intermedia
	Eucalyptus gummifera
Bloodwood, Red	*Eucalyptus polycarpa*
	Eucalyptus hemiphloia
Box Grey	*Eucalyptus microcarpa*
Box, Molloy Red	*Eucalyptus leptophleba*
Ironbark, Broad-Leaved Red	*Eucalyptus siderophloia*
Ironbark, Grey	*Eucalyptus drepanophylla*
Ironbark, Gumtopped	*Eucalyptus decorticans*
Ironbark, Narrow-Leaved Red	*Eucalyptus creba*
Ironbark, Red	*Eucalyptus sideroxylon*
Luster (or Turpentine)	*Syncarpia glomulifera*
Messmate, Gympie	*Eucalyptus cloeziana*
Penda, Brown	*Xanthostemon chrysanthus*
Tallowwood	*Eucalyptus microcorys*
Turpentine (see Luster)	
Yapunyah	*Eucalyptus ochrophloia*
Group 2. Hard, heavy, reasonably strong.	
Ash, Crow's	*Flindersia australia*
Ash, Leopard	*Flindersia collina*
Hollywood, Yellow	*Vitex lignum-vitae*
Satinay	*Syncarpia hillii*
Group 3. Soft to moderately hard, moderately light reasonably strong.	
Bean, Black	*Castanospermum australe*
Gum, River Red	*Eucalyptus camaldulensis*
Pine, Coast Cypress	*Callitris columellaris*
Pine, White Cypress	*Callitris glauca*

Source: From 'Queensland Building Timbers and Specifications for Their Use', by C. J. J. Watson, Department of Forestry pamphlet No. 5, 1964.



A ploughed fire-break on each side of the fence protects post and wire. 1·60 mm high tensile barb is very prone to fire damage.

POST STRENGTH AND SIZE

37. Mr R. S. Johnstone in an article 'The Strength of Preservative-treated Round Posts' produces information on the load needed to break round posts of varying diameter and species set at varying depths. He also examined steel posts and found they bend at much lower loads than those needed to break 75 mm round softwood posts and 60 mm round hardwood posts.

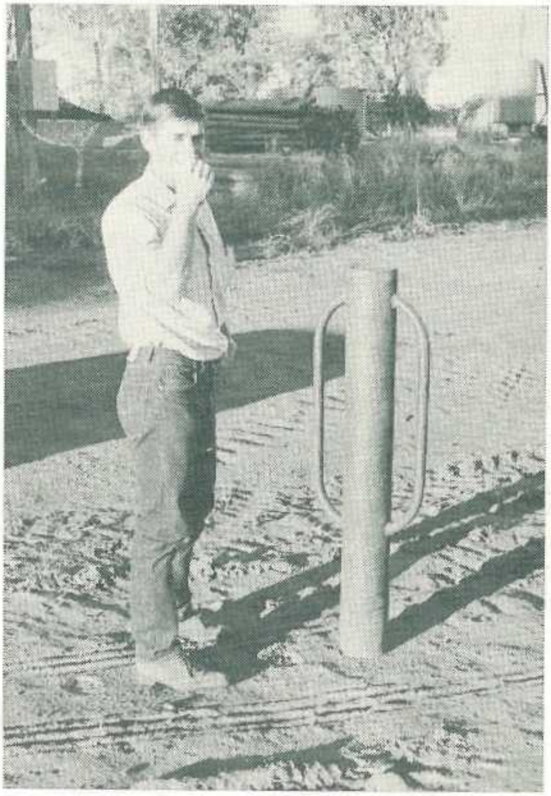
38. Similarly work by professor Henry Giese of Iowa State College U.S.A. which is reported by Bishop in 'Farm Fence Construction' shows that when 60 mm wooden posts and 180 cm posts are set 60 cm deep and subjected to the same load the top movement of wooden posts was less than that of steel posts.

39. It follows, therefore, that if steel posts make a satisfactory fence then the wooden posts presently used in most fences are larger than they need be. However, there are two situations where large diameter posts may be a better choice. These are wet areas where posts may sink and gullies where posts, particularly steel ones, tend to lift out.

40. Large diameter posts, however, are not the only solution in these situations. Bedlogs could be used or a steel post could be driven in full depth and the fence post anchored to it. In gullies, rails or large stones are often tied to the fence either to hold it down or to prevent animals crawling under, or both.

STEEL POSTS

41. Steel posts are available either as black varnished or galvanized posts. Galvanized posts are considerably more expensive than black varnished posts. But in areas where heavy corrosion of wire occurs they should be considered. However, the black varnished posts have been observed to last longer in the ground in most situations.



Timber and steel post driver made from bore casing.

42. Giese showed than 165 cm steel posts set 45 cm deep are much less stable than 180 cm posts set 60 cm deep. The 180 cm posts required one and one-half times the pull to produce the same amount of top movement as the 165 cm posts. Therefore, if 180 cm posts are spaced one and one-half times as far apart as 165 cm posts, fences of equal rigidity will result.

STRAINER POSTS

43. Strainer and end assemblies must be made of timber posts. The size of posts depends on the design of the assembly. Details are given in paragraphs 84 to 95.

CHOICE OF LINE POSTS

44. In choosing line posts, the main function to consider is the ability of the posts to prevent overturning of the fence. Most cattlemen consider steel posts are adequate to prevent overturning under conditions of normal stock activity. Johnstone's work with steel and wooden posts showed that the load needed to break 70 mm round pine posts was 40 to 90 kg more, depending on depth of set, than the load needed to bend steel posts. He further showed that 60 mm round Spotted Gum posts set 760 mm in the ground would not break until the load reached 140 kg more than the load at which steel posts bend.

45. If durable local timber is scarce, splitting of large posts into smaller ones should be considered. Such posts are likely to be as strong as steel posts and provided they do not have to be transported over too great a distance may be cheaper. Timber posts are generally stronger than steel posts and if the installed costs are similar then timber is preferable. However, even if suitable hardwood is available on the property, steel posts may still be cheaper as they are easier to transport and easier to install.

46. Where soil movement causes posts to lay over as time passes, wooden posts should be used in preference to steel posts as they resist soil movement better and remain vertical longer.

Droppers

47. The main purpose of droppers is to maintain the spacings between the wires in a suspension fence. However, there are other functions that droppers can perform and these can influence the choice of materials.

48. A secondary purpose for droppers can be to distribute any impact on the fence evenly to all wires in the panel. Not everybody agrees that this is a necessary function of droppers. However, if droppers are to fulfil this function, they must be both strong and rigid. Two types of droppers have these qualities:

- Timber droppers.
- A commercially made angle iron dropper—the Waratah high tensile steel fence dropper.

49. Another reason for having substantial droppers is to make the fence more visible to stock. Some graziers consider this is important.

50. Wire droppers sometimes fail to maintain the spacings between line wires. They often bend on impact. Once bent, they pull the top and bottom wires closer together.

51. There are a number of types of dropper made from steel. These are listed below and some comments are made about each.

- The lightening dropper—is easy to install but is not easily seen. It is hard to see and bends on impact and in so doing draws the top and bottom wires of the fence closer together. If it bends at a loop, the wire which should be held in the loop may jump out. Bent droppers are easy to straighten.
- Spiral twist droppers—are easy to install. These droppers are hard to see and bend on impact. Bent droppers are easy to straighten.
- Universal droppers are similar to spiral twist droppers and the same comments apply.
- Warratah high tensile galvanized steel fence droppers are easily seen and are also easy to install. However, installation requires special clips and a fixing tool.

52. Wooden droppers are also used but Bishop found that they hasten corrosion on the wire. They are easily seen and are usually fixed to the fence by placing the wire in a pre-sawn groove and then using tie wire to hold them in place. The grooves in wooden droppers may be cut commercially or on the property.

53. Home-made droppers have been made from both wood and wire. Home-made wooden droppers can be rough sawn battens in which the producer either cuts grooves where the wires will run or drills holes to take tie wire. Homemade droppers can also be made by splitting timber on the property.

54. A number of producers have made their own wire droppers. These are patterned on the lightening dropper and the methods used vary from extremely simple to highly complex. The wire used is usually either 4 mm or 5 mm.

Wire

55. The factors which affect the life and usefulness of fencing wire are the diameter of the wire, tensile strength and the amount of corrosion likely to occur in the area where the fence is to be erected.

56. High tensile wire is now universally used. The choice for plain wire is confined to 2·8 mm or 2·5 mm diameter. The latter is adequate for most fencing. Barbed wire is available in 2·5 and 1·6. All these wires have adequate tensile strength for fencing—but the lighter barbed wire may be broken if hit by heavy animals. When stocking pressure is heavy then the heavier wire is justified.

Corrosion

57. Corrosion occurs in two phases. First the galvanizing is lost from the wire. Secondly, the steel in the wire rusts. These processes occur continuously, gradually reducing the strength of the wire until it breaks.

58. Galvanizing is a comparatively thin coat of zinc over the steel. Major differences result from the galvanizing method. Heavily galvanized coatings contain three times as much zinc as standard galvanizing. The patented carpo process produces a soft wire with galvanized coating superior in bond, strength and flexibility. Plain fence wire which is heavily galvanized is identified with a red tag and standard galvanized wire is identified with a blue tag.

59. It is worth noting that thin wires have a lighter coating of zinc than thicker ones, with all three galvanizing processes.

60. The rate at which zinc is lost from the wire varies according to atmospheric conditions: In wet rural areas the corrosion rate is likely to be double that of dry rural areas; in coastal areas the rate of corrosion is likely to be four to six times that of dry areas; in industrial areas the rate of corrosion is likely to be eight to twelve times that in dry areas. Locality will therefore govern the choice of galvanizing.

61. Other factors besides atmospheric conditions will affect the life of zinc coating on wire. These are discussed in appendix II.

TABLE VII

PLAIN WIRE SPECIFICATIONS

Gauge	Weight Per Coil	Length Per Coil	Tensile Rating
mm	kg	m	
4·00	49	500	Mild steel
3·55	47	600	Mild steel
3·15	46	750	Mild steel
2·80	48	1 000	High tensile
2·50 Flexabel	58	1 500	High tensile
2·50 Tyeasy	58	1 500	High tensile

PLAIN WIRE

62. The specifications of plain wire are shown in table VII. The plain wire most commonly used for line wires in fences is 2·5 mm. In Queensland, it is usually used in combination with barbed wire. 4 mm wire is seldom used now, though at one time if plain wire was used it was almost invariably 4 mm.

63. 3·15 mm mild steel wire makes excellent tie wire as it is strong enough to withstand shock loadings without untying and soft enough to be easily worked. Unfortunately, it is normally available with standard galvanizing only. However, it can be heavily galvanized to special order.

64. 2·5 mm high tensile plain wire is readily available in both standard and heavily galvanized coatings. 1·6 mm wire is only available in heavily galvanized form.

BARBED WIRE

65. Fencing and barbed wire are synonymous in the Queensland beef industry. But, is barbed wire really necessary?

66. Many experienced cattlemen believe it is. They claim, with some justification, that the barbs discourage cattle from foraging through the fence and that they also discourage gossiping over the fence. Both of these practices can lead to cattle learning to push through or over a fence.

67. However, even 1·6 mm barbed wire is more than twice as expensive as 2·5 mm plain wire per km of wire. If plain wire were used to replace barbed wire without the fence being electrified, it would probably be necessary to use extra wires and possibly extra posts and/or droppers to give an equally effective fence. Extra wires, droppers and posts add to the cost and increase the labour content.

68. To determine whether plain wire fences are as effective as barbed, it would be necessary to test a number of combinations of both under varying conditions and then do some careful costing. However, since the advent of high-powered, low impedance electric energizers there is no question about the effectiveness of plain wire fencing provided the wire is electrified.

69. Many graziers, of course, use a combination of plain and barbed wire in their fences and find it very effective. Others use only barbed wire.

70. There are only two types of barbed wire in common use in Queensland. These are 2·5 mm Iowa pattern and 1·6 mm reverse twist.

71. The Iowa pattern consists of two 2·5 mm line wires with barbs made of 2 mm wire. It is obtainable in standard and heavy galvanising. Each reel holds 400 m of wire and weighs approximately 43 kg. The breaking strain is approximately 450 kg.

72. The 1·6 mm reverse twist wire consists of two 1·6 mm line wires with 1·6 mm barbs. The reverse twist allows the wire to run out flat when it is unreeled. It is only supplied with a heavy coating of galvanizing. Each reel contains 500 m of wire and weighs approximately 21 kg. The breaking strain is approximately 450 kg.

73. Many graziers in extensive areas have stopped using 1·6 mm barb as it becomes brittle after a fire has been through the fence. Generally, only the bottom wire is affected. Iowa pattern wire is not affected by most grass fires.

FABRICATED WIRE

74. Two types of fabricated wire are used in cattle fences. They are hinged joint and ring lock. The manufacturers of each make a number of types of wire which they recommend for cattle. They also make sheep wire, sheep and cattle wire and pig wire.

75. These wires are manufactured from high tensile wire and normally have a standard galvanized finish but can be supplied heavily galvanized if the quantity required is sufficient to justify a production run.

76. Fabricated wire has not been used extensively for cattle fences. It has, however, found more extensive use alone and in combination with barb wire in sheep and cattle fences.

TABLE VIII

SPECIFICATIONS OF FABRICATED WIRE REGARDED AS SUITABLE FOR CATTLE

Brand Name	No. of Line Wires	Height mm	Vertical Wire Spacing mm	Roll Length m	Roll Weight kg	Rolls per km
Cyclone Range Cattle ..	4	700	900	500	93	2
Cyclone Station Country ..	5	700	900	500	113	2
Cyclone Cattle	6	900	300	200	75	5
Cyclone Strongline All Stock	7	1 000	600	200	75	5
Hinge Joint 5/67/30 ..	5	670	300	200	65	5
Hinge Joint 6/70/30 ..	6	700	300	200	74	5
Hinge Joint 6/90/30 ..	6	900	300	200	75	5

Construction

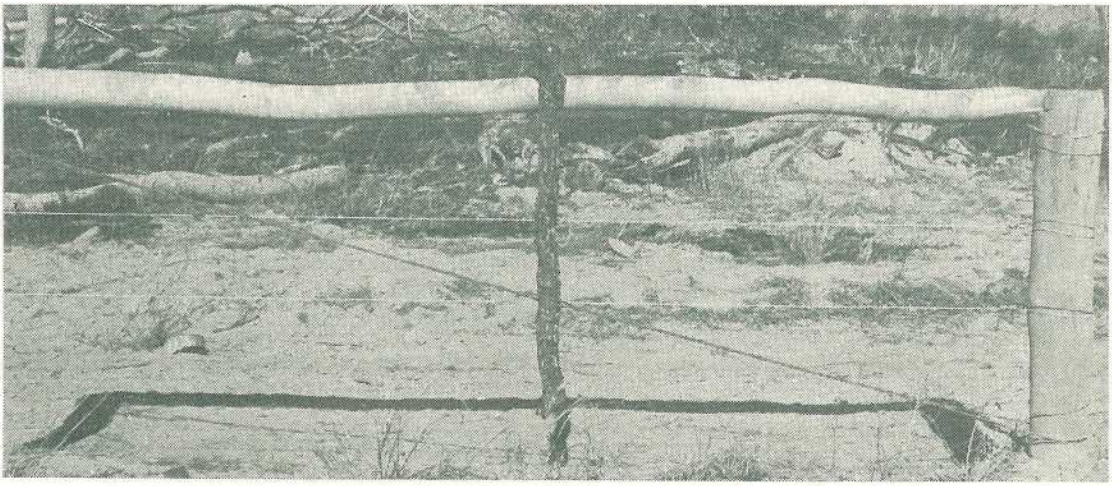
Posts

SETTING POSTS

77. Before discussing fence ends, corners and line posts, some discussion of the methods of setting posts is warranted.

78. The usual method of setting wooden posts has been to dig a hole with a crowbar and shovel or tractor-mounted post hole digger and shovel, stand the post in the hole and then refill the hole with the soil taken out, ramming the soil as it is replaced. Concreting fence posts is not warranted.

79. Either of the above processes is time consuming and Bishop quotes the results of work done in the U.S.A. which shows that driving wooden posts saves time. A team using a power driver set 16 posts per hour while a team using a post hole digger set six posts per hour, and a team using bar and shovel set four posts per hour.



Tension must be kept on the diagonal brace in the assembly to reduce the chances of its failing. If tension is applied with a winding stick the stick must be left in and restrained against the horizontal stay.

The heavy strainer post supported by a diagonal stay butted against a large stone or bedlog is less stable than the assembly. It tends to pull out over the stay. In this case, the top wire is 1.8 m above ground level.

80. The way in which posts should be driven into the ground depends on soil moisture and whether the posts are to be driven by power driver or by hand. Any driven posts must be pointed.

81. When the soil is dry it may be necessary to drive into an undersize hole even with a power driver. With a hand driver, difficulty will be experienced even in moist soil when driving posts of more than 130 mm diameter. However, posts of this diameter are much larger than is necessary for an efficient fence (see paragraph 38).

82. A driver made from 152 mm bore casing to weight 14 to 18 kg is suitable for use by one man in driving small, round posts. Two men can conveniently use a driver made from 200 mm bore casing and weighing 36 kg to drive posts of 127 to 152 mm diameter.

83. In addition to being a quicker method of setting posts, driving gives a post which stands loading better. Tests on single span assemblies showed that they carried 50% more load when posts were set by driving than when the posts were set by ramming into an over-sized hole.

STRAINERS AND CORNERS

84. Strainer and corner posts are the foundation of a fence. If one fails, a section or the whole fence may fail.

85. Although the single, heavy, back breaking post with a diagonal stay butted against a bed log or stone is still in use strainer assemblies for ends and corners are becoming more common. These assemblies are based on engineering principles and although the posts need only be light (of small diameter) they will stand greater loads than single posts with diagonal stays. Diagrams of these assemblies are shown in figure 1.

