PART 4

REVIEW OF PRIMARY INDUSTRY

History of the Condamine–Maranoa Region

EXPLORATION. Some time elapsed between discovery of the Darling Downs by Cunningham in 1827 (Fox 1921) and exploration of the Maranoa and adjacent lands. It was not until December 1845 that Lt. Col. Sir Thomas Mitchell with a party of 29 advanced from the south up the Narran River (Mitchell 1848). The expedition established its first depot at St. George's Bridge, a natural rock crossing on the Balonne River just below the present site of the St. George (Jack Taylor) weir. From here, he explored the Balonne and Cogoon Rivers before establishing a second depot to the north on the Maranoa River. Thence the expedition continued north and north-west, covering the Maranoa River and the headwaters of the Belyando and Victoria (now the Barcoo) Rivers before returning to the first depot in early November 1846. On the return trip to Sydney a month later, Mitchell encountered settlers along part of the Moonie River.

Dr. Ludwig Leichhardt, on an expedition from Moreton Bay to Port Essington in 1844 and 1845, crossed Dogwood Creek, a tributary of the Condamine River just north of the Condamine-Maranoa region (Leichhardt 1847). The only other explorer of major importance to approach the area was Augustus Charles Gregory. He crossed the upper reaches of the Maranoa River in 1858 in search of the remains of Leichhardt's ill-fated 1848 expedition to West Australia (Gregory and Gregory 1884).

SETTLEMENT AND DEVELOPMENT. Settlers entered the area from the east and south. The Leslie brothers who settled on the Darling Downs in 1840 (Fox 1921) are credited with being the first pastoralists in what was later to become Queensland. During this period, squatters arrived on the Macintyre River from the south. In 1841, 'Tinker' Campbell squatted in the Tara area near the Condamine River (Ferguson 1964) and a map of this region in 1863 shows six 'runs' covering the present-day shire.

Initially pastoral industries were based on horses and cattle. The distance from ports, and the consequent high cartage costs on wool, rendered sheep an unattractive proposition to many owners (Corfield 1959); in addition, sheep did not 'overland' as well as cattle. Legislation in 1867, which restricted the movement of sheep from Victoria and New South Wales to Queensland and was aimed at controlling the spread of 'scabby mouth', also favoured cattle (Armstrong 1970). However, during the 1870s, investment from the south allowed development of improved transport, fences, and dams for stock water, while a marked rise in wool price in 1873 combined with this to encourage sheep production. The western part of the project area received a boost with the discovery in the 1880s of artesian water supplies. By the turn of the century, development generally was further promoted by improved communications, subdivision by the Government, the introduction of machine shearing and a rise in beef prices.

Stock numbers rose steadily, and with an increasing emphasis on sheep production (Heathcote 1965), to reach peaks in 1894, 1914 and 1939. In the early 1900s, there were more than 1 000 000 sheep and 26 000 cattle in the St. George district and 600 000 sheep and 24 000 cattle around Surat, while before the 1915–1916 drought there were 500 000 sheep and 36 000 cattle in the Goondiwindi petty sessions district.

The development of extensive tracts of brigalow country was first undertaken by settlers in the Tara district shortly after 1900 (Payne 1959). Dairying extended beyond Roma at the same time, and cheese and butter factories were established at Inglewood, Millmerran, Omanama, Yelarbon and Texas. Major agricultural development did not take place until much later although isolated interest was shown in such crops as wheat, oats, maize, lucerne, grapes and tobacco. Wheat varietal trials for the area were mentioned as early as 1904 (Queensland Department of Agriculture and Stock 1904). The corresponding report for 1905 contained comment by R. E. Soutter on the development of a site of 320 ha at Bungeworgorai which became the Roma State Farm and investigated wheat, sorghum and horticultural crops and introduced grasses until 1935. At that time, the area was abandoned in favour of land further east, for the main work of the farm had become wheat breeding and testing. In the western part of the area, with the exception of the St. George irrigation scheme, agriculture was considered to have been of no importance in regional development (Heathcote 1965.)

ESTABLISHMENT OF TOWNS AND SHIRES. The Crown Lands District of Maranoa was gazetted in November 1848 when it was separated from the undefined Liverpool Plains Pastoral District of New South Wales (Taylor 1959). On his return to Sydney in 1847, Mitchell had recommended the establishment of a township on the Balonne River 32 km upstream from the junction with the Cogoon River. Accordingly, in 1849, surveyor Burrowes selected a site and named it Surat and this became the administrative centre for the Maranoa pastoral district (Armstrong 1970). In 1861, the district was divided into Maranoa East, with Surat as administrative centre and Maranoa West, with its administrative centre at St. George's Bridge and this was subsequently gazetted the town of St. George in 1863. Armstrong (*loc. cit.*) also records that the principal towns in the area in 1860 were Dalby, Condamine and Surat, while Mungindi was well established at the time of State separation in 1859.

The boundaries of the shires of Waggamba and Inglewood were established in 1879, Balonne and Warroo in 1903, Tara in 1912 and Millmerran in 1913. Goondiwindi was proclaimed a town in 1860, Inglewood in 1862, Millmerran in 1870, Bollon in 1872, Dirranbandi in 1885 and Tara in 1910.

DEVELOPMENT OF THE RAILWAY. The railway came to Toowoomba in 1867 and reached Warwick in 1871 (Camm 1970). The link to Dalby was completed in 1868, and by 1880 the line had reached Roma which was the terminus for 3 years (Taylor 1959). The Warwick line was extended to Inglewood by 1907, Goondiwindi by 1908, Talwood by 1910 and reached Dirranbandi in 1913 (Murphy 1954). The line to Millmerran was completed in 1911 while the Inglewood-Texas line was built between 1910 and 1919 (Camm *loc. cit.*). The Tara line, completed in 1911 (Payne 1959), was extended to Meandarra by 1927 and Glenmorgan by 1931 (Queensland Railway Department personal communication).

Many of the abovementioned lines were short agricultural links developed primarily for the encouragement of agricultural settlement rather than as purely commercial enterprises (Camm *loc. cit.*). Between 1870 and 1880, however, the first railways on the Darling Downs carried twice as much revenue from the cartage of wool as from the cartage of agricultural produce. Apart from benefits in transport and communication, these lines also had the effect of stimulating town growth.

SPREAD OF THE RABBIT. The rabbit was reported to be spreading north and east from western New South Wales in the 1880s. It had spread to Queensland by 1887 (Heathcote 1965) and was reported near Dirranbandi by 1890. Much of the Condamine-Maranoa basin was over-run, although the rabbits showed a strong preference for the sandy red country rather than the black soil plains. The Queensland Government in 1892 attempted to encourage control of the pest by offering to extend the tenure of lessees who erected rabbit-proof fences. Graziers tried various other means to reduce the rabbit population, including trapping, poisoning and shooting, but it was not until the myxomatosis virus was introduced in the early 1950s that the pest was restrained. The subsequent use of '1080' poison has maintained the depressing effect on rabbit populations.

THE PRICKLY PEAR PROBLEM. *Opuntia inermis* (common prickly pear) had a major impact on land use and development in the late 1800s and early 1900s in Queensland and northern New South Wales, particularly in the brigalow lands. The main sources in the following brief discussion of prickly pear are Dodd (1940) and Mann (1970).