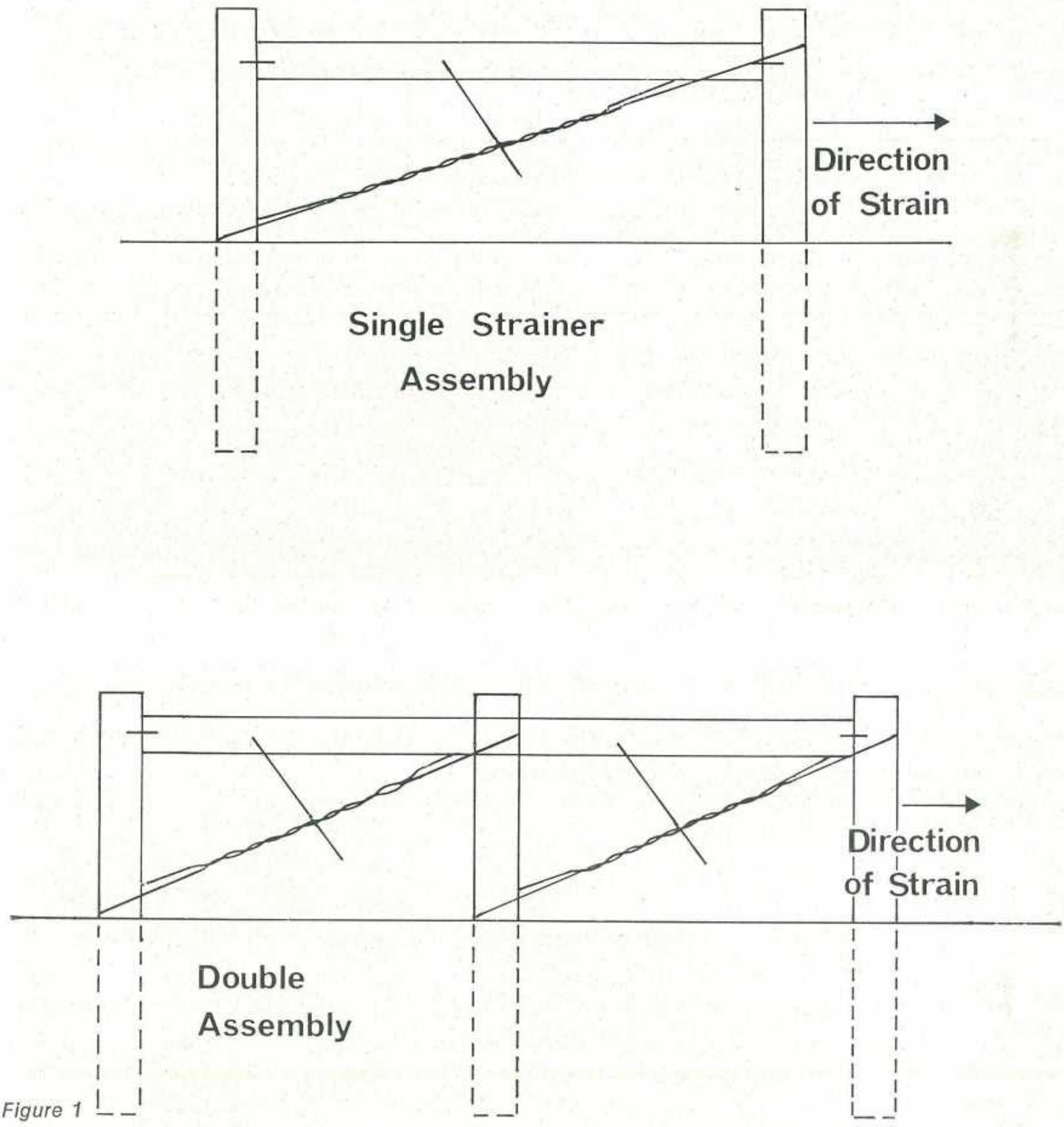
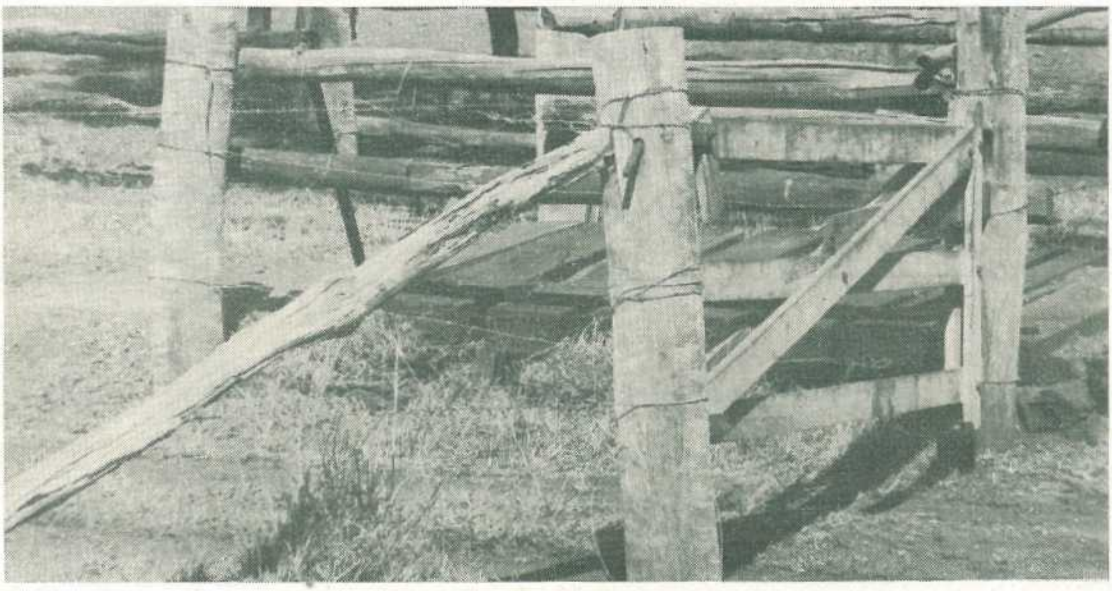
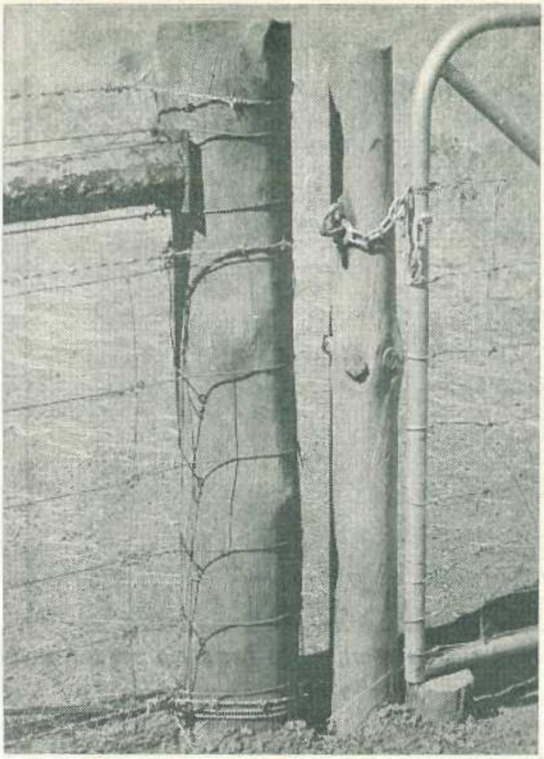

Direction
of Strain
Single Strainer
Assembly
Direction
of Strain
Double
Assembly

Figure 1

A bolt through the post or through a piece of pipe attached to the horizontal stay may also be used to maintain tension on the diagonal brace.



Wooden or steel gates can pull strainer posts over whether attached to an assembly or to the single strainer with a diagonal stay.



A gate post and support beside the strainer will prevent damage.

TABLE IX

SPECIFICATIONS FOR TIMBER NEEDED TO MAKE FENCE END AND CORNER ASSEMBLIES

3.35 m single span	Minimum post size diameter in mm
End post set 1.06 m in ground	150
Brace post set 1.06 m in ground ..	130
Stay (3 m)	130
Tension Member—Two double strands of 3.55 mm wire	
4.87 m double span	
End post set 1.06 m in ground	130
First brace post set 1.06 m in ground	100
Second brace post set 1.06 m in ground	90
First stay (2.44 m)	100
Second stay (2.44 m)	90
Tension members—two double strands of 3.55 m wire	

FENCE ENDS AND CORNERS

86. Practical experience under Queensland conditions indicates that where waterlogging of the soil occurs or where the soil becomes very plastic when wet it is necessary to improve on the end assemblies recommended above. One such improvement is the assembly reported by Weller and Venamore (Advisory Leaflet 780, Division of Animal Industry). This is based on the principles recommended by Professor Giese but incorporates a compression post to impart added strength (figure 2).

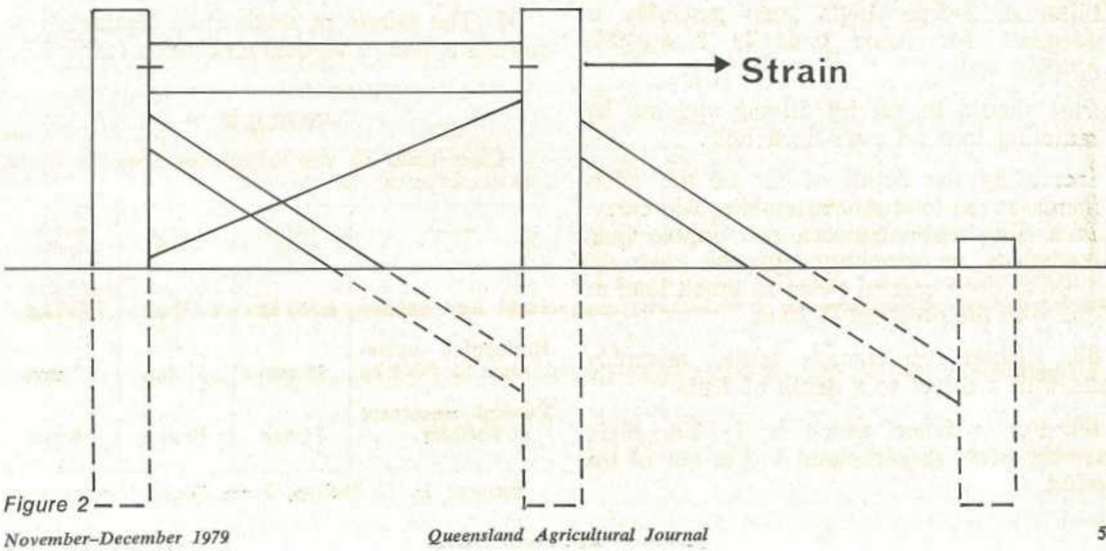
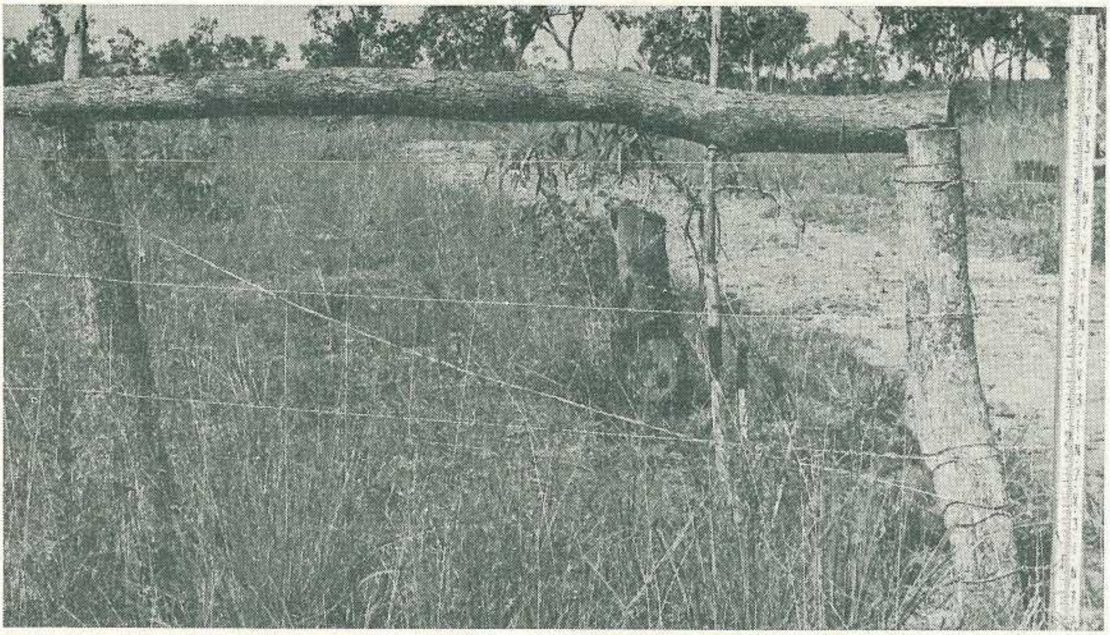


Figure 2



Strainer assemblies are more likely to fail if the horizontal stay is short, if the posts are set too shallow, or if the diagonal brace cannot be kept tight.

87. From the report given by Bishop in 'Farm Fence Construction' on the work done by Professor Giese, the following comments can be made on end assemblies and corners:

- Longer assemblies withstand heavier loads and are less likely to fail than short assemblies. A 3·5 m single span assembly is adequate for fence ends in reasonable holding soil.
- Post should be set by driving and not by ramming into an over-sized hole.
- Increasing the depth of set of the posts increases the load that assemblies will carry. In a comparison between two double span assembles, an assembly with the posts set 1·06 m deep carried twice as much load as one with the posts set 0·76 m.

88. Bishop recommends setting assembly posts with a driver to a depth of 1 m.

89. For a fence which is 1·22 m high, assembly posts should stand 1·3 m out of the ground.

90. Single and double span assemblies were tested as corner structures by Professor Giese. Double span assemblies perform best because one double span tends to stabilize the other. This reduces the chances of failure due to buckling

91. The failure of single span assemblies at corners is due to vertical movement (table X).

TABLE X

COMPARISON OF THE EFFECTS OF LOAD ON THREE ASSEMBLIES USED FOR CORNERS.

——	2·44 m single	3·35 m single	4·27 m double
Total load carried	1 360 kg	1 770 kg	3 630 kg
Horizontal movement at 1 360 kg	93 mm	64 mm	17 mm
Vertical movement at 1 360 kg ..	85 mm	70 mm	8 mm

SOURCE: H. G. Bishop, Farm Fence Construction.

92. The University of New South Wales has used end and corner assemblies made with 75 mm or 100 mm pipe posts, a 50 mm pipe rail and a wire brace at their Arid Zone Research Station at Fowlers Gap. The posts are concreted into a 30 cm diameter hole 1·2m deep. Further information on their construction methods can be had by obtaining the leaflet 'Fowlers Gap Fences' from the University.

DIAGONAL BRACE

93. During Professor Giese's work the question of how strong the tension brace has to be was also investigated. It appears that two loops (four strands) of 3·55 mm wire is sufficient.

94. Experience has shown that a 12 mm metal rod threaded at one or both ends can be used effectively as a tension brace for assemblies. Where a wire brace is used, it is important that the winding stick used to apply tension to the brace be left in and restrained against the stay. If this is not done, the brace will unwind when the fence is strained with resultant loss of rigidity in the assembly. This could lead to failure.

95. One method used to tension a wire brace consists of a 12 mm bolt with a long thread and a chain link welded to the head. The bolt is put through a hole near the top of the post and the nut given a few turns to hold it. The wire twitch is then put around the bottom of the strainer, threaded through the chain link and tied off as tightly as possible. The brace is then tensioned by tightening the nut on the bolt.

GATES AND ASSEMBLIES

96. Metal or wood gates should not be swung on the end of a straining assembly. If the gates are left open for any length of time they tend to drag the post over sideways. This could cause the assembly to twist and fail upon restraining of the fence or when the fence suffers a sudden impact. This problem can be overcome by erecting a gate post beside the strainer.

INTERMEDIATE STRAINERS

97. In longer fences, it is usual to have intermediate strainers between ends such as gates and corners. Often a single, large, unbraced post is used. However, a more efficient arrangement is a single span assembly which is cross twitched to take the pull of the fence in both directions (figure 3). This type of intermediate strainer has been found successful in waterlogged areas on 'Swan's Lagoon' (Condon and Venamore 'Cost of Suspension Fencing', *Queensland Agricultural Journal*, July, 1971).