The pear, a native of tropical America, became naturalized where it was introduced in sub-tropical Australia. The first recorded observation was in 1839 at Scone; the first introduction into the Condamine-Maranoa region was by Gore in 1843 at Yandilla. In 1888, a number of pastoralists in the Goondiwindi district petitioned for the destruction of the pear to be allowed as an improvement, while the first reports of infestation in the St. George area came in 1900 (Heathcote 1965).

Prickly pear started to get out of control in 1870; it spread rapidly after the 1902 drought, and reached a peak in 1925. By 1920, many stations had been abandoned and the leases of big runs surrendered because of the pest. At its height, the pear was estimated to have spread over 24 million hectares of Queensland and New South Wales, half of which was so densely infested as to be rendered useless for primary production. Of the area affected, 80% was in Queensland, largely between the 750 mm and 500 m isohyets, the worst-hit areas being the brigalow lands. Almost all the study area was infested to some degree except the westernmost portion; the worst affected regions were the Tara and Waggamba shires where one-half to two-thirds of the area suffered heavy infestation.

The first release of *Cactoblastis cactorum* occurred in 1926, and by 1928 the insect was destroying the two main pear pests, common prickly pear and *O. stricta* (spiny prickly pear). The early 1930s saw the collapse of the pear stands followed by heavy regrowth due to a decrease in insect population. The stands collapsed again as the insect population built up and by 1932 the pear had virtually disappeared. *O. aurantiaca* (tiger pear), the most serious of the minor pear pests, was thinned out by 80 or 90% following the introduction in 1932 of the cochineal insect, *Dactylopius* species.

AGRICULTURE IN THE CONDAMINE–MARANOA BASIN

Statistics and trends

Wheat, forage oats, grain and forage sorghums, barley, sunflower, millet and panicum are grown in the Condamine-Maranoa basin. Wheat is the major crop (appendix 6) occupying on average 53% of the total cultivated land, 18·9% of Queensland's wheat (10-year average from 1960-61 to 1969-70) being produced in the area. Forage oats and grain sorghum contribute 24% and 16% respectively to the total area cultivated and although the extent of other crops is relatively small, barley and sunflower are important. The high total area of forage crops reflects the pastoral background of most production units. Land use studies show that only 5% of the six shires is cultivated and the area of introduced pasture, although increasing, is extremely small at less than 2% of the area (map 7).

A peak of 421 000 ha under crop occurred in 1969-70, following a record wheat harvest in 1968. In 1970-71, following a dry winter and the introduction of delivery quotas in 1969-70 the first major reduction in area of cultivation in 15 years occurred. Although an increase occurred in 1971-72, the trend to a reduced rate of expansion is evident. A decrease in 1972-73 was largely due to poor seasonal conditions.

The increase in total area cultivated was regular in Millmerran, Inglewood and Warroo shires, and exponential in Waggamba, Tara and Balonne during the period 1957-58 to 1969-70 (figure 11).

Expansion into cropping did not take place until initial resource development for pastoral purposes (timber treatment, fencing and provision of stock watering points) was well advanced, progressive reduction in the size of holdings had occurred, speedy and cheap methods of handling scrub with heavy tractors were available, a buoyant financial position had developed and tax concessions were available for expenditure in development (Bott 1963). Factors which contributed to an irregular advance in agriculture suggested by the same author were miscalculation of a desirable farm size, reluctance to a change in way of life, poor machinery and technology, crop losses caused by kangaroos, wild pigs and birds, and uncertainty of optimum land use practices.

Falling wool prices, attractive wheat prices, regrowth control, the trend to diversification, suitable soils, the desire to achieve a capital gain, and the effect of the 1965 drought are included as factors in the expansion of agricultural areas (Queensland Department of Primary Industries 1971*b*). Skerman (1952) mapped areas in the Maranoa and the St. George-Dirranbandi regions, pointed out their potential for wheat growing and suggested that, unless there were a vigorous resumption project, the areas were unlikely to add significantly to total wheat plantings until leases expired after 1960.

Forage oats is usually the first crop planted after clearing brigalow forest. It takes advantage of the initial release of nitrogen and allows time for further cleaning-up of the land before crops requiring mechanical harvesting are planted. As the gilgaied surface becomes more level and as experience is gained in farming, wheat areas increase at the expense of forage oat areas. Subsequently, some land is planted to summer grain and forage crops to allow a spread of use for farming machinery and labour.

Agricultural practices have developed along normal broad-acre lines. Second-hand farm machinery has often been used in the early phase of cropping. The usual area cultivated ranges from 200 to 300 ha of combined winter and summer crops. To achieve better operating conditions, an increase in tractor size occurs in the second phase. Finally large power sources and multiple hitch equipment are employed. The acquisition of the machinery best suited to an individual's requirements is difficult. Total replacement at one time is expensive and gradual replacement is difficult to arrange due to the problem of poorly matched equipment during the change-over phase.

Cultivation practices for the winter crops vary with soil types but some factors have emerged as being important for consistent success. It is well accepted that ploughing after an October-November harvest must be carried out quickly