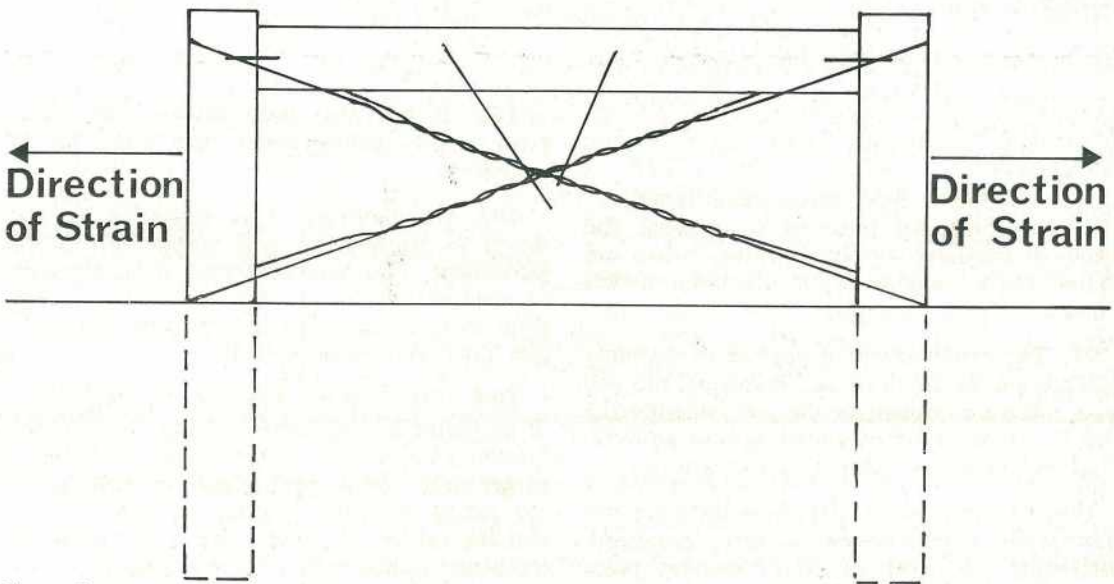
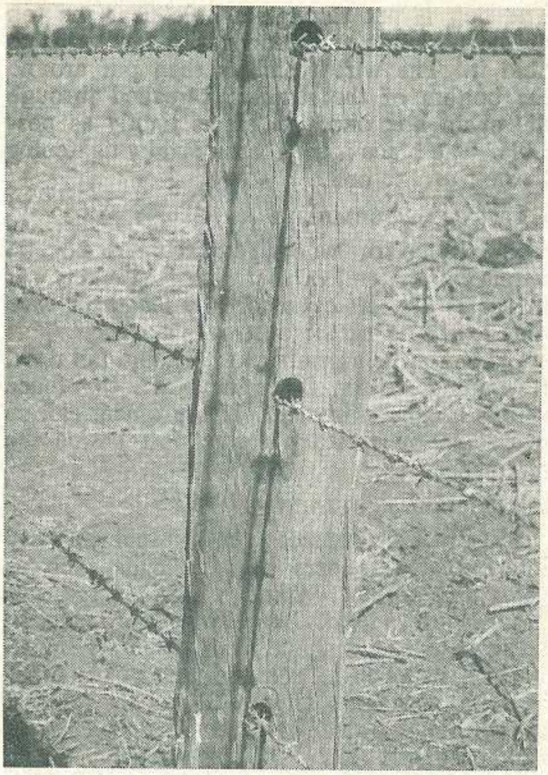
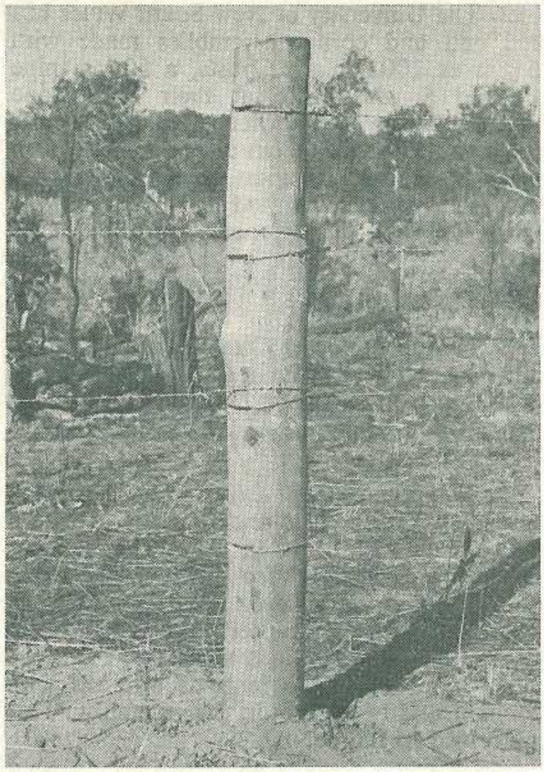


Figure 3



Drawing wire through holes in posts causes faster corrosion. Water in the holes dries out slowly allowing the corrosion to go on for a long time. The galvanizing also wears off the wire on the edges of the post.



Tying wire into saw cuts will increase the rate of corrosion for the same reasons as drawing the wire through holes in posts.

LINE POSTS

98. Line posts have three main functions. The major one of these is to prevent the fence overturning or lying down when an animal pushes against it or otherwise makes contact.

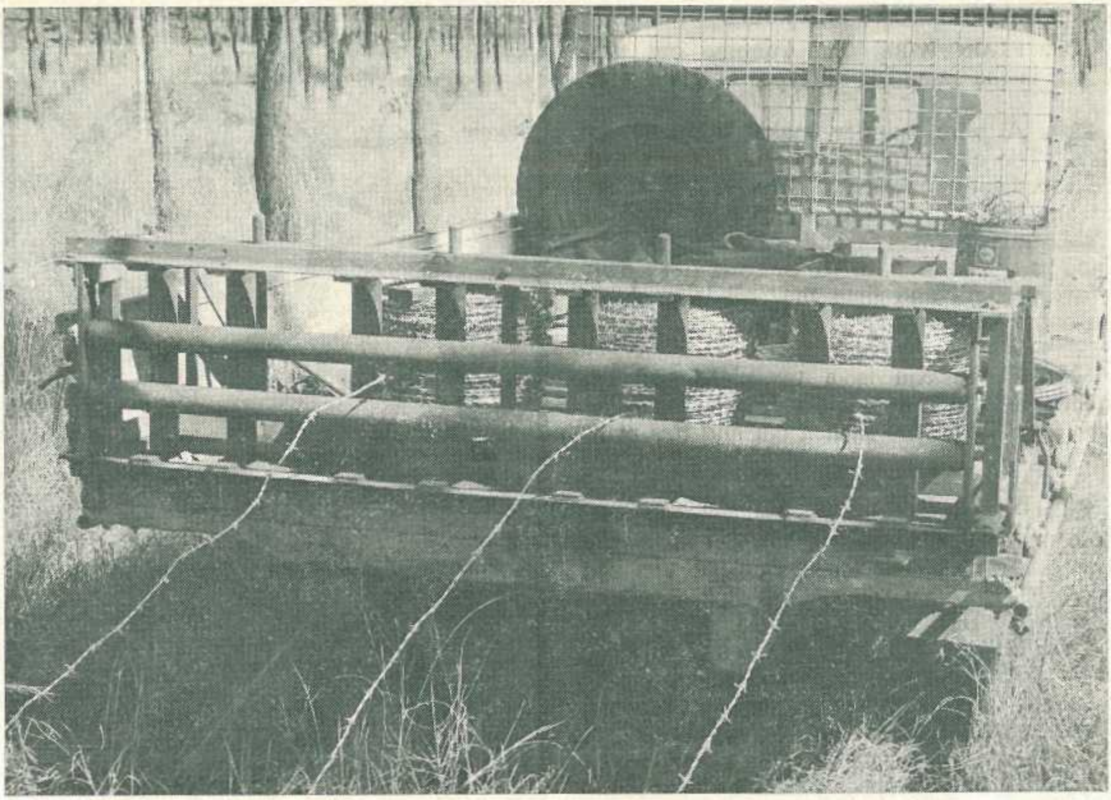
99. The resistance of a post to overturning depends on its depth of set, diameter, the soil type, moisture content of the soil, whether the post is driven or set by ramming into an oversized hole and the tension of the wires.

100. Diameter of the post is of little importance while depth of set is very important. Increasing the depth of set of wooden posts one-third will double resistance to overturning.

101. It has also been shown that driven posts stand loading better than posts set by ramming.

102. On some soil types, posts have a tendency to lay over as time passes due to soil movement. To overcome this, it is necessary to reduce the distance between posts. Setting posts deeper also helps to overcome this problem (see also paragraph 46).

103. The second function of line posts is to maintain the height of the fence above ground level so as to discourage stock trying to get over. Wide post spacing permits sag—the extent of which depends on wire tension and the use of droppers. Sag is not generally important unless maintenance is ignored (paragraph 166).



Multi-reel runners make running barbed wire easier and quicker. This machine which is capable of running four barbs at a time is mounted on the back of a truck.

104. The third function of line posts is to help maintain the spacing between individual wires in the fence. Other factors which are important in maintaining spacings are wire tension and, in suspension fences, the number of droppers between the posts. To some extent, there is interaction between these factors.

105. Low wire tension can be compensated for by reducing the distance between posts and vice versa. Alternatively, if wires are spaced close, posts or droppers could be spaced further apart.

SITING LINE POSTS

106. When the fence line is pegged it is usual to mark it out with steel posts placed at intervals of 200 to 300 m. If line posts are driven, all that is required to site them in is the top wire of the fence. This wire can be run from strainer to strainer and then the line posts driven in at intervals along it.

107. If post holes have to be dug for wooden line posts it is necessary to position each post individually as the wire would get in the way while the hole is being dug and the post positioned in the hole. When positioning such posts, it is usual to site forward on the markers rather than back on the posts already standing.

Wire

108. The factors about wire which should be considered when constructing a fence are handling, straining, knotting and hanging.

Handling wire coils and rolls

109. Plain wire. The running out procedure is the same for all types of plain wire.

110. A wire spinner makes running out easy. The coil is placed on the spinner with the top facing upwards. The four ties are cut and the starting end which is denoted by a 'start this end' tag is pulled out in the same plane as the coil. A metre or so is run slowly to avoid snags and then the coil is ready to run out by pulling on the free end.

111. If the coil is a two-piece coil the outside ties are removed and the first piece run out. The second tie is then cut and this piece run out.

112. Do not remove the tie on the second piece until the first piece is run out as tangles may occur with the loose ends of the two pieces.

113. Bolting the wire spinner down will mean that tangles are likely to cause the wire to break. If the spinner is not bolted down, it will be pulled off the vehicle. A choice has to be made as to whether joining the wire with a knot or lifting the spinner back on the vehicle is the lesser of the two evils (see paragraph 141 for knotting).

114. If no spinner is available, it is necessary to bowl the coil away from the operator and not just to pull the loose end away from the stationary coil. If the wire is pulled out while the coil remains stationary, the wire twists and forms a cork screw effect. If bowled out the coil runs the same as if on a spinner (Figure 4).

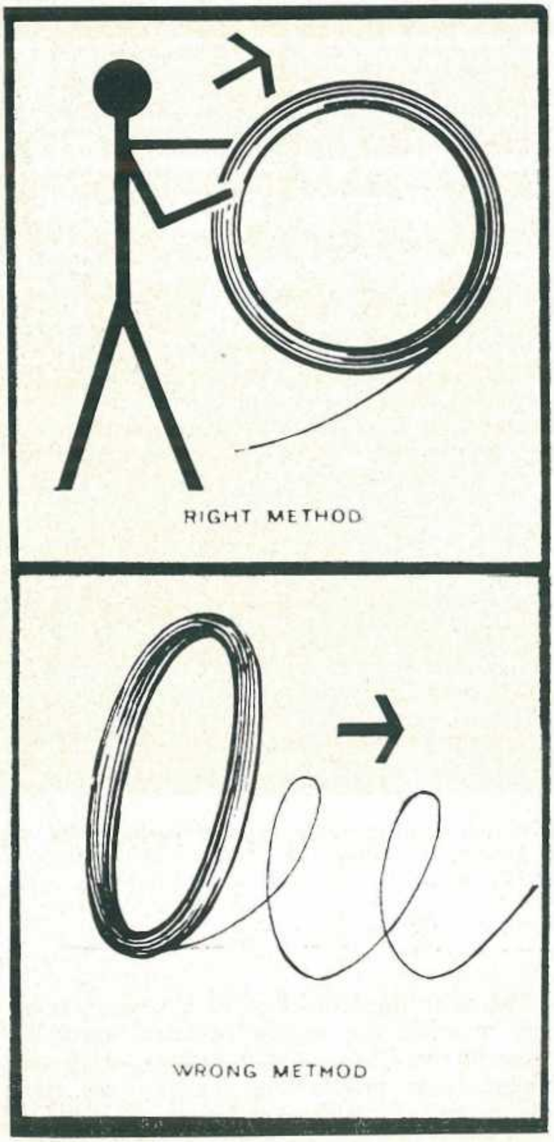


Figure 4

115. Barbed wire. Barbed wire is rolled on to reels. This makes handling reasonably easy. It also makes possible the use of multiple wire runners. In general, the loose end of the wire is tied to a post and then the coil or coils are moved down the fence line (the top wire is the wire nearest the fence).

116. Fabricated fencing. Fabricated fencing is prepared in rolls. To attach it to the post stand the roll near the strainer and unroll 3 to 5 m. Trim the wire ends and if necessary remove one or two of the upright wires to make it easier to tie the coil to the strainer. When tying the wire to the strainer ensure that the upright wires are parallel to the strainer.

117. All wires should be tied on to posts in the same manner, that is, the wire should be run around the post half-hitched on to itself and then finished off with three and a-half or four turns around the running wire (Figure 5).

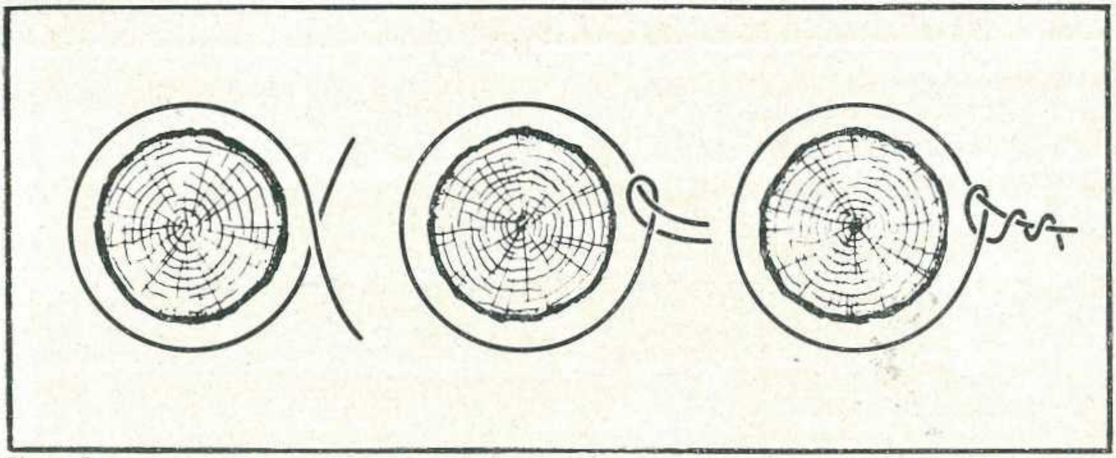


Figure 5

STRAINING THE WIRE

118. When straining fence wire (applying tension) three factors must be considered. These are: the effect of tension on the wire itself, the effect of tension of the fence end and, making the fence stockproof.

119. Wire must not be strained beyond its elastic limit. However, the load required to exceed the elastic limit of the wire is much greater than the load which is safe to apply to the fence end. This is not therefore of practical importance.

120. Over normal working loads, wire will be elastic, and for any given size of wire the 'stretch' produced will be proportional to the load and constant for each additional increment of that load until the yield point is reached. The 'stretch' produced in wires of different size when they are subjected to the same tension will vary according to the size of the wire. (table XI).

121. Tension strainers are essential in a fencer's tool kit. These should have tension gauges incorporating a compression spring rather than a tension handle.

122. A final tension of 1·33 kilonewtons is desirable. To achieve this, the wire must be given a greater initial tension to allow for movement of the strainer posts. The degree of initial tension depends on the length of strain and type of wire. For 2·5 mm high tensile wire, the following initial tension is suggested when fencing flat country:

Strain length		Initial tension	
m	(chains)	KN	(lb.)
100	(5)	2·67	(600)
200	(10)	2·00	(450)
400	(20)	1·67	(375)
850	(40)	1·50	(337)
1 650	(80)	1·41	(318)

Further information on wire tension is given in appendix III.

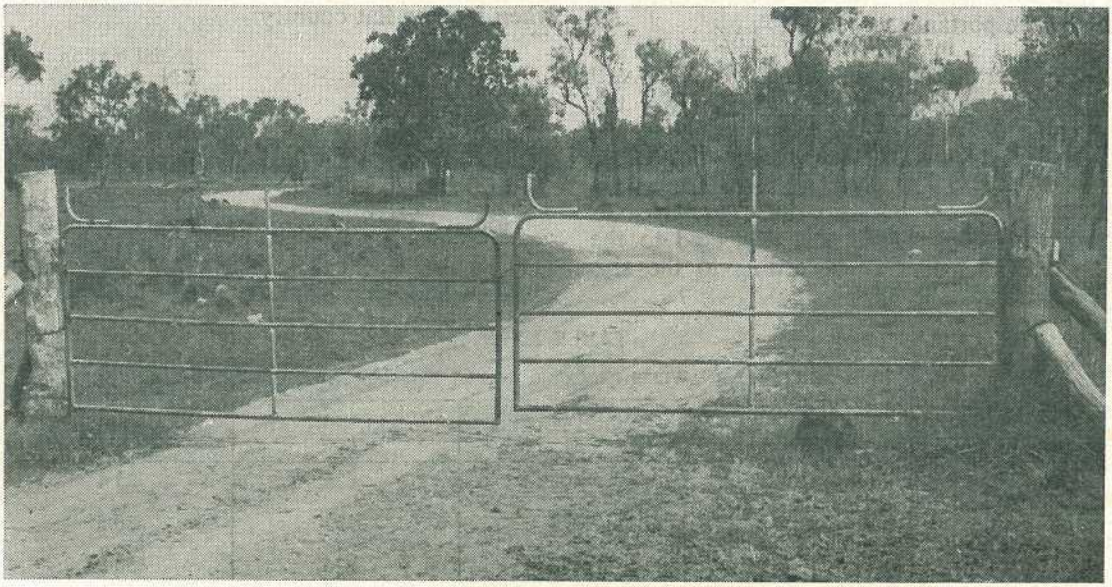
TABLE XI

ELASTIC RATE OF THREE PLAIN WIRES RECORDED IN MM PER 445 NEWTONS PER 100 M

GAUGE mm	TYPE	YIELD POINT kg	BREAKING STRAIN kg	ELASTIC RATE per 445 N
4	mild steel	408	635	25·4
3·15	mild steel	272	392	30·5
2·5	H.T.	408	626	50·8

SOURCE: University of New South Wales, 'Fowlers Gap Fences'.

A simplified barb wire running machine mounted on the carry-all of a tractor.



A typical home-made iron gate is filled with iron rails welded across the centre.

123. While it is possible to give recommendations as to the tension that should be used on wires when fencing on flat country it is not possible to follow these recommendations when fencing broken country. A great deal of judgement and commonsense is required when straining wire over broken country and the rougher the country the more judgement that is required.