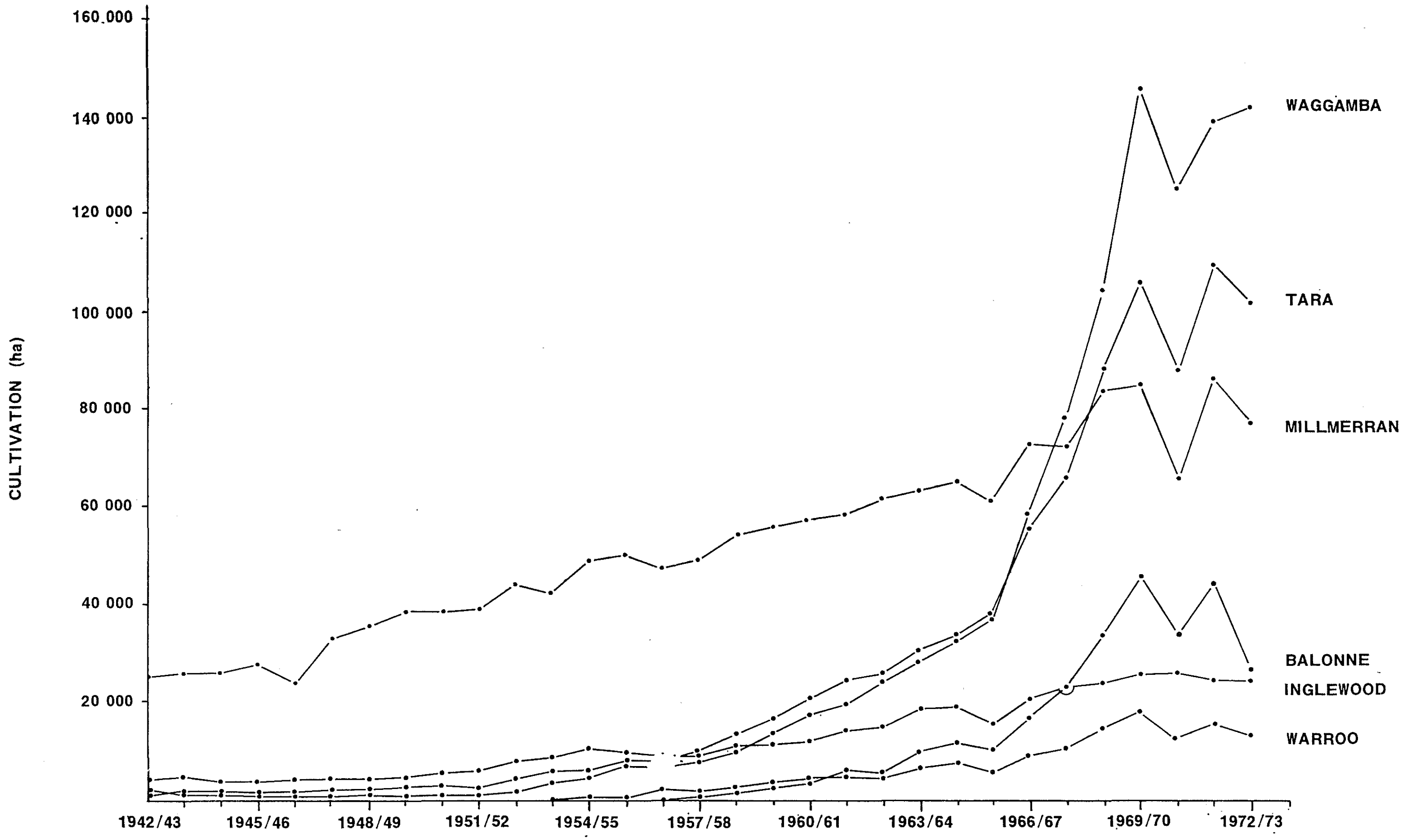


Figure 11.—Trends in the total area of cultivated land in six shires for the period 1942-1974 (hectares).

and at least before Christmas. This early ploughing cuts and incorporates wheat stubble and leaves the soil in a receptive condition for high intensity early summer storms. Successful grain growers have theorized that there is no surplus of time nor moisture for the breakdown of stubble. The procedure is contrary to soil conservation literature and Shaw (1971) recommends delaying initial cultivation in an attempt to reduce the erosion effects of summer storms. However, it agrees in principle with the work of Waring *et al.* (1958*a*) on the Darling Downs, where the available moisture at planting (122 mm) was made up of both the moisture stored during the summer fallow (56 mm) and moisture accumulated prior to the previous harvest (66 mm). Early ploughing facilitates the conservation of this moisture by halting weed growth and closing the cracks which develop in these soils. Stubble burning is not generally practised except where a high-yielding crop leaves large amounts of residue. Soil conservation officers favour stubble mulching because of the desirable effect of this practice in preventing soil erosion. *Waring et al.* (1958*a*) found no significant difference in moisture accumulation between sites stubble-mulched and those stubble-burnt and the success of its promotion will depend on demonstrating that soil erosion is reduced and stubble does not impede the planting operation. The advantages and disadvantages of the alternative methods of handling crop residues have been reviewed (Queensland Department of Primary Industries 1972) and it was concluded that no simple recommendation would cover all situations.

Given suitable grain prices the area will continue to expand its wheat plantings. Because of the closely integrated agricultural and pastoral enterprises the areas of forage crop will also expand.

Climate in relation to agriculture

The essential principle emerging from studies of the relationship between single climatic factors and the geographical distribution of plants, animals and soils is to correct for the decreasing efficiency of rainfall under rising temperature by means of a function involving both (Prescott 1934). Estimates of crop and pasture growing seasons which consider the Condamine–Maranoa basin have been prepared (Andrews and Maze 1933; Davidson 1935; Prescott 1938; Miles 1947; Farmer *et al.* 1947; Prescott and Thomas 1948-49; and Thornthwaite 1948). Miles (*loc. cit.*) determined that the pastoral growing season ranged from 2 to 6 months from west to east while the agricultural growing season was 2 months in the Inglewood and Millmerran shires.

The development of water balance models has allowed more accurate estimation of growing seasons. Most notable of the programs used in Australia for the estimation of soil water regimes is the WATBAL program (Keig and McAlpine 1969*b*). The storage and retrieval of climatic data has been simplified by the preparation of the AUSTCLIMDATA program (Keig and McAlpine 1969*a*) which contains data for two centres within and five centres in close proximity to the study area.

Even without the plant growth data which would allow precise simulation of crop growth, the water balance technique affords the most realistic means of comparing the plant growth environment at different centres. J. S. Russell (personal communication) has made available a water balance program which employs daily rainfall data summed into 5-day periods, monthly evaporation figures derived from pan evaporation data, a run-off function following that of Fitzpatrick and Nix (1969) and an apportioning of moisture into two stores. The first of these (Store 1) is related to available soil moisture and the second (Store 2) to moisture below wilting point. The allocation of moisture to each store can be varied to account for different soil textures, common ratios and their respective soil types being: 60:40 for a loam or clay-loam, 70:30 for a sandy loam, and 75:25 for a loamy sand. This program has been applied to daily rainfall data for the period 1937 to 1968 for six centres within (Tara, Goondiwindi, Surat, St. George, Dirranbandi, Bollon) and three centres outside (Dalby, Roma, Charleville) the Condamine–Maranoa basin.

Figures containing histograms of monthly rainfall and evaporation and a graph of mean available soil moisture for a loam or clay-loam soil using the above program have been prepared (map 3). The period of maximum soil moisture storage is winter. A second but lower peak of favourable moisture occurs during February-March for the more easterly centres. The misleading effect of early spring rains for planting summer crop is revealed by the decline in mean available moisture until late December or early January. Thus winter cropping will be more successful than summer cropping, and December-planted summer crops will have more favourable moisture conditions than spring-planted crops.

The probability of having moisture available for plant growth is also determined for the nine centres (figure 12). A comparison of the cropping environments at Dalby, Tara and Goondiwindi shows very similar probabilities for the winter period while Dalby has higher probabilities in the late summer and spring. A comparison between Dalby, Surat, Roma and St. George shows a small reduction in winter probability and an increasing difference in summer and spring. The western centres of Dirranbandi, Charleville and Bollon show greatly reduced probabilities compared with Dalby except during early winter.

Using simulation techniques based on a dry matter curve, the estimated production of forage oats has been predicted (J. S. Russell personal communication). This provides a useful tool for a comparison of plant growth at different centres and on different soil types over a period of years.

At Dalby, Goondiwindi and Tara, the greater number of crops on a clay loam soil are in the 2 244 to 4 486 kg ha^{-1} range of dry matter (table 26). At St. George and Roma, the greater number are in the 562 to 2 243 kg range while at Surat a similar but wider spread occurs. In the three most western centres, the distribution indicates that most crops are low yielding. Charleville has a very high probability of low crop yields.