124. In practice, it is best to strain the wire until what is considered enough tension has been applied and then tie the wire on to the posts at the top of the rises and in the bottom of the gullies. The tension on the wires can then be checked with a device suggested by Bishop (figure 6). If the tension is too high or too low the wire should be untied from the posts and strained again.

125. With barbed wire, check that barbs are not snagging on posts or obstructions in the ground during straining.

126. Straining methods such as the forked stick and plug, a tractor, or wire strainers without a tension gauge are not much use if you want a fence that can be relied upon. However, you can strain with a tractor or four-wheel-drive vehicle, and fix the tension strainer to the bumper bar of the vehicle.

127. Both serrated and pressure grip strainers will damage the wire and cause some weakening. The loss of strength caused by this damage, however, will be significantly less than the loss of strength caused by a knot. Only pressure grip strainers are suitable for use with high tensile wire.

128. If the galvanizing is broken by the strainers, as it often is, this will cause premature weakening of the wire due to rusting.

129. FABRICATED WIRE. Because of the closeness of the verticals in fabricated fencing, the individual line wires do not require as much tension as the wires in single line fencing. One manufacturer recommends a tension of 0·9 KN for each line wire. The tension should be applied evenly to all wires. (Ensure that the verticals are parallel to the strainer posts).

130. Multi-grip strainer clamps for use with fabricated fencing are made commercially. These clamps allow all wires to be strained at the one time.

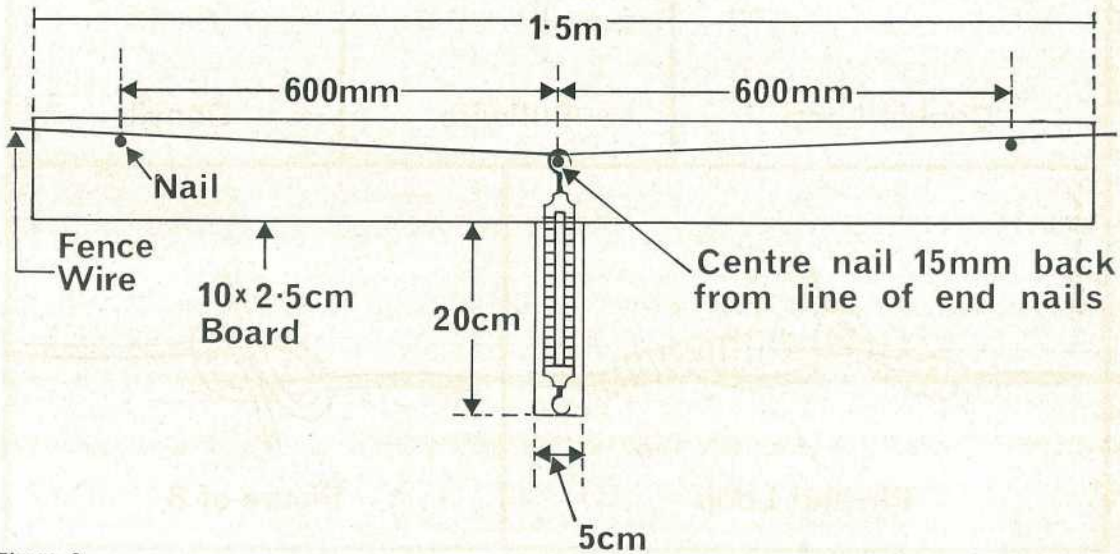


Figure 6

Knots

131. Fencing wire is generally knotted where it is strained. Depending upon the knot used and the type of wire in which it is tied the loss of strength can be as much as 62% with the usual plain wires.

132. Of the knots commonly used in fencing (see figure 7) the figure-of-eight knot is the strongest. Bishop quotes research results which indicated that its strength varies between 66 and 83% of the strength of the wire in which it is tied.

133. Bishop also points out that the figure-of-eight knot has disadvantages. It can not be tied without losing at least 52 mm of length before the strain is taken in the wire. This is a serious disadvantage which rules out its use for short strains. With long strains of high tensile wire, however, it is possible to pull in an extra 50 mm of wire before tying the knot. Thus, when the strainers are released, the wire will be returned to correct tension.

134. Bishop also indicates that knots are less efficient in high tensile wire than in soft wire. Medium tensile wire is intermediate. There is also a tendency for knots to be less efficient in thin wires. Whatever knot is used it should be tied tightly and neatly. Do not rely on the tension in the wire to tighten it.

135. When straining plain wire and barbed wire, most fences strain at one end using a length of plain wire tied to the fence end and then knot the line wire and the plain wire together. Instead, the line wire can be pulled past the strainer post by hand and tied around the fence end to eliminate the inefficient knot.

136. With this method, it may be necessary to pull in 25 to 50 mm of wire after the correct tension is reached to allow for lack of tension in the wire between the strainers and the fence end.

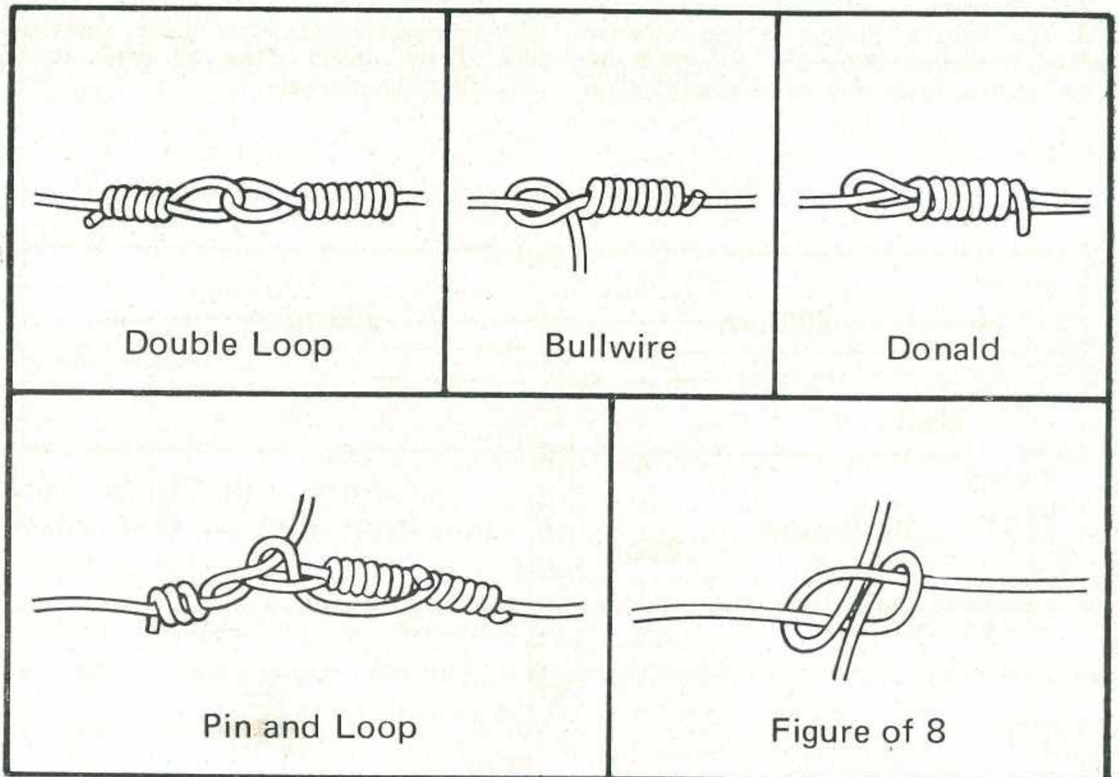
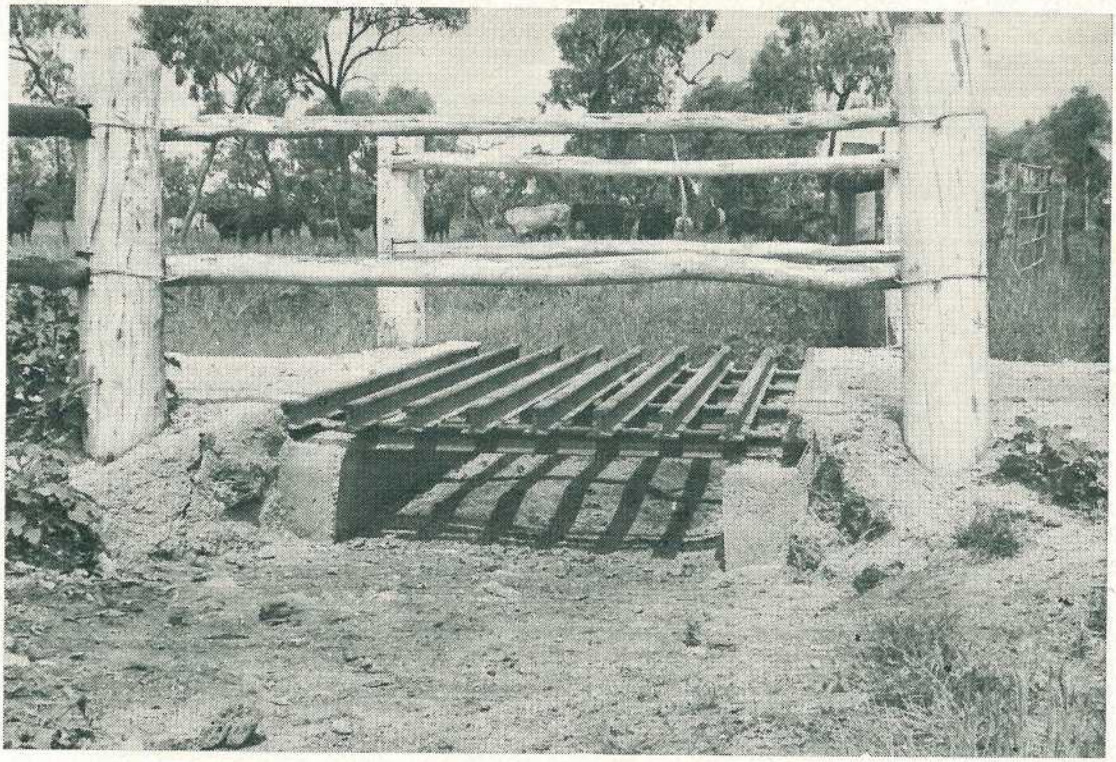


Figure 7



Stock learn to walk grids if they fill with soil. A well cleaned out grid will prevent stock trying to cross and may prevent a serious accident.

137. Another method of eliminating the knot is erection of a dummy strainer post (figure 8) behind the fence end. When the wire is strained to the correct tension it is stapled to the post to hold it temporarily and then tied off around the fence end in the normal manner.

138. If strains of 400 m are to be used with fabricated wire it is almost inevitable that the wire will be joined as there are very few types of fabricated wire fencing made up in rolls of this length.

139. Bishop found that the most efficient knot for fabricated wire was the double loop. Its efficiency varied from 61 to 84% of the strength of the wires in which it was tied. The figure-of-eight knot gave comparable, but slightly lower results, and was much more difficult to tie.

140. When joining rolls of fabricated fencing, remember that vertical wires from both rolls must be parallel. This is not easily achieved when using figure-of-eight knots. The easiest way to achieve it is to tie a vertical from one roll against a vertical of the other. This is very simply done using double loop knots.

141. The knots commonly used to join wire are shown in figure 7. It is worth mentioning that it is possible to tie the figure-of-eight knot incorrectly. The method shown in figure 7 is correct.

Tying off the wire

142. The usual method of tying wire to the strainer is to bend the wire around the post and half hitch the short end on to the running wire tight up against the post. The knot is finished off by making three-and-a-half or four turns of the short end of the running wire (figure 5).

Hanging the wire

143. Wire may either be fixed to line posts using tie wire or staples. It should not be run through holes in the posts as this will increase the rate of corrosion.

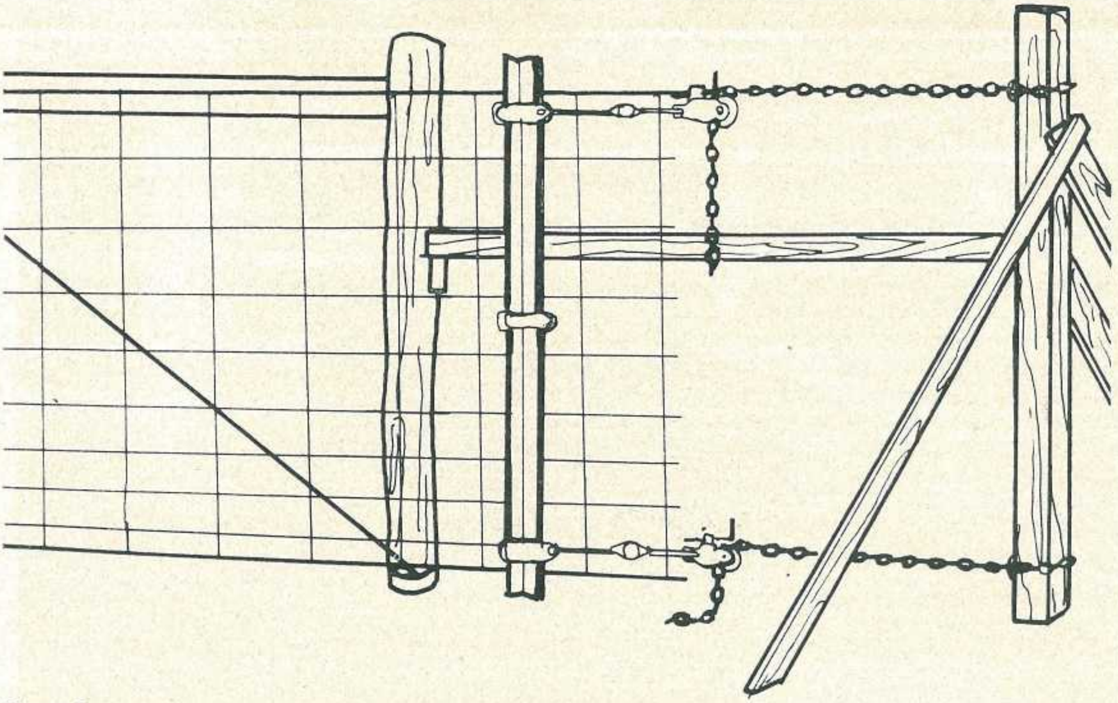


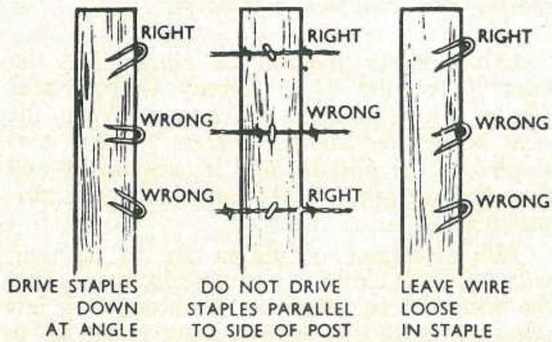
Figure 8

144. Where tie wire is used wooden posts are frequently bored with a small diameter bit and the tie wire put through the hole. The tie wire is then twisted on to the line wire. As has already been stated, this practice can cause an increased rate of corrosion in the wire (see appendix II). A similar problem occurs when steel posts are used, but the galvanizing is worn off the tie wire in this case by movement against the post.

145. Flaking of the galvanizing where the tie wire is turned on to the line wire can lead to an increased rate of corrosion. Carpogalvanized wire may overcome the problem of flaking.

146. If corrosion caused by the tie wire is a serious problem, plastic-coated wire may be worth considering.

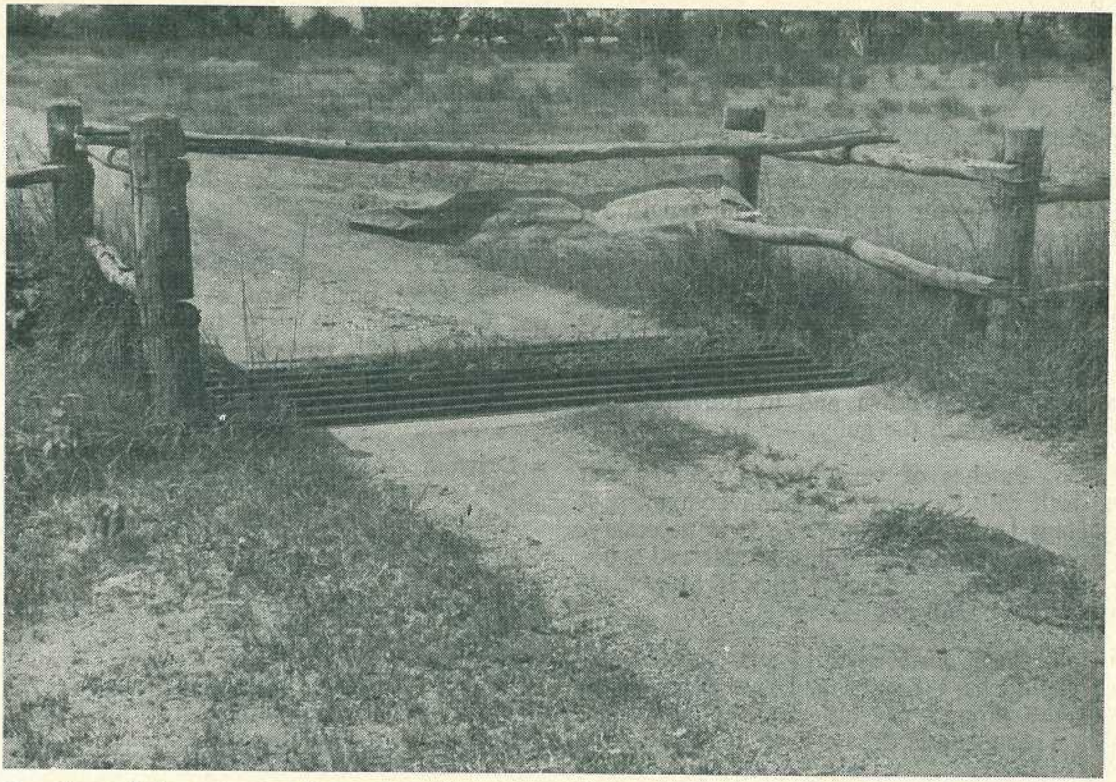
147. Most fencers cut their own ties. Do this in advance and make up the ties into bundles for carrying. Pre-formed ties are available commercially. Staples are usually only used with softwood posts. However, there is no reason why they could not be used when treated hardwood posts carrying a reasonable amount of sap are used. Provided the staples are fully galvanized they will not increase the rate of corrosion of the line wires.



Use staples as shown above for positive fixing to wooden posts.

Figure 9

148. There are a number of wrong ways to drive staples but only one correct way. Figure 9 shows the correct way to drive staples.



Sometimes it is necessary to put a rail across grids to prevent cows getting back to weaners held in yards or to prevent horses getting out of the horse paddock.

149. When fabricated wire is used, it is often advantageous to connect it to barbed wires which are run above it. This can be done with tie wire; starting from the top line of the fabricated wire take three or four twists around each barb working from the bottom one up. Commercial coupling clips made from high tensile wire are also available for this job.

SUSPENSION FENCING

150. Many of the principals which apply to the construction of conventional fencing also apply to suspension fencing but the peculiarities of construction related to suspension fencing are outlined here.

CORNERS AND ENDS

151. Normal practice is to place strainers at intervals of 400 m but with a plain wire fence strainers can be placed at intervals of up to 1·6 km.

152. Mawson says that corner assemblies should be erected each time there is a change in the direction of the fence line. Against this, Brian says that straight fences are not necessary and that straining wire around curves or indeed around an angle of up to 45° is no problem with plain wire.

Naturally, it is necessary to support posts where the fence changes direction. Depending upon the size of the angle where the fence changes direction, and how well the ground holds the support, the latter might vary from a steel post driven in at an angle to a single span assemble splitting the angle. If the assembly is to be used as a strainer, however, then use a double span assembly (see paragraph 87).

153. When broken ground has to be fenced, place strainer assemblies strategically to avoid great irregularities in the height of suspended spans from ground level. The exact placement of strainers is a matter of commonsense, but on broken ground locate them at the top of rises and near the bottom of gullies.

Line posts

154. Much of the maintenance work on conventional fences is on posts, often as a result of fire damage. The post spacings used in suspension fences greatly reduce this maintenance requirement.

155. Make the panels even in length on flat ground, but on broken or undulating ground place posts at the top of rises and towards the bottom of depressions. Unless there is a distinct gully at the bottom of a depression, place the post right in the bottom. If there is a gully, attach rails to the fence both to hold it down and to prevent cattle crawling through the gully.

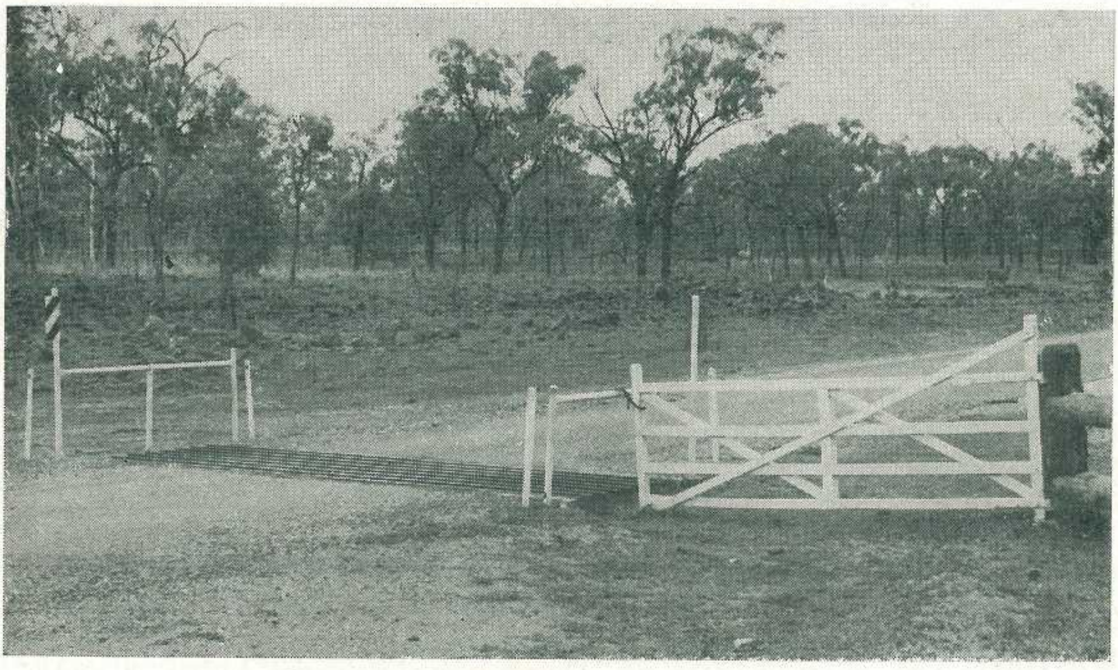
156. Patches of very broken country can be dealt with by resorting to conventional post spacings in those areas where it is necessary. Vary post spacing according to soil and topography—do not necessarily stick to even spacings if the country varies.

157. Steel posts used in suspension fencing should be 1·8 m long. Drive them 0·6 m into the ground as this gives better results than 1·65 m posts driven 0·45 m.

158. When erecting the fence over slightly broken ground and using steel posts leave them about 8 cm higher than normal until the wire is attached. Then go back and adjust the fence height to suit the topography by varying the post height. Some posts may be left a little high and others driven a little further than normal in tailoring the fence to the shape of the land.

159. Steel posts have a tendency to lift out when they are used in the bottom of depressions. This tendency is worse with suspension fences than with conventional fences. It can be overcome in a number of ways:

- Drive a steel post in as far as possible. Drive the post which the fence wire will be tied to alongside the first post. Tie the two posts together.
- Drive a 240 cm steel post in at an angle. Then straighten the post into the normal position.
- Tie a heavy weight such as a log or a stone to posts in the bottom of hollows.



It is often necessary to have a gate close to agrid so that cattle can be put through the fence.

STAPLES

160. If using wooden posts in a suspension fence DO NOT STAPLE the wires to the posts as the movement of the panels levers the staples out.

DROPPERS

161. The main function of droppers is to maintain spacings between wires.

162. With spiral twist and universal droppers, it is difficult to maintain correct wire spacing while they are being put on the fence. To overcome this, drive nails into a board at the distance each wire will be from the ground. Rest the bottom of the board on the ground and each wire on its nail while putting the dropper on (figure 10).

163. With lightening droppers, the middle wire or wires in the fence are locked into open loops. This is due to the way in which the loops are formed and the way it is necessary to twist the dropper to get the wire into the loop with the dropper in the upright position.

164. The top and bottom wires can be twisted into the open cork screw ends of the lightening dropper with the handle end of a file or a flat piece of steel.

165. Waratah h.t. galvanized steel fence droppers are fixed to the fence with special clips and a fixing tool which must be ordered with the droppers. Instructions on how to use the clips and fitting tool are included in the packaging.

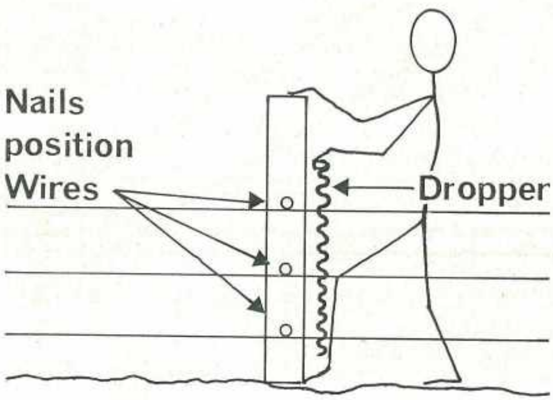


Figure 10

WIRE SAG

166. Sag in the wire can be a problem with a suspension fence if maintenance is not adequate.

Wire sag is affected by a number of factors:

- Post spacing. The greater the distance between posts the greater the sag.
- Number of droppers. The more droppers between two posts the greater the weight and the greater the sag.
- Types of dropper. Heavy wooden droppers cause more sag than wire ones. Wooden droppers long enough to rest on the ground will reduce the sag between posts but may lean over, giving the fence an 'untidy' appearance.
- Number of wires. Four and five wire fences have more problems with sag than three wire fences.
- Wire size. Thick wires are heavier and their weight produces more sag than thin wires. Thick wires are less elastic than thin ones and are therefore more likely to be stretched by heavy droppers or an impact.

167. Sag should not be a problem if you use no more than four strands of 2·50 mm wire, with post spacings of 30 m and four droppers between posts.

Gates, grids and flood gates

168. Gates, grids and flood gates are essential components of any fence and as such warrant some discussion.

GATES

169. Two basic types of gate are used commonly. These are the rigid wood or iron gate and the wire gate.

WOOD OR IRON GATES

170. Wood and iron gates are either made as a single gate or double gates. Whichever method is used the principals of gate construction are the same. The major considerations when deciding whether to use a single gate or double gates are the width of the opening and the material used to build the gate.

171. Generally, double wooden gates should be used for openings of 2·1 m or longer as the weight of longer gates is too great for the post to support.

172. Single iron gates can be used for gateways up to 3·6 m. Beyond this length, weight becomes a problem.

173. If the tall gate posts with a cross bar at the top are used the problem of weight is largely overcome and wider single gates can be used.

174. Bush timber and milled timber is used to make wooden gates. Gates made from bush timber are usually made with mortice and tennon joints.

175. When milled timber is used, the gates are seldom jointed but rather the components are bolted together. A typical gate consists of three horizontal bars bolted between double vertical bars at each end with a diagonal brace bolted to the horizontal bars (figure 11).

176. Commercially made iron gates are available but many people make their own. Iron gates are usually made of welded pipe.

177. Home-made gates usually have horizontal bars welded across the centre while commercially made gates may be filled with chain wire or weldmesh.

GATE HINGES

178. The hinges used on wood and iron gates and where they are fixed to the gate and the post affect the arc that the gate will swing through.

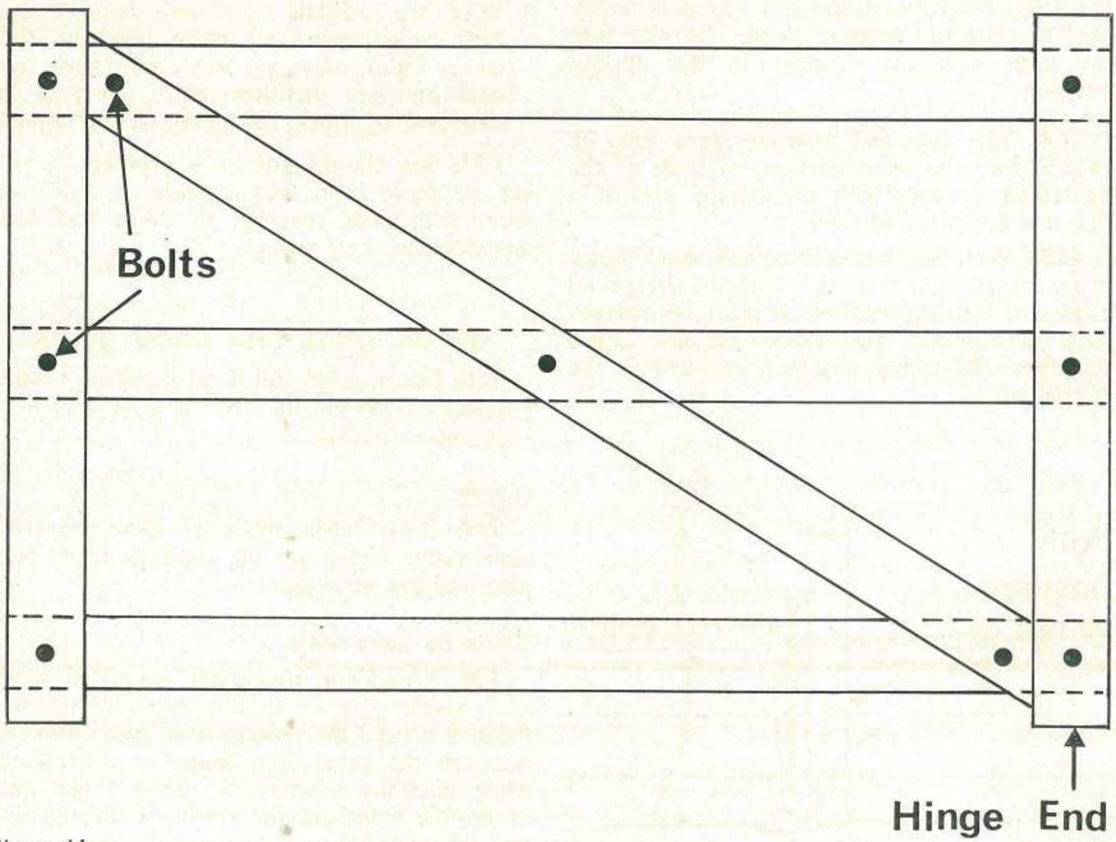


Figure 11

179. When hinges are mounted on the side of the gate they can either pivot on fixtures mounted on the side of the post (figure 12) or in the line of the fence (figure 13). In both situations the gate will swing through an arc of about 110° and will only open one way. Side mounted hinges will not allow the gate to be folded back against the fence unless the gate is in a corner.

180. Gates with 'centre' mounted hinges swing through 180°. If mounted on the side of the post they will swing back against the fence but will only open in one direction (figures 14 and 15); if mounted on the post in the line of the fence they will open both ways but not back against the fence (figures 16 and 17).

181. With a little extra time and effort a double-acting hinge that will allow the gate to open either way and at the same time swing back against the fence from a pivot point in the line of the fence can be made up (figure 18).

WIRE GATES

182. The wire gate or 'cocky' gate is probably the most commonly used (and most maligned) gate on Queensland cattle properties. At its most basic, it consists of three or four strands of barbed wire tied between two sticks or steel posts and is barely long enough to close the gap it is designed to fill.

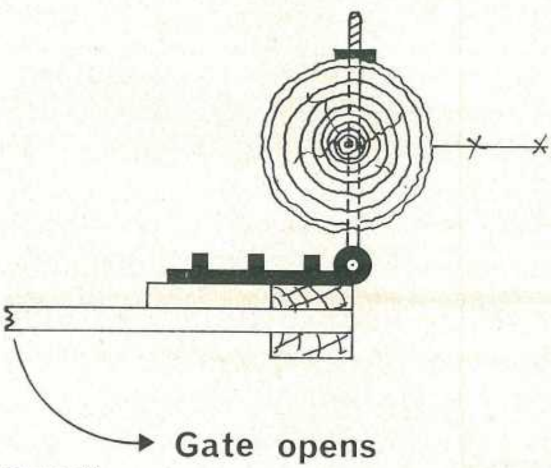


Figure 12

183. The stick at one end of the gate is tied permanently to one of the gate posts while the stick at the other end is fastened by one of a number of more or less easily secured latches to the other post.

184. Attempts to improve on the design of wire gates have usually only resulted in the addition of one or more 'droppers' to the gate. The droppers help to prevent the wires becoming tangled when the gate is opened but if the gate is a long one and there are a number of heavy wooden droppers on it they can sometimes cause tangles.

185. Further improvements to the wire gate were reported by Marlowe in the January 1969 edition of the *Queensland Agricultural Journal*. These improvements produce a gate which can be opened from a horse and which costs little more than the usual wire gate (figures 19 and 20).

186. GATE LATCHES. Wire gates made to the designs suggested by Marlowe can be latched either with a chain around the post and the upright or with a wire loop over the top of the upright.

187. The normal wire gate requires a loop at the bottom of the strainer to hold the bottom of the stick and is secured at the top by any one of four common methods.

188. The methods of securing the top of the gate are: a loop of wire which is attached to the top of the strainer and which drops over the top of the gate stick, two methods involving a stick tied to the strainer with a short length of chain or wire that wraps around the gate stick (figures 21 and 22), and a loop that passes through the strainer to a tension pole.

189. The wire loop attached to the strainer is the latch which causes most difficulty. It is often too tight. The other methods cause little difficulty although if the tension pole is used it should not be too heavy; a long, light pole being easier to use than a short, heavy one.

GRIDS

190. Grids made from railway line or pipe are available commercially in a range of sizes and load capacities. They are an expensive item to purchase or build and install and the loads they will be expected to carry and the width of the trucks that will cross them should be considered carefully before a choice is made.

191. Wooden grids are still made occasionally by some producers but they are also expensive. Specifications used for Main Roads Department grids are shown in figure 23.

192. One of the main problems with grids is that they have a tendency to fill with dirt as time passes. This problem can be reduced (but not eliminated) if the grid is built on top of the ground and the road built up to the level of the grid. If this method of installation is adopted avoid having short sharp ramps leading up to the grid as they tend to throw the back end of the vehicle into the air at low speeds and can completely launch a vehicle into the air at higher speeds.

193. Remember also that the traffic will compact the newly built-up roadway and some maintenance of the approaches may be needed soon after the grid is installed.

194. If a grid does fill with soil it should be cleaned out before stock begin to walk across it. Stock trying to cross a grid are likely to get feet trapped between the rails and may be injured or cause a vehicle using the road to have an accident. Also some stock learn to walk grids and one that needs cleaning out is only encouraging them to learn.