TABLE 26

FREQUENCY WITH WHICH PREDICTED DRY MATTER YIELDS OF FORAGE OATS FALL WITHIN GIVEN RANGES

Centre	Range of Dry Matter Yields (kg ha^{-1})						
	Less than 561	562 to 1 121	1 122 to 2 243	2 244 to 3 364	3 365 to 4 486	4 487 to 5 607	5 608 to 6 728
	%	%	%	%	%	%	%
Dalby ..	4	8	21	26	29	9	—
Goondiwindi	4	4	30	22	30	4	1
Tara	12	11	27	20	25	1	—
Surat ..	21	12	34	21	6	3	—
St. George ..	21	18	40	12	3	3	—
Roma ..	19	19	41	12	4	2	—
Dirranbandi ..	28	31	25	12	—	3	—
Bollon ..	31	43	21	3	—	—	—
Charleville ..	53	26	17	2	—	—	—

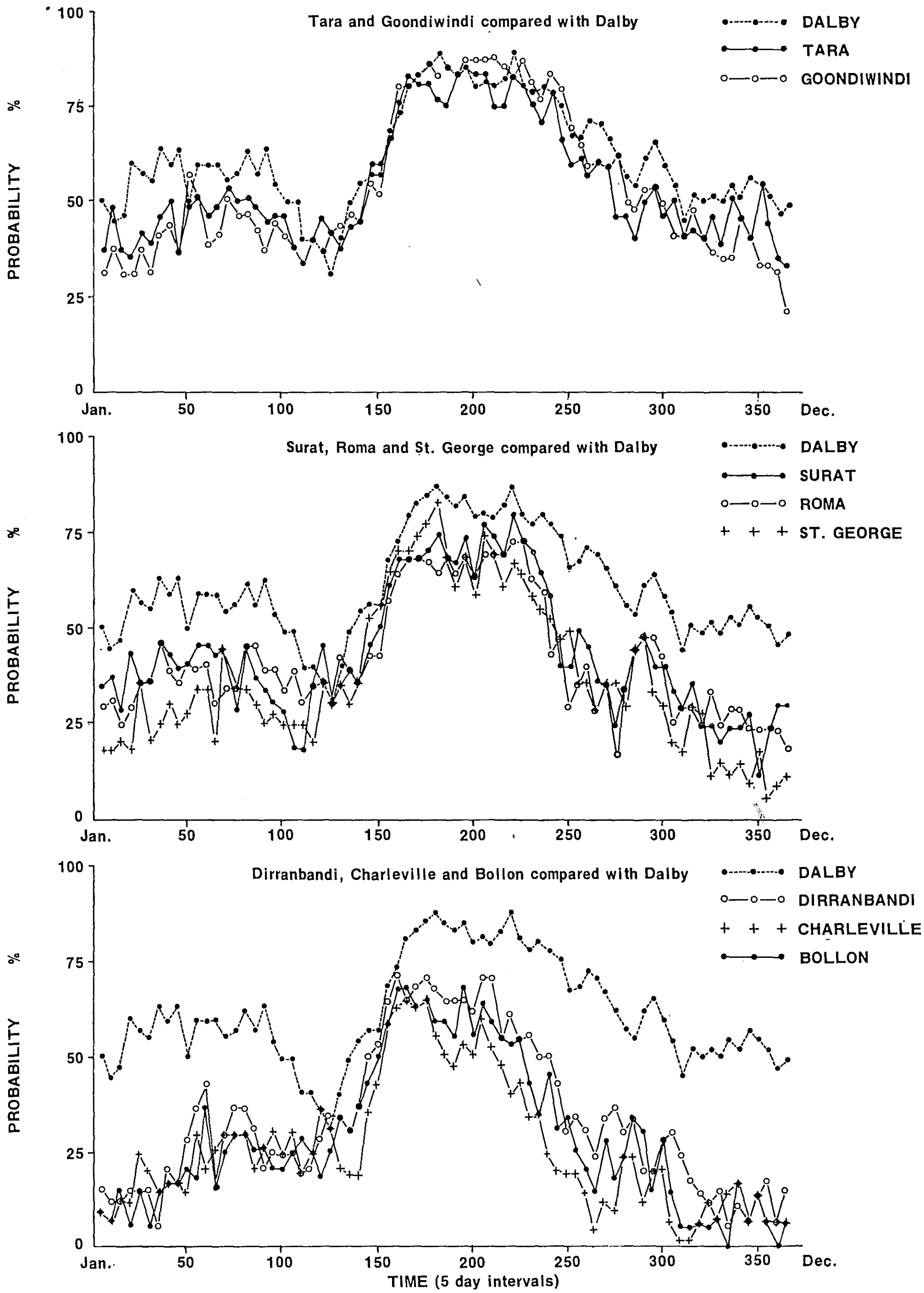


Figure 12.—Probability of moisture being available for crop growth in eight centres compared with that for Dalby.

TABLE 27

PREDICTED ANNUAL FORAGE OAT PRODUCTION (KG HA^{-1} DRY MATTER) ON TWO SOIL TYPES FOR 32 YEARS

Soil Type		Surat	St. George	Dirranbandi	Bollon
Clay loam ..	Mean ..	1 743	1 445	1 230	925
	Std. Dev. ..	1 232	1 180	1 085	724
Sandy loam ..	Mean ..	1 821	1 633	1 292	1 042
	Std. Dev. ..	1 348	1 322	1 128	928

By varying the amount of moisture allocated to each moisture store, the influence of soil type on crop performance can be examined. In marginal cropping areas, the advantages of the larger moisture storage capacity of a clayey soil can be compared with the more efficient use of small falls of rain by crop grown on a loamy soil. Soil types examined were a loam or clay loam (60:40 allocation) and a sandy loam (70:30 allocation) for the centres of Surat, St. George, Dirranbandi and Bollon. The mean production over a 32-year period varied little in response to soil type (table 27).

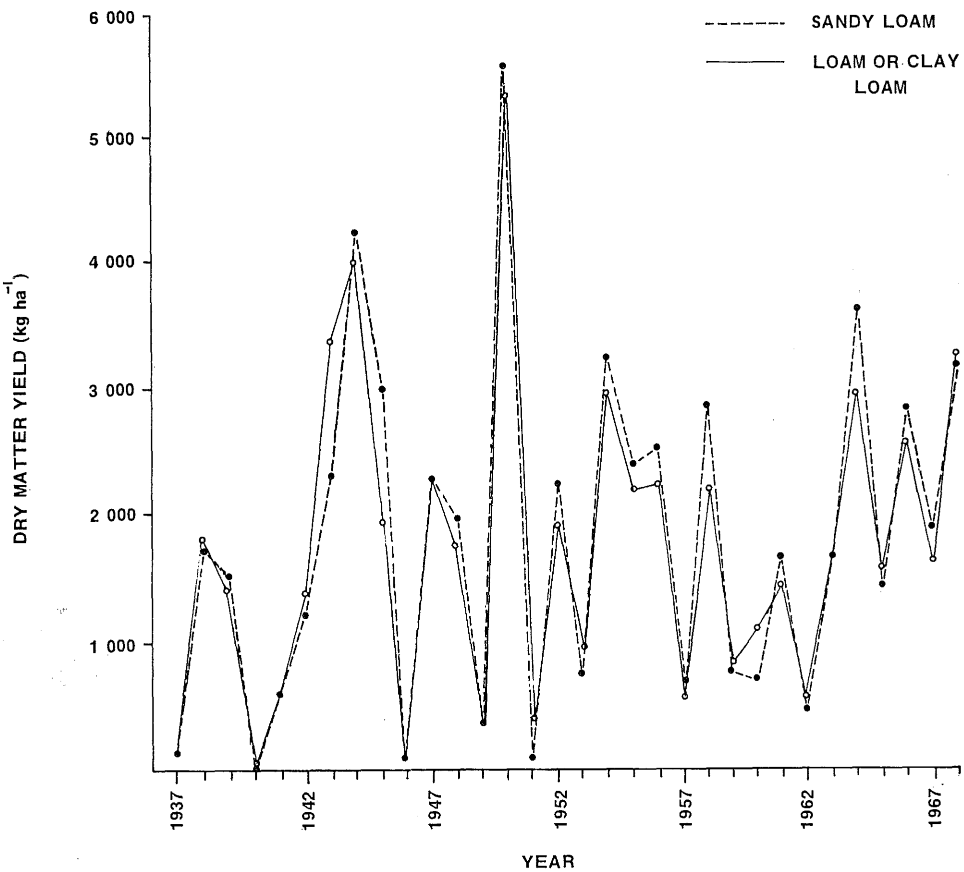


Figure 13.—Predicted yield (kg ha^{-1} dry matter) of forage oats on two soil types at Surat for the period 1937 to 1968.

The difference between centres is more pronounced; the production of forage at Bollon is approximately one-half that at Surat on a long-term basis. The figures for Dirranbandi and St. George are intermediate between the two.

On the basis of district opinion on the likelihood of growing useful forage oat crops, it is probable that the economic break-even point for this practice lies within the range shown for these four centres.

While the influence of season on production is extreme, no consistent response to soil type within season is evident (figure 13). There is an indication for the loam to perform better in above-average seasons and the clay to provide some production in dry years. However, there are exceptions to both situations and there was no significant difference between the predicted production from the two soil types for the centres examined.

Winter cropping

WHEAT. Wheat is planted on an area which averaged 205 000 ha for the seasons 1969 to 1973 inclusive. Although pastoral activities are carried out in conjunction with cropping, interest in wheat for grazing and for grain is not widespread. The suitability of the variety for grazing in the event of crop failure is an advantage, however, and awned types have lost favour because of their poor acceptance by stock. The vulnerability of non-awned types to feral pig damage is considered a disadvantage.

The major wheat-growing area corresponds with the brigalow lands of Waggamba, Tara and Millmerran shires (appendix 6). Although lighter-textured soils are suitable for wheat growing in the south-east, most growers favour heavier-textured soils with higher moisture-storage capacities. These include the grey and brown soils of heavy texture (brigalow lands, grasslands and open woodlands) and the brown clay loams characteristic of belah vegetation.

The decreasing probability of having moisture available in August and September causes many crops to experience moisture stress during the grain-fill period and yields are reduced accordingly. Growing season rainfall was correlated with yield only for the month of August for 2 dry years of a 4-year experiment carried out on the adjacent Darling Downs (Waring *et al.* 1958*b*). Sub-optimum soil moisture in spring acts to the advantage of grain quality as it is partly responsible for the grading of a high proportion of wheat from the Condamine–Maranoa basin as 'prime hard'. An average 48% of the wheat marketed from the study area is graded prime hard, the range being 88% to 1%.

Wheat is the major crop in the Condamine-Maranoa basin.

A good crop of Timgalen wheat grown in the Inglewood district.

Cultivation requirements for wheat vary little throughout the region; there is only a small increase in summer cultivation requirements in the more favoured areas. The first operation after an average crop is to plough to a depth of 10 to 13 cm with a broad-acre disc plough either singly or in dual hitch. After a light crop, the first operation may be carried out with tines. Wet summer conditions cause heavy weed growth and this may require a second ploughing. Where possible, this is avoided and secondary cultivation is carried out with tine equipment. In the early operations following ploughing, scarifiers (generally in tandem hitch) or similar heavy tined implements are employed. Later, and particularly approaching the time of planting, combines or light broad-acre cultivators are used to produce a fine tilth. Known as 'wide line' cultivators, these provide economical and effective operation on well developed cultivation land. The average number of workings following initial ploughing is three cultivations followed by planting. This, however, depends on seasonal conditions.

Management of the cultivation just before planting could explain some of the difference in results obtained by individual growers. In an area where planting opportunities are limited, the ability to plant on small falls of rain is important. Those operations which retain soil moisture close to the surface will allow planting on smaller falls of rain. A longer growing season results. Some growers have superior skills in manipulating soil tilth and depth of dry soil through a more advanced cultivation technique. The importance of small falls of rain is apparent when the percentage frequency of receiving increasing amounts of rainfall is considered (table 28). For example, during the critical planting period of May and June, the chance of receiving 25 mm of rain is nearly 20% less than the chance of receiving 13 mm of rain.

Planting time is also influenced by the probability of crop loss through frost incidence at flowering. Prevention of head formation or damaged heads and pinched grain can result from frost. Early planting exposes the crop to greater frost incidence. Nix (1969-70) considers that the major constraints upon Australian wheat crops are time of sowing rains and frost occurrence and the result is a water deficit during the post flowering phase which limits yield. Thus, planting time for wheat is a compromise between early planting when an adequate growing season can be expected and mid season planting when both frost risk and yield potential are reduced. The effect of planting time on length of growing season has been reported for Biloela (Allen and George 1956) where an April planting led to a growing season of 160 days and a June planting to one of 140 days. May and June wheat plantings over 12 years gave considerably higher yields than plantings outside these months (Coyne 1972).

TABLE 28

FREQUENCY OF RECEIVING STATED AMOUNT OR MORE OF RAIN FOR MAY AND JUNE (%)

Centre		Coomrith	Talwood	Goondiwindi	Tara	St. George	Dirranbandi
Years of Record		63	39	73	40	87	79
Month	mm						
May	13	57	69	70	57	72	59
	25	44	44	55	45	46	43
	39	30	33	37	32	—	—
	51	24	23	22	20	26	25
	76	11	18	11	10	16	18
June	13	70	90	78	77	76	73
	25	56	56	60	65	52	54
	39	41	46	47	47	—	—
	51	29	28	37	25	29	25
	76	10	13	18	15	11	13

Sources: Coomrith, Talwood, Goondiwindi and Tara data extracted from a table by Isbell (1957); St. George and Dirranbandi data extracted from tables by Wheatley (1969).

The preferred planting time in the Condamine–Maranoa basin is May–June, though planting as late as August is practised when suitable planting rain does not occur during earlier months. Although good crops have resulted from the later plantings the probability is low. Even if moisture conditions are favourable, the chance of avoiding high temperatures during maturity are poor as the mean maximum temperatures for St. George during September, October and November are 25·3°C, 29·3°C and 32·8°C respectively. Asana and Williams (1965) report a 16% reduction in yield for a 6°C rise in temperatures when three temperatures (25°C, 28°C and 31°C) were applied from a week after flowering until maturity. The risk of crop loss due to early summer rains during harvest is also increased (table 1).

Planting rates are decreasing throughout the area. Average planting rates are 9 to 14 kg ha^{-1} in the south-east and 8 to 11 kg ha^{-1} for the remainder of the area. This rate is increased to 16 to 18 kg ha^{-1} for a late planting because the plant has less opportunity for tiller development.