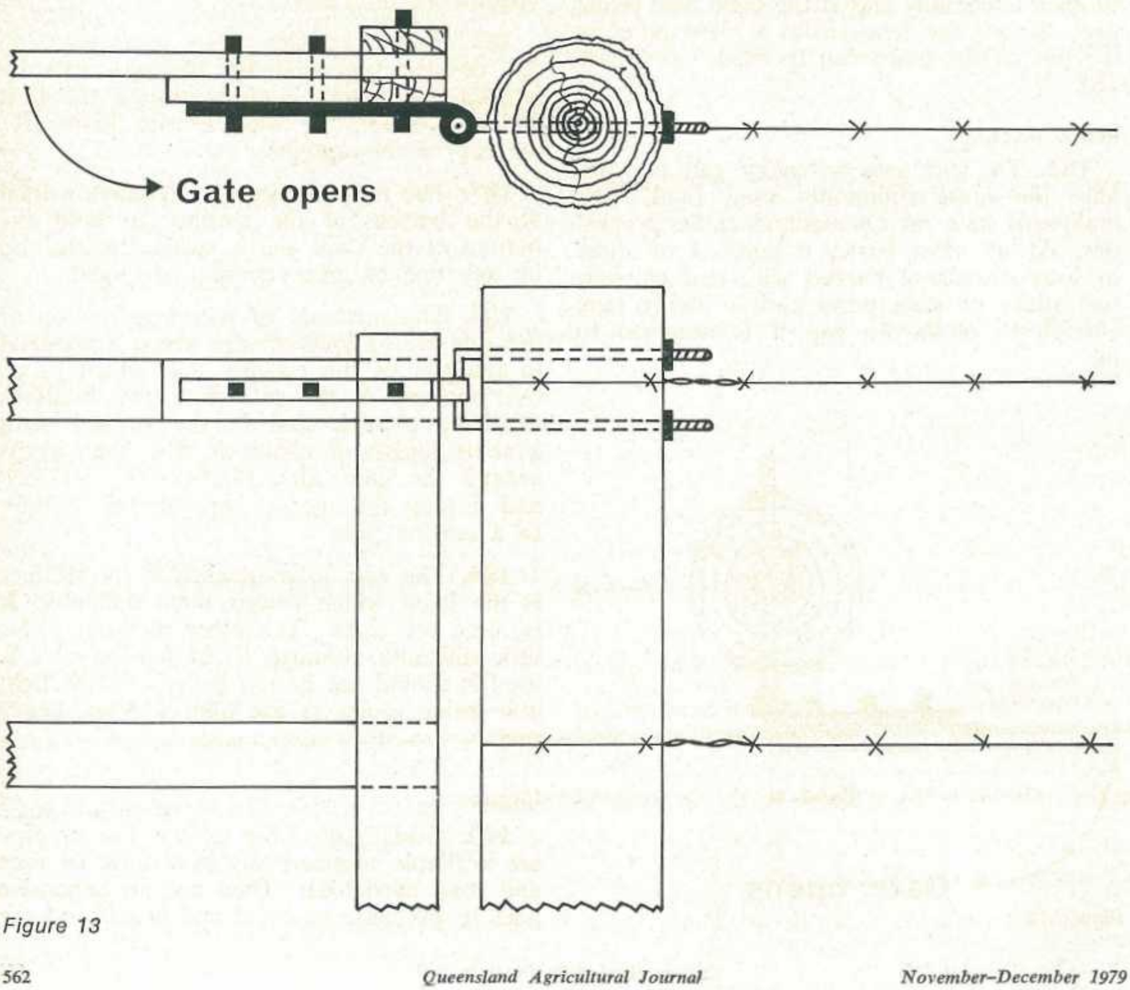


Figure 13

195. Grids make travel convenient as they replace gates on roadways. However, there are two problems which often occur. The first is that it is usually necessary to have a gate close to the grid so stock can be put through the fence. The second problem is that it is often necessary to put a rail across grids to prevent cows trying to get back to calves weaned in yards or to stop horses getting out of the horse paddock.

196. It is also usual to stand a post at each corner of the grid and either barbed wire or rails between the posts parallel with the road. This prevents stock trying to get around the end of the fence. In some cases people place a strainer post in the middle of each side behind the rails. This would appear to be no more effective than using one of the corner posts as the strainer, but is certainly more expensive.

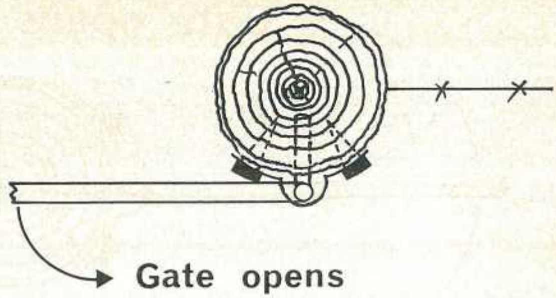
Flood gates

197. Flood gates are usually constructed on one of two principals—either a cable is strung across the floodway and rails suspended from it, or a 'normal' fence is built and soft wire used to tie the fence to the strainer assembly at one side of the floodway.

198. When the first alternative is used, a cable is sometimes made up by twisting a number of strands of plain wire together but at other times commercially made (albeit secondhand) steel cable is used.

199. With the normal fence, it is often necessary to tie rails to the bottom of the fence in places to hold it down and prevent stock crawling underneath. The soft wire used to tie the fence to the strainer allows the fence to give and be pushed aside under pressure of flood waters. This prevents the whole fence from being washed away and reduces losses in time and materials.

200. Mr R. B. Clapp formerly of 'Langi Oonah', Bonshaw, N.S.W. designed and patented a flood fence after many standard fences on his property had been swept away by floods in the Dumaresq River. This was described in an article in the August 1974 edition of the *Queensland Agricultural Journal.*



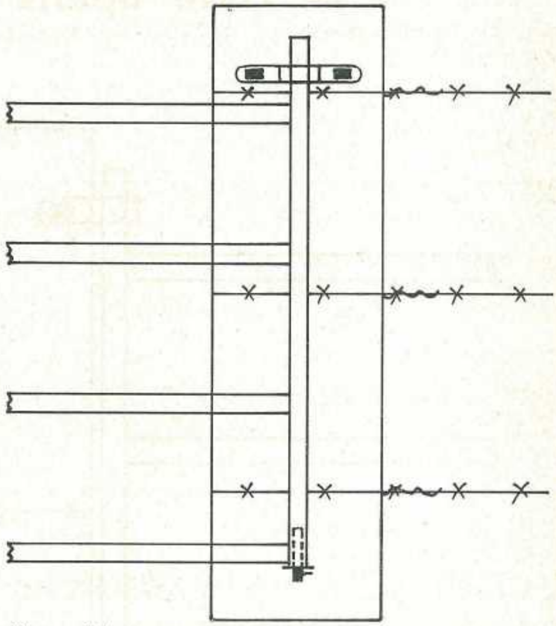


Figure 14

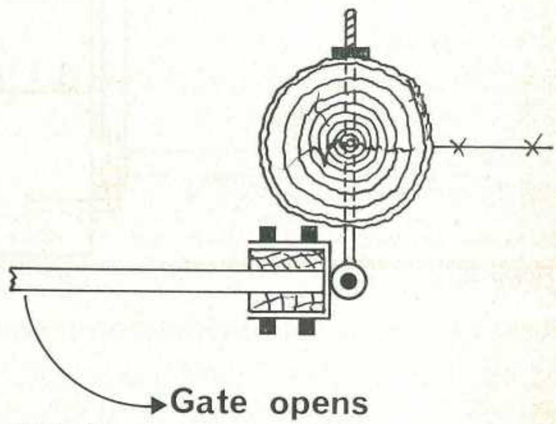


Figure 15

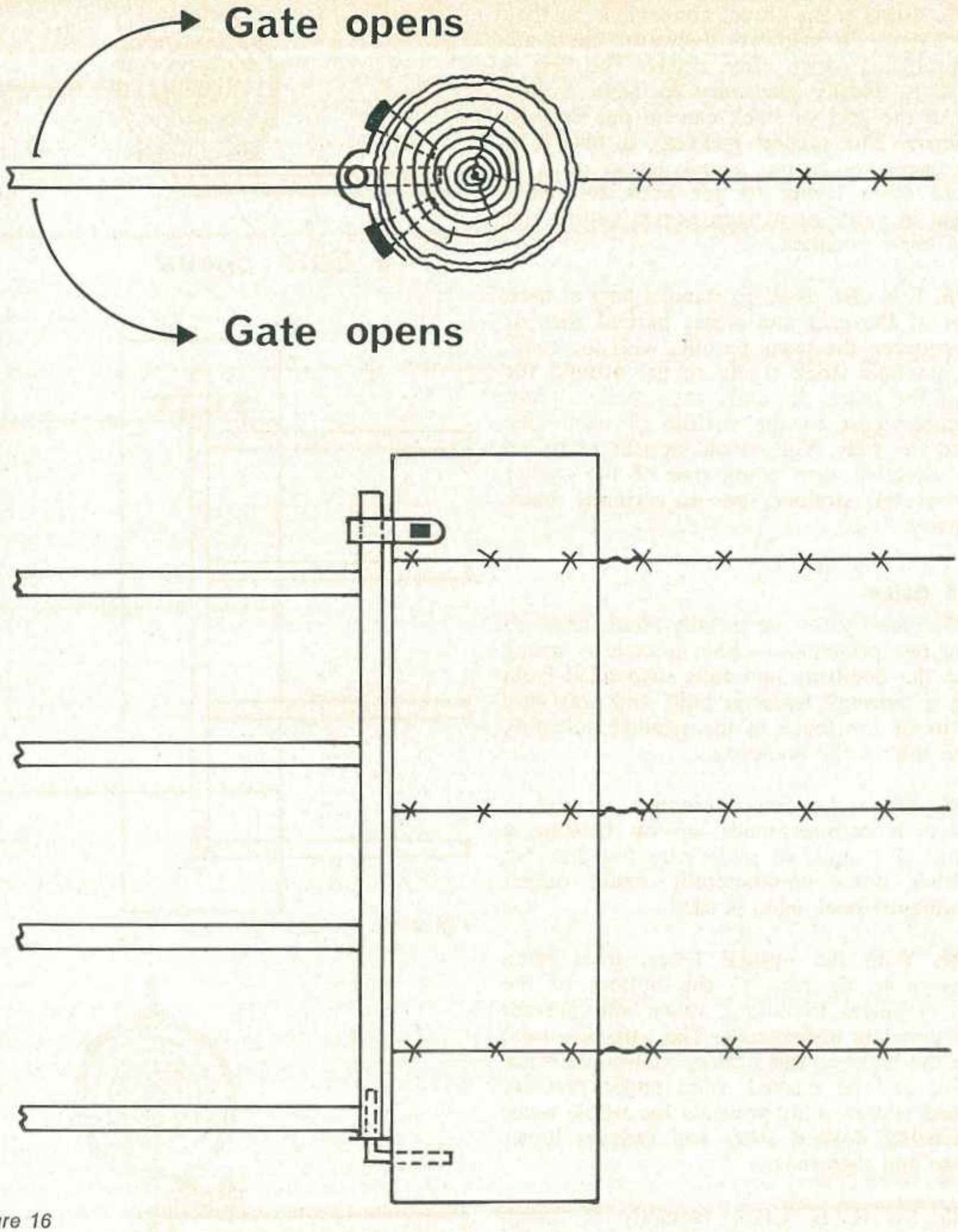
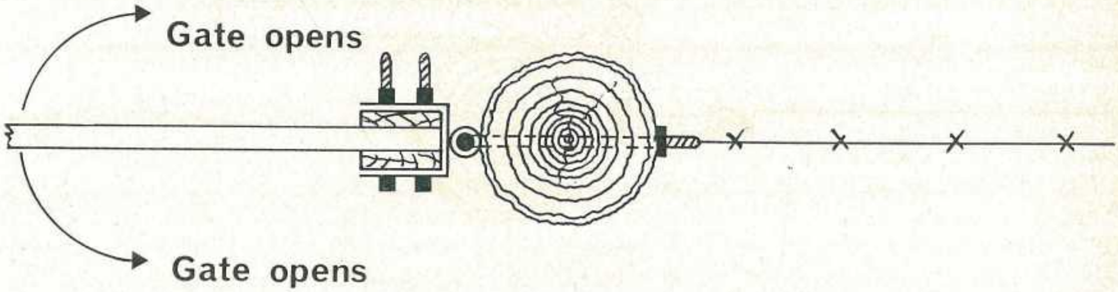