The cultivars of wheat planted are largely influenced by State Wheat Board requirements for prime hard grading. Each year, growers are advised of those cultivars which will be accepted for consideration for prime hard premium. In 1972-73, Mendos, the favoured cultivar for the Western Downs and Maranoa for many years was rivalled by Gatcher whose area planted had been insignificant 2 years previously (table 29). Gamut, Timgalen and Spica were next in importance. Spica is only now losing popularity after many years of preference as a type which performed well under poor conditions.

TABLE 29

AREA PLANTED (HA) OF THE SEVEN MOST PREFERRED WHEAT CULTIVARS FOR THE WESTERN DOWNS AND MARANOA COMPARED WITH SOME QUEENSLAND STATISTICS

——	Mendos	Gatcher	Timgalen	Gamut	Spica	Festiguay	Gala
1972–73 Season							
Area planted Western Downs	50 779	44 181	24 204	21 645	20 884	5 283	1 304
Area planted Maranoa ..	5 511	2 021	137	722	1 977	472	101
Area planted Q'land	106 565	145 623	87 147	83 567	43 037	20 269	4 578
Yield (Q'ld) t ha^{-1}	0·649	0·727	0·699	0·819	0·784	0·735	0·756
1971–72 Season							
Area planted Western Downs	61 526	13 360	23 771	29 480	27 087	8 919	2 931
Area planted Maranoa ..	10 701	2 916	1 827	3 332	5 386	1 532	524
Area planted Q'land	153 557	75 061	110 113	104 539	59 397	36 670	9 831
Yield (Q'ld) t ha^{-1}	1·081	1·347	1·268	1·435	1·178	1·406	1·441
1970–71 Season							
Area planted Western Downs	32 254	628	10 837	11 119	11 821	4 873	1 767
Area planted Maranoa ..	7 780	14	1 074	1 274	2 432	408	117
Area planted Q'land	93 063	4 302	66 096	45 096	24 097	26 841	6 212
Yield (Q'ld) t ha^{-1}	0·309	1·020	0·458	0·432	0·222	0·439	0·325

Source: State Wheat Board (Queensland).

A feature of the wheat yield characteristics of the area is the great variation which can occur between years. Grain growers will harvest any crop whose value is greater than the cost of the harvesting operation and some low harvest yields are recorded. There are estimates of yield for parts of the Condamine–Maranoa basin which range from 1·2 to 1·6 t ha^{-1} for the Inglewood Shire (Queensland Department of Primary Industries 1970*b*) to 1·0 to 2·0 t ha^{-1} for the Warroo Shire (Queensland Department of Primary Industries 1971*d*) while the Australian Bureau of Statistics (1958-59 to 1969-70) records an average yield for the six shires of 1·1 t ha^{-1}. Possibly the most accurate source of average statistics is the State Wheat Board. The long-term average yield determined from wheat depots throughout and adjoining the area is 1·0 t ha^{-1} planted (appendix 7).

Care must be exercised in the interpretation of these averages. The records include few years when large areas have been cropped. Also, many records are from new cultivation areas where crops are being grown by people with limited experience of the particular crop. Thus, if statistics are to be used to gauge the potential of wheat growing then the results of experienced farmers on well-established cultivation areas should be examined. It is apparent from interview data that the true potential for wheat growing is greater than the figures indicate and would represent the difference between profitable and unprofitable crops in some seasons and areas. Thus, there is a large potential return from improved agronomic practices and allowing for seasonal variations there should be a gradual increase in wheat yields in this area.

OATS. The statistics for oats growing show that forage oats is the second most important crop in the Condamine–Maranoa basin, 89% being planted for grazing and the remainder for grain. For the 4 years 1969–70 to 1972–73, an average of 63 000 ha of oats were planted annually (appendix 6). On established cultivation and in competition with wheat, oats is normally planted on soils of lighter texture such as those supporting a belah community (RO4) and those of the poplar box-sandalwood woodland community (Oc21).

The probability of profitable wheat growing diminishes as total rainfall decreases to the west. Oats growing offers an alternative and climatically less demanding form of land use where physiological maturity need not be reached to provide a useful return. The commencement of grazing depends only on receiving sufficient rain for the development of secondary roots. Consequently, the range of usefulness of oats extends farther into drier areas than does wheat growing. The importance of oats will increase in these areas because of the need for control of woody weeds (*Eucalyptus* spp. and *Eremophila* sp.) which can be achieved through cultivation.

As oats takes the place of wheat in drier areas so too will introduced pastures rival oats as the location becomes still more arid. This situation is approached in the western parts of Balonne and Warroo shires.

Cultivation procedures for growing oats, although employing basically the same machinery and having similar aims to those of wheat farming, have some major differences. Because frost does not harm oats, planting can be carried out early in autumn to take advantage of a longer growing season. The number of cultivations can thus be reduced by one in many instances. Later, when cattle fattening is completed, two courses of action are available: Use the remaining material with other classes of stock or, as with wheat, plough early to conserve residual soil moisture. Specialists in crop fattening favour early ploughing while pastoralists may decide that the benefits of spring grazing outweigh a potentially higher yield in the following crop.

The preferred planting time for slow-maturing forage oats is March-April while quicker-maturing cultivars can be sown from April to July (Martin 1965). Cultivars of different maturity are often used to complement each other. February plantings are attempted but high temperatures detract from this practice. Late planting rains are a problem for oat growers as the plant not only has a reduced growing season but the rate of development is slow due to low temperatures. Barley or wheat are occasionally substituted for oats in a late planting because of their better rate of early development under cold conditions. High temperatures in spring can cause rapid maturity of the late-planted crop leading to a short grazing season and unfinished stock.

The planting rate does not appear to be critical. On the average, 28 to 40 kg ha^{-1} of seed is planted, the rate varying more with variety than with location. Growers with weed-free cultivation keep their own seed and the local sale of planting grain has been an attractive sideline. Small areas of crop on heavier soils or a well grown portion are retained for this purpose. In high rainfall years when sufficient animal numbers are not available to utilize crop growth, oats grain has been harvested in volume and stored for its traditional role as a safe stock feed.

The most popular single cultivars planted in the Condamine-Maranoa basin are Belar (medium maturity) and Camellia (slow maturity) (table 30). Cooba, Algerian, Benton and Bentland are also planted on significant areas. A wide variety of other cultivars is encountered, the seed of which has been harvested locally for many years and whose identity may now be suspect. These types collectively are planted over a larger area than any single cultivar.

The major use of oat forage is for cattle fattening. Features which growers consider in cultivar selection are the rate of dry matter production, grazing preferences of stock, recovery rates following grazing and the ability to produce into the early summer months. From personal experience and with the aid of extension information, they select one or more types which suit their particular needs. The frequency of planting oat crops is high for a relatively low rainfall area. Although all planted crops do not provide an extended grazing period, it is uncommon not to obtain some useful grazing. It is estimated that crops are planted in more than 90% of years. This is exceeded in the Waggamba, Inglewood and Millmerran shires. Crop performance in animal grazing days is estimated for Waggamba shire as 2 470 sheep-days or 247 beast-days grazing per hectare (Bott 1963); for the Tara Shire (Queensland Department of Primary Industries 1971*b*) as 222-272 beast grazing days per hectare; and for the Warroo Shire (Queensland Department of Primary Industries 1971*b*) as 222 beast grazing days per hectare. When compared with the distribution of yields for forage oats crops as determined by simulation (table 26), the above figures appear high. This could be because animals obtain part of their intake from pasture when grazing forage oats or to a conservative estimate of yield capacity in the simulation programme.

TABLE 30

AREAS OF OAT CULTIVARS PLANTED IN SIX SHIRES FOR 1972–73 (HA)

Cultivar	Inglewood	Millmerran	Waggamba	Tara	Balonne	Warroo	Total
Belar	567	761	3 863	1 578	1 838	300	8 907
Camellia	494	1 679	1 776	2 789	650	795	8 183
Cooba	1 330	713	546	2 476	121	89	5 275
Algerian	473	1 391	648	1 974	494	32	5 012
Benton	541	879	2 375	711	337	61	4 904
Bentland	309	840	1 706	870	105	452	4 282
Minhafer	—	1 047	105	638	51	—	1 841
Saia	273	719	259	97	40	—	1 388
Other named types	126	944	664	620	124	49	2 527
Other types	1 524	1 669	4 222	3 528	1 450	1 142	13 535
Total	5 637	10 642	16 164	15 281	5 210	2 920	55 854

Source: Australian Bureau of Statistics (personal communication).

The grazing management of both stock and crop is important. Stocking rates vary from a beast to 0·4 ha in the climatically favoured areas to a beast to 0·8 ha in the drier areas. Incorrect estimation of stocking capacity can lead to a large proportion of unfinished cattle at the end of the grazing period. Animals restricted to paddocks of oats without access to some grass will not perform at their best, particularly in the early stages of grazing. A mineral supplement to prevent bone chewing is necessary on most soil types. Some oat cultivars can be set stocked (slow-maturing types) while medium or quick-maturing types may need to be spelled following an early grazing.

TABLE 31

AREA OF BARLEY PLANTED IN SIX SHIRES FOR THE PERIOD 1970–71 TO 1973–74 (HA)

Year	Inglewood	Millmerran	Waggamba	Tara	Balonne	Warroo	Total
1970–71	1 247	9 251	1 615	2 377	1 881	627	16 998
1971–72	1 994	21 329	2 724	3 732	1 461	392	31 632
1972–73	1 111	12 578	950	1 644	478	164	16 925
1973–74	1 458	16 724	3 198	2 790	1 254	405	25 829

Source: Australian Bureau of Statistics (1970–71 to 1973–74).

BARLEY. Barley is of minor importance in most of the evaluation area (table 31) and up to 70% of the total plantings can occur in the Millmerran Shire.

In 1972–73, Millmerran, Tara and Waggamba shires produced 87% of the total production. Average yields in the Millmerran Shire are 1·6 t ha^{-1} on brigalow soils (with an increase to 2·0 t ha^{-1} with good farming practices) and yields on similar soils farther west are 0·3 t ha^{-1} less than these (Queensland Department of Primary Industries 1970*c*). Clipper variety has outyielded Prior in trials (Walsh 1971) and is now the only variety considered by the Barley Marketing Board for malting quality. Some grazing types (Cape and Skinless) are planted for winter feed.

The factors which contribute to high protein levels in wheat are detrimental to malting-grade barley. Consequently, most of the production is milling or feed barley. Some lower fertility soils of the eastern shires can produce grain of malting quality. With its high salt tolerance, barley has a place on some brigalow lands. Increased interest in feed grains could promote this crop to a more prominent position in the future. Barley is one of the preferred grains in dry lot feeding and both occasional and permanent feed lots were increasing in the area prior to the 1974-75 price slump in the beef industry.

OTHER WINTER CROPS. Other winter grazing crops attract little attention. Field turnip and rape have been grown on a limited scale. These tap-rooted species could have potential on deep, clay soils where recovery of soil moisture from depth may not be complete under fibrous-rooted grain crops. Their independence of post planting rain is an advantage.

Fluctuating interest is shown in other winter grain crops, most probably as a result of market influences. In the Millmerran Shire, linseed ranges from 400 to 10 000 ha and canary seed from 400 to 1 600 ha. Limited areas (<400 ha) are planted in the Tara and Waggamba shires.

Summer cropping

The area is not as well suited to summer cropping. Furthermore, it is less suited to summer grain cropping than to summer forage cropping because of the more critical moisture requirements of the former. The water balance study described earlier indicates that soil moisture decreases until late December or early January and increases until the end of March. Summer cropping practices should thus be programmed to take advantage of this period of improved moisture.

Because of the less favourable conditions compared with those for winter cropping, other factors must operate to warrant summer cropping. In the Condamine–Maranoa basin, these are firstly the value of standover summer crop, failed summer crop or summer crop stubble; secondly, a spread of cropping activities throughout the year; and thirdly, diversification.

GRAIN SORGHUM. On the basis of area planted, grain sorghum is the third most important crop grown. Significant increases in area have occurred despite losses caused by birds and pigs. Over the period 1969–70 to 1971–72, the planted area increased nearly five-fold (table 32), the largest increases occurring in the brigalow lands. The introduction of the wheat delivery quota system in 1969–70, the failure of wheat planting rains in the winter of 1970 and suitable summer rains caused the rapid expansion in grain sorghum area in 1970–71. Orderly marketing of grain through the Grain Sorghum Export Committee of the Queensland Graingrowers' Association and favourable returns were added stimuli to the increase in grain sorghum areas.

Interview data indicate that many experienced grain growers plant grain sorghum in September and October when early spring rains provide planting conditions. The error in this practice is apparent when the data on available soil moisture are considered (figure 12), and planting should be delayed until December. Where adequate soil moisture is available, sorghum seedlings will withstand the high temperatures experienced during this period. Early-planted crops can sustain yield reductions due to 'heat blast' caused by high temperatures during flowering. Late plantings can be damaged by midge infestation during flowering in favourable seasons (Queensland Department of Primary Industries 1971*b*).

TABLE 32

AREA OF GRAIN SORGHUM PLANTED IN SIX SHIRES FOR THE PERIOD 1968–69 TO 1973–74 (HA)

Year	Inglewood	Millmerran	Waggamba	Tara	Balonne	Warroo	Total
1969–70 ..	221	8 221	1 558	1 240	344	186	11 770
1970–71 ..	1 045	18 583	8 232	13 389	3 391	1 893	46 533
1971–72 ..	2 021	17 441	12 748	19 021	2 615	2 323	56 169
1972–73 ..	1 713	19 452	11 769	15 920	3 052	2 271	54 177
1973–74 ..	961	18 402	14 620	13 121	2 257	1 504	50 865

Source: Australian Bureau of Statistics (1969–70 to 1973–74).

There is a strong trend towards reduced planting rates in all sorghum growing areas and 2·2 to 3·4 kg ha^{-1} of seed appears adequate. Because of the need to provide adequate moisture in the later stages of growth, soils should be selected which have a high water storage capacity and the lighter red soils should be avoided.