Figure 16



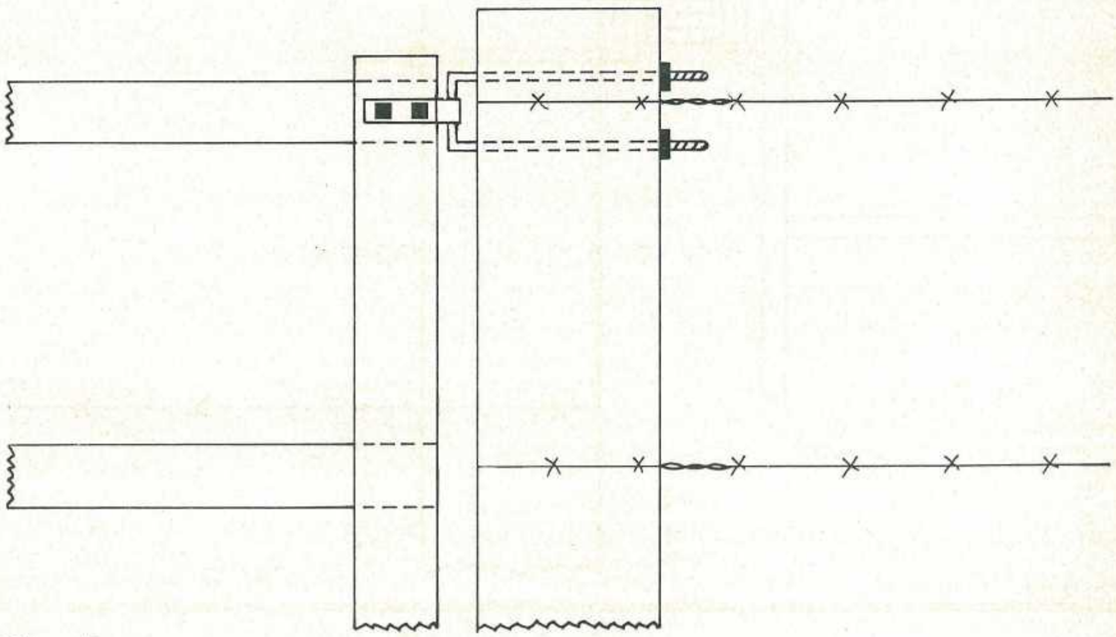


Figure 17

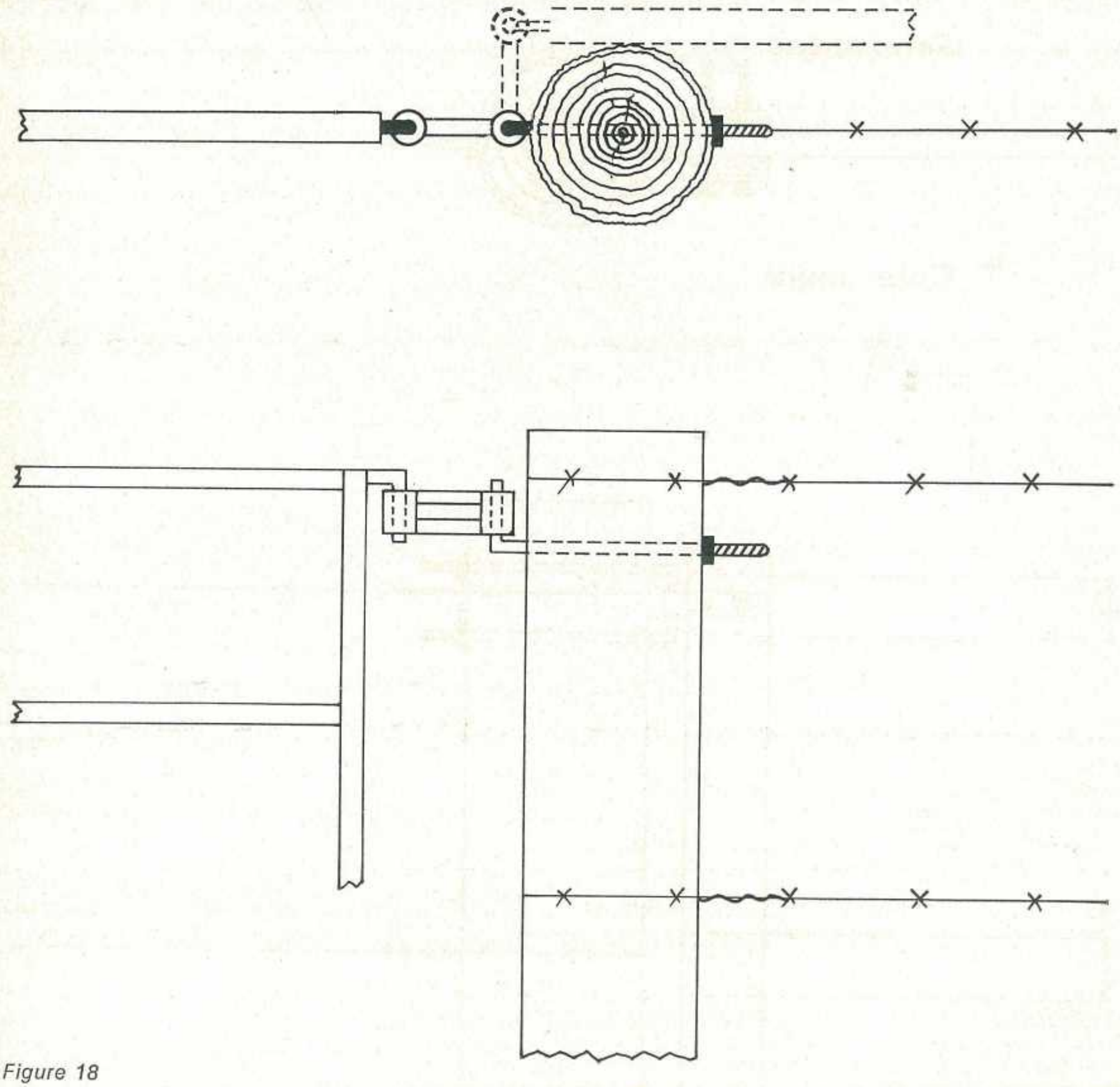


Figure 18

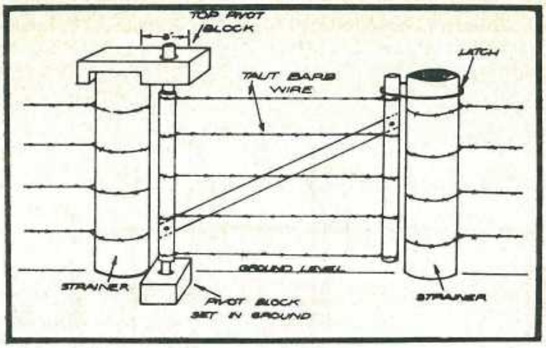


Figure 19

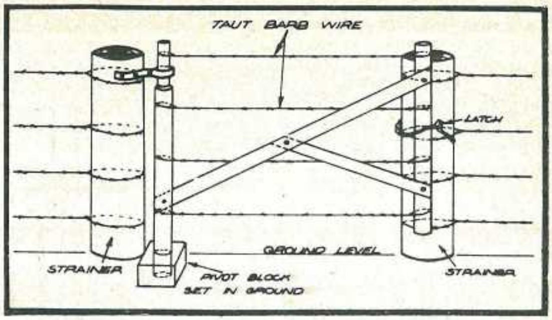


Figure 20

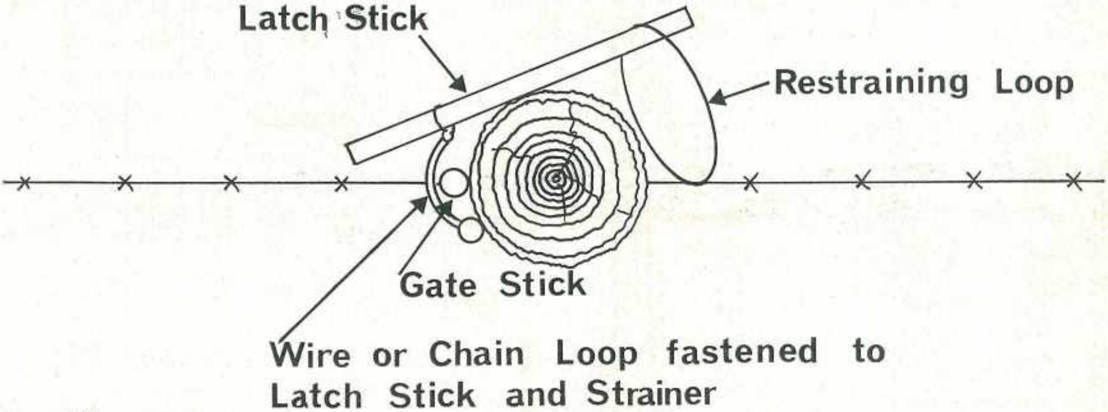


Figure 21

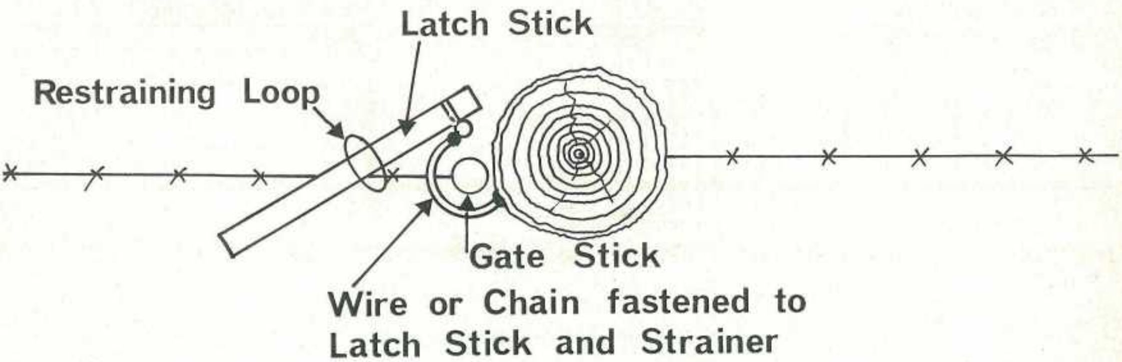
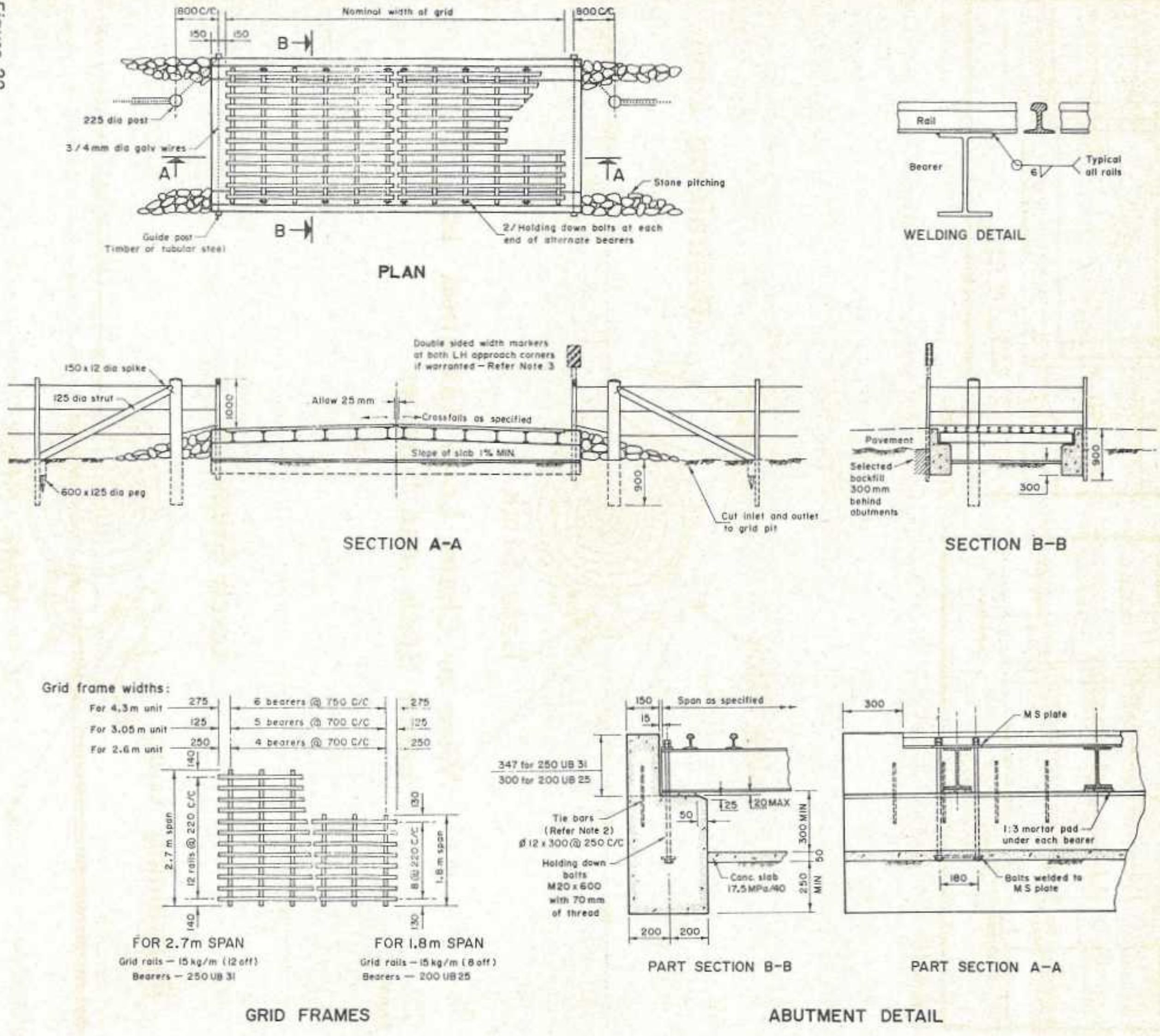


Figure 22

Figure 23



800 C/C
Nominal width of grid
800 C/C
150
150
B
225 dia post
3/4mm dia galv wires
A
A
Stone pitching
Guide post
Timber or tubular steel
B
2/Holding down bolts at each end of alternate bearers
PLAN
Rail
Bearer
6
Typical all rails
WELDING DETAIL
Double sided width markers at both L.H approach corners if warranted – Refer Note 3
150 x 12 dia spike
125 dia strut
1000
Allow 25 mm
Crossfalls as specified
Slope of slab 1% MIN
600 x 125 dia peg
900
Cut inlet and outlet to grid pit
SECTION A-A
Pavement
Selected backfill 300mm behind abutments
300
900
SECTION B-B
Grid frame widths:
For 4.3m unit
275
6 bearers @ 750 C/C
275
For 3.05m unit
125
5 bearers @ 700 C/C
125
For 2.6m unit
250
4 bearers @ 700 C/C
250
140
2.7 m span
12 rails @ 220 C/C
140
130
8 @ 220 C/C
1.8 m span
130
FOR 2.7m SPAN
Grid rails – 15 kg/m (12 off)
Bearers – 250 UB 31
FOR 1.8m SPAN
Grid rails – 15 kg/m (8 off)
Bearers – 200 UB 25
GRID FRAMES
150
Span as specified
15
347 for 250 UB 31
300 for 200 UB 25
25
20MAX
50
Tie bars (Refer Note 2) Ø 12 x 300 @ 250 C/C
300 MIN
Holding down bolts M20 x 600 with 70 mm of thread
Conc. slab 17.5MPa/40
50 MIN
250 MIN
200
200
PART SECTION B-B
300
M S plate
1:3 mortar pad under each bearer
180
Bolts welded to M S plate
PART SECTION A-A
ABUTMENT DETAIL

Brucellosis tested swine herds as at 1-11-79

Aboriginal and Islanders Advancement Department, Cherbourg.	LW
P. & N. Batterham, Raby Park, Inglewood.	L, LW
R. A. & B. E. Bool, Rossvale Stud, M.S. 223, Nobby.	LW, L
D. J. Brosnan, Bettafield, Mt. Murchison, via Biloela.	LW, L
N. J. Cotter, Olarey, Goomeri.	LW
G. F. & A. M. Dean, Home Creek, Wooroolin.	LW, LB
E. Diete, 'Ettrock', Ingoldsby.	X
O. F. Douglas and Son, Greylight, Goombungee.	W
C. P. & B. J. Duncan, Colley, Flagstone Creek, Helidon.	LW
J. A. & B. L. Duncan, Ma Ma Creek.	LW
Dunlop Meats Pty. Ltd., Coondulla Stud, 8 Malkara Street, Townsville.	L, LW
L. Fletcher, 'Par-en-eri', P.O. Box 143, Mundubbera.	LW, L
K. P. Fowler, Northlea Stud Farm, Hogg Street, P.S. 1436, Toowoomba.	L, LW
M. R. & J. E. Fowler, 'Donna Lyn' M/S 195, Pittsworth.	LW
N. E. P. & M. P. Fowler, care of Kewpie Enterprises, Kingaroy.	L, LW, X
K. H. & B. Franke, Delvue, Cawdor.	LW
W. A. Freeman, Trevlac, Rosewood.	LW
N. E. & J. Geysing, Oakhurst, via Maryborough.	LW
S. C. Goodwin, Windera, M.S.F. 571, Murgon.	L
D. F. & R. F. Goschnick and W. M. & K. J. Pearce, 'Echoes', Bancroft, via Monto.	LW
T. G. & E. A. Gosdon, Naumia, Dalby.	L, LW
D. G. Grayson, Wodalla, Killarney.	L, LW
A. H. & R. N. Grundy, Markwell Piggeries, M.S. 499, Toowoomba.	L, LW
H. M. Prison, Etna Creek, via Rockhampton.	LW
H. M. State Farm, Numinbah.	
H. M. State Farm, Palen Creek.	
G. R. Handley, Locklyn Stud, Lockyer.	B
P. & R. K. Hinchliffe, Oakview, Milman, via Rockhampton.	L, LW
R. F. & V. D. Hudson, Rondel, Hogg Street, Wilsonton.	L, LW
K. B. & I. R. Jones, 'Cefn', M.S. 544, Clifton.	LW, L
C. & D. I. Kajewski, Glenroy, Glencoe, via Toowoomba.	LW, L
R. E. & 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
E. R. Kimber, Tarella, M.S. 805, Mundubbera.	LW, B
I. E. & C. C. Kimber, 'Splenda View', Coalstoun Lakes, M.S. 698, Biggenden.	L
V. F. & B. L. Kruger, Greyhurst, Goombungee.	LW
V. & C. A. Kuhl, 'The Mounts', Boodue, M.S. 222, Oakey.	LW
R. R. & L. M. Law, 'Summerset', M.S. 757, Kingaroy.	LW, L
C. J. Lorenz, M.S. 499, Toowoomba.	L
T. J. Lucas, M.S. 243, Nanango.	LW
A. L. Ludwig, Beauview, Cryna, via Beaudesert.	B
Maranoa Stud Piggery, Mitchell.	L, LW
K. Mathieson, Iderway, Gayndah.	LW
W. Neuendorf, M.S. 794, Kalbar.	B
D. O'Connor, Rollingstone.	L, LW, X
G. R. & B. J. Patch, 'Kiara', Bell.	L, LW, X
L. A. Peters, Moonlight, Bongeen.	L
Queensland Agricultural College, Lawes.	B, LW
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. & V. M. Ruge, 'Alvir' Stud, Biggenden.	LW
D. W. & L. J. Sharp, 'Arolla' Lavella, via Millmerran.	LW, L
G. A. Smith, 'Miandetta', M.S. 162, Warwick.	X
Smyth and Heness, Woorilla, Goomeri.	L, LW
L. B. & L. J. Trout, 'Caminda', Crawford, via Kingaroy.	L, B
Westbrook Training Centre, Westbrook.	B
L. J. Willett, Wongalea, Irvingdale, M.S. 232, Bowenville.	LW, L
K. Williamson, Cattermul Avenue, Kalkie, Bunaberg.	LW, L

KEY

Landrace—**L**
Berkshire—**B**
Wessex—**W**
Large White—**LW**
Tamworth—**T**
Crossbreed—**X**

Aquatic plants of Queensland part 3.

The duckweeds of Queensland

by T. D. Stanley, Botany Branch

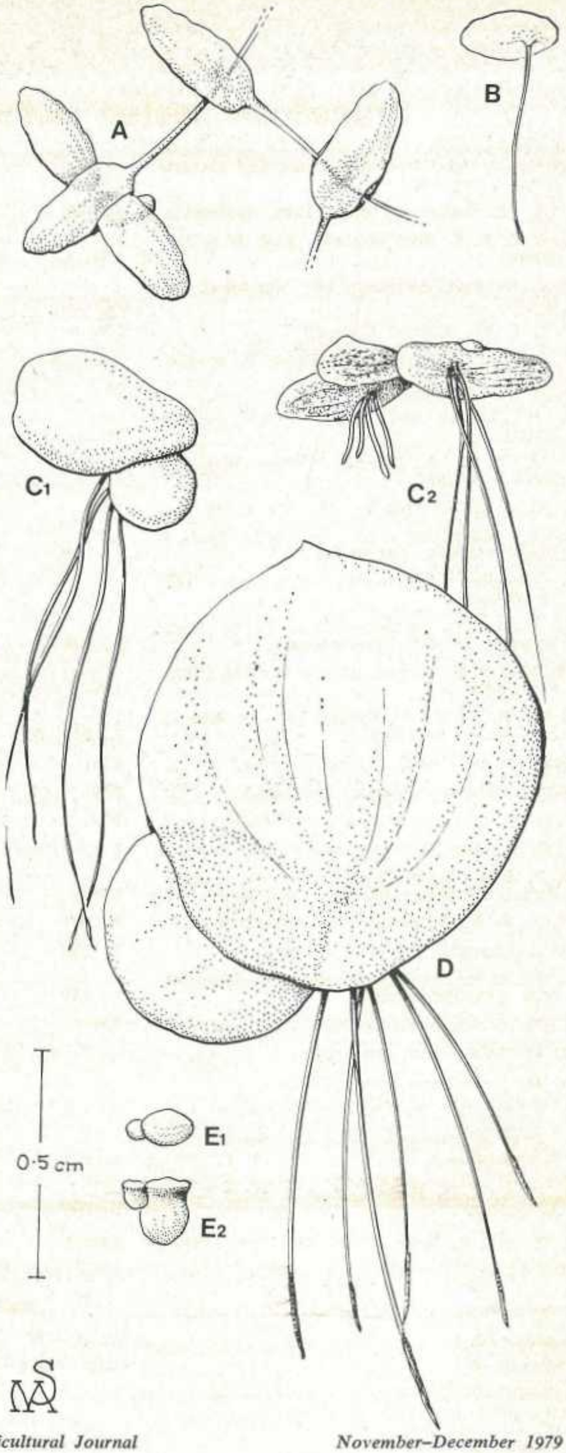
DUCKWEEDS are small, free-floating plants found on or slightly beneath the surface of still or very slow-flowing fresh water. All belong to the family Lemnaceae.

These plants are among the smallest and simplest-flowering plants in the world. One species, *Wolffia globosa,* is the smallest flowering plant in Australia.

Five species of duckweed in three genera occur in Queensland.

All of the duckweeds consist of a green, flattened or turgid structure known as the thallus. Roots may or may not be present. Each thallus has 1 or 2 lateral pockets from which small buds appear. These buds grow into daughter thalli which eventually break away from the mother thallus. This is the most important means of propogation. The plants also produce flowers in the lateral pockets. Male flowers consist of a single stamen and female flowers of a single ovary with a short style and terminal stigma. Fruits are not abundant.

During cold weather, the duckweeds usually disappear. They over-winter by seed and vegetatively by small thalli which sink to the mud and rise to the surface the following season to continue growth.



Drawing at right. A *Lemna trisulca* from above. B. *Lemna minor* from below showing solitary root. C_1 *Spirodela oligorrhiza* from above. C_2 *Spirodela oligorrhiza* from below showing roots. D. *Spirodela polyrhiza* from above. E_1 *Wolfia globosa* from above. E_2 *Wolfia globosia* from the side.

Tiny duckweed
(Wolffia globosa)

These are tiny plants often appearing as a greenish tinge on the water surface. The species is usually found mixed with other species of duckweed.

DESCRIPTION: The thallus is more or less globular with a flattened upper surface. The flattened upper surface floats at the water surface with the remainder of the thallus submerged. When viewed from above, the emergent face of the thallus is ellipitical and 0·5 m to 0·8 mm long. Roots are not present. Each plant has one lateral pocket from which the daughter thallus is budded. Only two thalli remain connected at any one time.

GEOGRAPHICAL DISTRIBUTION AND HABITAT: *Wolffia globosa* is found in still, fresh water in eastern coastal Queensland. It is usually found in association with other species of duckweed and for this reason is easily overlooked.

Tiny duckweed is also found in New South Wales, Victoria, South Australia and northern Western Australia as well as in Southern and Eastern Asia.

IMPORTANCE: When present in association with other species of duckweeds it may contribute to the blocking of pump inlets. Otherwise, it is of no real importance other than as a botanical curiosity.

Common duckweed
(Lemna minor)

This is a common species often forming dense mats of opaque green plants on the water surface.

DESCRIPTION: *Lemna minor* floats on the water surface and has a flattened, opaque, green, more or less elliptic thallus. Each thallus is 1 to 3 mm long with one to three noticeable veins. A solitary root, 1 to 5 cm long, is present on each thallus. Each thallus has two lateral pockets. The thalli remain connected in groups of two to six.

GEOGRAPHICAL DISTRIBUTION AND HABITAT: Common duckweed is found in still, fresh water in the eastern part of Queensland. It often occurs mixed with thin duckweed. In Australia, the species is also found in New South Wales, Victoria, Tasmania, southern South Australia, south-western Western Australia and around Darwin in the Northern Territory. It is also found throughout the world, except in the coldest areas.

IMPORTANCE: This species can block pump inlets if present in sufficient quantities but usually it is not troublesome.

Specimens from Queensland almost certainly do not represent *L. minor* in the strict sense. Some authors place the Queensland specimens in either *L. perpusilla* or *L. paucicostata*. However, because of problems in delimitation of the species, the Queensland specimens have been included in the broad circumscription of *L. minor*.

The delimitation of the species depends on fruiting characters. Fruiting specimens are seldom collected.

Ivy duckweed
(Lemna trisulca)

This species has several thalli all connected at right angles to each other by slender stalks.

DESCRIPTION: The thallus is thin and translucent, flat, broad-linear to oblong, and has a rounded sometimes notched and usually minutely-toothed apex. Each thallus contracts abruptly at the base into a slender stalk. The upper part of the thallus is 2 to 8 mm long while the stalk is 1 to 13 mm long. Two lateral pockets are present on each thallus. Roots are usually absent.

When not flowering, the plants float just below the water surface, but while flowering float on the surface, exposing their flowers to the air.

GEOGRAPHICAL DISTRIBUTION AND HABITAT: Ivy duckweed is rare in Queensland. It is known only from a few places in the south-eastern part of the State and has been collected once from near Charters Towers in northern Queensland. The species is also known from New South Wales, Victoria, Tasmania, southern South Australia, the Kimberleys of Western Australia as well as Europe, Africa, Asia and North America.

IMPORTANCE: It is of no economic importance.

Thin duckweed
(Spirodela oligorrhiza)

Plants of this common species have several roots.

DESCRIPTION: *Spirodela oligorrhiza* is a species which floats on the water surface. The thallus is flattened, opaque, green, elliptic to obovate with one to five veins usually visible on the upper surface. It is generally 2 to 5 mm long. Each thallus has two to eight roots, each usually 1 to 4 cm long. Two lateral pockets are present on each thallus.

GEOGRAPHICAL DISTRIBUTION AND HABITAT: Thin duckweed is found right along the coastal and subcoastal parts of eastern Queensland in still, fresh water. It is also found in New South Wales, Victoria, South Australia and Western Australia as well as in Southern and Eastern Asia, New Zealand and many of the islands in the South Pacific Ocean.

IMPORTANCE: If present in sufficient quantities, it can block pump inlets.

Large duckweed
(Spirodela polyrhiza)

This is the largest of the duckweeds but it is rarely collected.

DESCRIPTION: The species is surface floating with a more or less rounded thallus which is flat, opaque and yellowish-green. It is usually 5 to 8 mm long. Each thallus has 5 to 15 longitudinal nerves and many fine roots. Two lateral pockets are present on each thallus.

GEOGRAPHICAL DISTRIBUTION AND HABITAT: The Queensland Herbarium has only a single specimen of this species collected in Queensland. This was collected at Eidsvold in 1914. Large duckweed is also known from the Northern Territory and Victoria. It is found in most warm parts of the world except in South America.

IMPORTANCE: It is of no economic importance.

Field Key

1. Thallus less than 1 mm long. Roots absent .... *Wolffia globosa*
   Thallus 1 mm or more long. Roots present or absent 2
2. Roots 1 or none per thallus 3
   Roots 2 or more per thallus 4
3. Mother and daughter thallii connected at right angles to each other by slender stalks .... *Lemna trisulca*
   Mother and daughter thallii not connected by slender stalks .... *Lemna minor*
4. Thallus elliptic to obovate, usually 2 to 5 mm long .... *Spirodela oligorrhiza*
   Thallus more or less rounded, usually 5 to 8 mm long .... *Spirodela polyrhiza*

Q.A.J. subscription changes

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The new rates are: Ordinary—$9.00 per annum
Concession—$4.00 per annum

Year of a massive armyworm problem

by R. H. Broadley, Entomology Branch

IN September and October, 1978, Queensland winter cereal crop growers faced a massive armyworm outbreak.

In south Queensland (excluding the Burnett Region), 108 000 ha of winter crops were sprayed with insecticide to control the pests. Cost of this aerial spraying was $1.1 million, while direct crop damage was estimated at a further $500 000.

Yet considering the magnitude of the outbreak, yield losses attributable to armyworm damage were fairly small. The efficacy of control recommendations was a major factor in averting losses in most infested crops. The unavailability of planes and delays in detecting armyworms in crops were the main reasons for losses.

Approximately 90% of the area treated was sown to barley, though wheat, oats and canary were also attacked. This preference for barley has been demonstrated in previous armyworm outbreaks.

The species involved were the common armyworm (*Pseudaletia convecta* (Walk.)), also known as the barley grub, and the northern armyworm (*Pseudaletia separata* (Walk.)). The common armyworm was by far the most abundant of the two species, occurring in 98% of cases.

Damage

During the outbreak, two forms of damage were recorded:

- Direct defoliation caused by armyworm feeding.
- Head cutting, which occurred when high populations of large larvae developed at crop ripening.

Head cutting can lead to serious losses during a very short period. This type of damage manifested itself mainly in ripening crops—larvae fed on green stem tissue as the leaves dried out.

Spraying

Guidelines for spraying in the form of economic injury levels were developed to assist spray decision making.

Almost all spraying was done from the air, but some ground spraying was attempted during periods when planes were unavailable. Despite difficult conditions with windy and showery weather, high levels of control were achieved and, considering the total area involved, very few reports of poor results were received.

A single application in ripening crops was invariably sufficient when spraying was carried out in the latter stages of crop development.

Chemicals and formulations

Approximately 75% of the sprayed area was treated with chlorpyrifos 350 g a.c. ha^{-1} (Nabsol, Lorsban). Both the ultra-low-volume (ULV) and emulsifiable concentrate (e.c.) formulations produced excellent larval mortality 24 hours after spraying. This meant that the critical head cutting activities were curtailed almost immediately. The remainder of the crops were sprayed with trichlorfon 550 g a.c. ha^{-1} (Lepidex, Dipterex) or maldison ULV 700 ml ha^{-1} (Malathion ULV).

The efficacy of Departmental recommendations (except maldison ULV which could not be applied by ground equipment) was confirmed by subsequent small plot studies.

Natural enemies

Few predators of the armyworms were active during the outbreak and larval parasitism by native beneficials accounted for only a small percentage of the pests.

Recently, the Queensland Department of Primary Industries introduced a small parasitic wasp (*Apanteles ruficrus* Haliday) from New Zealand. The insect is being bred and released in Queensland and it is hoped that it will assist in reducing the armyworm problem in future years.

Subject index to volume 105 (1979)

index to pages and parts

Guide to pages

January–February .. 1–96
March–April .. 97–192
May–June .. 193–288
July–August .. 289–384
September–October .. 385–480
November–December .. 481–576

Aflatoxin .. 279
A.I. bull motel .. 299
training .. 229
Airstrip, farm .. 104
Ammonia, anhydrous .. 157
Apple growing .. 241
Aquatic plants pt. 2 .. 115
pt. 3 .. 570
Armyworms, field crops .. 433
problem .. 573
Australian carcass bruise scoring system .. 281
Barley guide, planting .. 239
Beef fat, measurement .. 54
Bentley cravat .. 521
Brucellosis eradication, Strain 19 .. 353
Bruising, tail tagging .. 113
Bursaries .. 396
Cabbage pests .. 222
Calf crush and cradle .. 2
Calves, creep feeder .. 321
Carcass, bruise scoring system .. 281
Cassava .. 58
Cattle, dairy, winter forage crops .. 121
management, crush and cradle .. 2
fencing .. 529
motor bikes .. 399
disease, ephemeral fever .. 401
worms .. 309
Celery, Septoria leaf spot .. 317
Cereals, winter weed control .. 332
Cottontails .. 203
Crops, field, armyworms .. 433
Cultivation, rice .. 194
Dairy industry, molasses .. 450
management, Bentley cravat .. 521
sheds .. 499
tropical pastures, irrigated .. 219
Dalby, wheat .. 405
Disease, bovine ephemeral fever .. 401
Dog, feeding .. 162
Displays, D.P.I. .. 302
Eucalypts, flowering times .. 363
Feeder, calves, creep .. 321
Feeding, economic, dog .. 162
Felt making .. 423
Fencing, cattle .. 529
Fertilization, phosphorus, white clover pastures .. 234
Flower production .. 163
Forage crops, winter, dairy cattle .. 121
Grain yields, measurement, test strips .. 188
Grape growing .. 8
Grass strips, parallel .. 198
Grazing stylos .. 109
Grevilleas .. 177
Guide, chemical, weed control, winter cereals .. 332
planting, grain sorghum .. 515
varietal, winter grazing .. 174
Helicopter mustering .. 52
Horses, shoeing .. 493
tetanus .. 478
Insects, navy beans .. 290
Inspection, meat .. 306
Irrigation, peanuts .. 31
tropical pastures, dairy industry .. 219
Landslip, Maleny plateau .. 145
Leptospermums .. 463
Maleny plateau, landslip .. 145
Measurement, beef fat .. 54
Meat inspection .. 306
quality .. 205
Brahman and British .. 208
Milk, production, ryegrass/clover pastures .. 444
sheds .. 499
Minimal disease pigs .. 272
Molasses, dairy industry .. 450
Motor bikes .. 399
Mustering, helicopter .. 52
Native plants, aquatic pt. 2 .. 115
pt. 3 .. 570
bursarias .. 396
eucalypts, flowering times .. 363
grevilleas .. 177
leptospermums .. 463
wattles, bipinnate-leaved .. 211
flowers in globular heads, pt. 1 .. 524
flowers in spikes .. 337
woody vines .. 374
Navy beans, insects .. 290
Owner-classer .. 326
Parvovirus, pigs .. 327
Pasture grass, setaria .. 136
ryegrass/clover .. 444
sown, South Burnett .. 386
sulphur deficiency .. 45
tropical irrigated .. 219
wet tropical coast .. 98
white clover, phosphorous fertilization .. 234
Peanuts, irrigation .. 31
Pests, cabbage .. 222
soybean .. 355
Phosphorous fertilization .. 234
Pastures, temperate .. 482
Pea, pigeon .. 487

Pigs, minimal disease 272
parvovirus 327
Pizzle dropping 35
Planting guide, barley 239

Recipes, sweet potato 94
yoghurt 383
Rice cultivation 194

Septoria leaf spot, celery 317
Setaria 136
Sheep, owner-classer 326
pizzle dropping 35
skins, drying 428
Shoeing horses 493
Soil conservation, parallel grass strips 198
Sorghum, grain, planting guide 515
Soybean, pest 355
Strain 19, brucellosis eradication 353
Stylo, grazing 109
Sulphur, deficiency, pastures 45
plant nutrition 49
Sweet potato recipes 94

Tail tagging, bruising 113
Temperature, heatwave probabilities 72
Test strips, grain yield 188
Tetanus, horses 478
Training, A.I. 229

Vines, woody 374

Wacol bull motel 299
Wattle, bipinnate-leaved 211
flowers in globular heads pt. 1 524
flowers in spikes 337
Weed control, winter cereals 332
cottontails 203
Wheat, Dalby 405
varieties 153
Winter, forage crops, dairy cattle 121
grazing, crop varietal guide 174
Wireworms, false 276
Worms, cattle 309

Yoghurt recipes 383

Colour section

Some sulphur deficiences i
Foliar symptoms of copper deficiency in wheat .. v
Lambs . . . why do they die? vii
Some Queensland wattles xi
Mango varieties xiii
Some Queensland wattles xvii
Insect pests of grain sorghum part 1 xix
Foliar symptoms of sulphur deficiency in wheat .. xxiii
Insect pests of grain sorghum part 2 xxv
Foliar symptoms of nitrogen deficiency in wheat .. xxix
Minor insect pests of macadamia—part 1 xxxi
Foliar symptoms of manganese deficiency in wheat xxxv

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Foliar symptoms of manganese deficiency in wheat

by N. J. Grundon, Queensland Wheat Research Institute.

MOST soils in the Queensland wheat belt are neutral or alkaline in reaction, with pH above 6·5.

On such soils, manganese is not readily available to plants and may become deficient when environmental conditions or cultural practices depress the available supply.

Plants growing in manganese deficient soil show characteristic leaf symptoms which can be used to diagnose the disorder. This article describes the symptoms for wheat.

The symptoms

Leaf symptoms increase in number and complexity as the deficiency becomes more severe. In mild forms of the disorder, the plants turn yellow and appear to wilt. In moderate to severe stages of the deficiency, leaves and plants may die.

LEAF CHLOROSIS: The younger, upper leaves turn yellow or chlorotic, beginning firstly as a mild interveinal chlorosis in the mid-section but rapidly spreading until the whole leaf turns a pale yellow-green. At this stage, the whole plant appears yellow-green in colour with only the very oldest, lowest leaves remaining a healthy bright green.

WILTING: The plants appear to wilt, and the stems and leaves droop downwards so that the leaves lie on top of the soil (plate 1).

GREY FLECKS: Small, elongated grey to white flecks or streaks appear in the interveinal tissue towards the base of the leaf blade soon after the leaves turn yellow and begin to wilt (plate 2). As the deficiency becomes more severe, these flecks of dead tissue appear in the mid-section of the leaf, but rarely proceed further towards the leaf tip.

In acute stages of the deficiency, the dead flecks join together to form a grey necrotic area at the base of the leaf, with the leaf tip remaining yellow-green (plate 3). This large area of dead tissue at the leaf base weakens the leaf which usually bends sharply or breaks at this point (plates 1 and 3).

LEAF DEATH: When manganese is severely deficient, the youngest leaves turn a straw-brown colour and form a thatch of dead leaves at the top of the plant (plates 1, 3 and 4). At this stage, the middle leaves usually have yellow-green leaf tips and dead, grey areas at the leaf base while the oldest leaves can remain bright green in colour. The stems and oldest leaves have a wilted appearance (plates 1 and 3).

Correction of the deficiency

Manganese deficiency can be corrected by adding manganese sulphate (10 to 20 kg per ha) or manganous oxide (2·5 to 5 kg per ha) as a soil dressing at planting. If the crop is growing, a foliar spray of 0·5% manganese sulphate (0·5 kg manganese sulphate dissolved in 100 L of water) at the rate of 100 L per hectare usually corrects the disorder.

Foliar symptoms of manganese deficiency in wheat

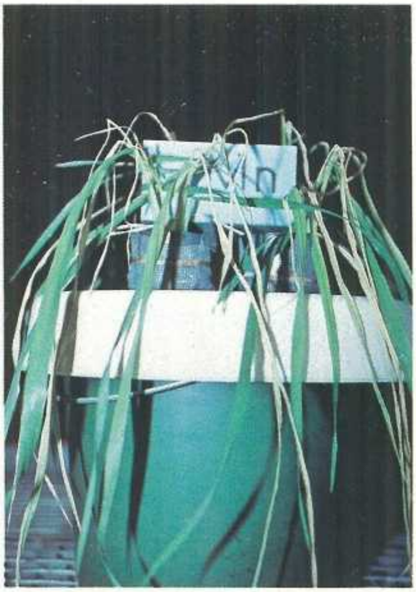

Plate 1. Wilted appearance of manganese deficient wheat. Note the dead younger leaves and the green, apparently healthy older leaves.

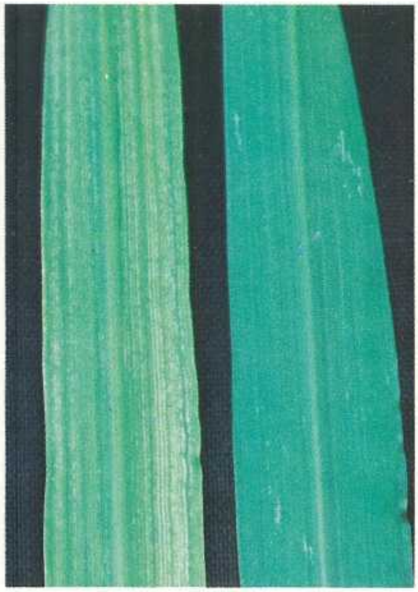

Plate 2. The grey or white flecking and streaking in manganese deficient leaf on the right is contrasted against the deep green, healthy leaf on the left.

Above. Plate 3. Wilted appearance of stems on severely manganese deficient wheat. The bases of the younger leaves have died while the bases of the older leaves are still green.

Right. Plate 4. The youngest leaves die and turn a straw-brown colour in severe manganese deficiency. Sometimes, the young leaves die before expanding from the leaf base of the older leaves.