Yields commonly range from 0 to 5·0 t ha^{-1} but the average is around 1·4 t ha^{-1}. Many crop failures and low crop yields are recorded. Crop residues fill a nutritional gap in beef cattle husbandry during the autumn early winter period. Thus, the economics of grain sorghum production depend not only on grain produced but also on the value of grazing or the sale of failed crops as agistment.

Hybrid cultivars have gained acceptance following poor initial results from types which lodged badly and whose stubble value was low. Alpha, the traditional open-pollinated type, is still well represented but its grain yielding potential is below that of the hybrids. The most popular cultivar during the 1972-73 season was DeKalb E57. It is suggested that the yield of grain sorghum will increase with improved agronomic practices.

FORAGE SORGHUM. Although forage sorghum plantings have been relatively minor in the past, their area is increasing. In 1972–73, some 26 730 ha of forage sorghums were sown in the Condamine–Maranoa basin. In an industry in which a high level of animal nutrition was considered secondary to obtaining one calf per cow per year, the reason for this increasing interest is not clear. It could be due to and depend completely on high returns for beef, or it could be due to the successful application of existing technology and progression to higher levels of refinement in production. Feeding for production as compared with merely feeding for survival has been one feature of animal husbandry practised in southern Australia which was largely ignored in Queensland.

Hybrid forage sorghum cultivars have been grown in the Condamine–Maranoa basin but do not fulfil the requirements for standover feed in autumn and early winter. Their rate of growth is extremely rapid, but their growth rhythm is similar to that of native pastures and their standover quality is not high. Traditional sweet sorghum and Sudan grass types are slower in their production of dry matter and their standover quality is high. For this reason, Sugardrip is the major variety planted, with 6 800 ha in 1972–73. Because of its greater perenniality *Sorghum almum* is used as a pasture species and is popular on brigalow soils in Waggamba and Tara shires. It is productive for up to 3 years.

SUNFLOWER. An attractive contract price and the need for crop diversification have led to an increase in the area planted to sunflower for the oil seed market. Some 9 000 ha were harvested in 1972 with major areas occurring in the eastern shires. A variety of agronomic techniques has been employed in the first few seasons of major plantings with variable results.

Sunflower loses favour as a crop for the Condamine–Maranoa basin because of its inability to provide grazing from failed or harvested crops. Average yields have been somewhat less than the early estimates of 0·6 to 1·3 t ha^{-1}. Sunfola, a high oil content cultivar, is the major variety grown and the grain is handled by the Queensland Graingrowers' Association who are agents for oilseed crushers.

OTHER SUMMER CROPS. A small and sporadic interest in millets as grain, hay and grazing crops is shown in the eastern shires. White French millet is the chief type grown for grain while Japanese millet is grown for grazing and grain. As millets have the advantage of a very short growing season, they are planted when seasonal conditions limit the use of alternative crops. Only a slow expansion of area is anticipated.

PULSE CROPS. Cowpeas grow well in the east and south-east of the area and provide valuable standover grazing during the autumn-early winter period. Caloona, Poona and Reeves cowpeas have all been grown successfully. Grain from cowpea crops finds a ready market. *Lablab purpureus* (lablab bean) is a suitable pulse crop and with improved cultivars will increase in importance.

Fodder conservation

Following drought periods in the 1960s and early 1970s and an overall interpretation of the climate as drought-prone, interest in silage production has been stimulated particularly in the Roma area. While some winter crops have been ensiled, forage sorghums provide the major proportion of silage. Statistics relating to silage production show that a peak of fodder stored occurred in 1970-71 (table 33).

TABLE 33

ENSILAGE STORED DURING THE PERIOD 1968–69 TO 1973–74 (T)

Year	Inglewood	Millmerran	Waggamba	Tara	Balonne	Warroo	Total
1968–69 ..	0	14	1 321	0	203	610	2 148
1969–70 ..	440	325	5 263	478	813	914	8 233
1970–71 ..	305	2 530	6 320	3 072	0	3 759	15 986
1971–72 ..	173	67	1 956	1 473	0	1 199	4 868
1972–73 ..	60	141	756	825	2 000	1 370	5 152
1973–74 ..	3	104	512	1 340	2 401	3 080	7 440

Source: Australian Bureau of Statistics (1968–69 to 1973–74).

Existing farming experience, availability of machinery and a suitable cropping environment are major advantages over purely pastoral areas, where ensilage making has met with limited success. How well the available crops can be stored as silage, how frequently will the material be required, how effective will it be as drought fodder, what are the costs involved and how much better is silage than the alternatives are matters for conjecture.

Some 10 000 t of hay are made annually from lucerne (the major source), wheat, oats, millet and pasture. Wheat can contribute largely to this total in years when grain crops are frosted. Of increasing interest as a means of short-term feeding is the use of limited facility feedlots. These allow stock to be 'finished' for sale when crops or pastures deteriorate. In keeping with this trend, the 'on property' storage of grain (possibly grain sorghum, barley or oats) hay or silage could increase. The successful storage of grain in underground silos (Tiller 1971) gives this concentrate a decided cost advantage in the comparison of forage types.

Weeds of Cultivation

An awareness of the importance of weeds of cultivation in the Condamine–Maranoa basin is shown in the five Shire Handbooks prepared by officers of the Queensland Department of Primary Industries. A publication describing weeds of the Warroo Shire and giving control measures is also available (Paull and Stirling 1972).

As the major areas of land have been cultivated for only a short period, economic loss due to weed presence is still small. However, weed species are present and the magnitude of the problem is increasing. Of these *Avena ludoviciana* and *A. fatua* (wild oats) in wheat are the most important, and the rotation of pastures and crop could be an alternative to expensive chemical treatment. A change from winter to summer crops also helps reduce infestation. Some farming areas are still free from this weed, but natural and mechanical means of dispersal will lead to infestation of these areas.

Salvia reflexa (mintweed), a summer-growing annual, is a pest of increasing importance on cultivation in the study area. Its presence in the Surat district in 1945 is recorded in a study of mintweed distribution (Roe and Shaw 1947). As a pasture component, its appearance coincides with poor rainfall years and high levels of utilization. With greater grass competition, its density decreases. In fallowed cultivation and early winter crops, it is emerging as a major pest. Chemical control, while available, is expensive and its success depends greatly on conditions at the time of application. *Argemone mexicana* and *A. ochroleuca* sp. *ochroleuca* (Mexican poppy) can flourish under a system of early oats planting, particularly on sandy loam soils.

A wide range of weeds of summer and winter growing habit occur including *Rapistrum rugosum* (turnip weed), *Emex australis* (spiny emex), *Sisymbrium orientale* (mustard), *Silybum marianum* (variegated thistle), *Carthamus lanatus* (saffron thistle), *Tetragonia tetragonioides* (New Zealand spinach), *Trianthema portulacastrum* (black pigweed), *Xanthium spinosum* (Bathurst burr) and *Bassia birchii* (galvanized burr).

Although cultivation is the main control measure employed, chemical applications are increasing and spot spraying, boom spraying and aerial application are all practised. Grazing by sheep is used to reduce the weed species of *Avena*. In early wheat growing records for the Maranoa, the cultivation of wheat paddocks after crop establishment is reported (Soutter 1934). Present extension literature (Paull *et. al.* 1971) refers to delaying planting by a few days to allow weed species to germinate and be controlled by the planting operation.

Fertilizer use

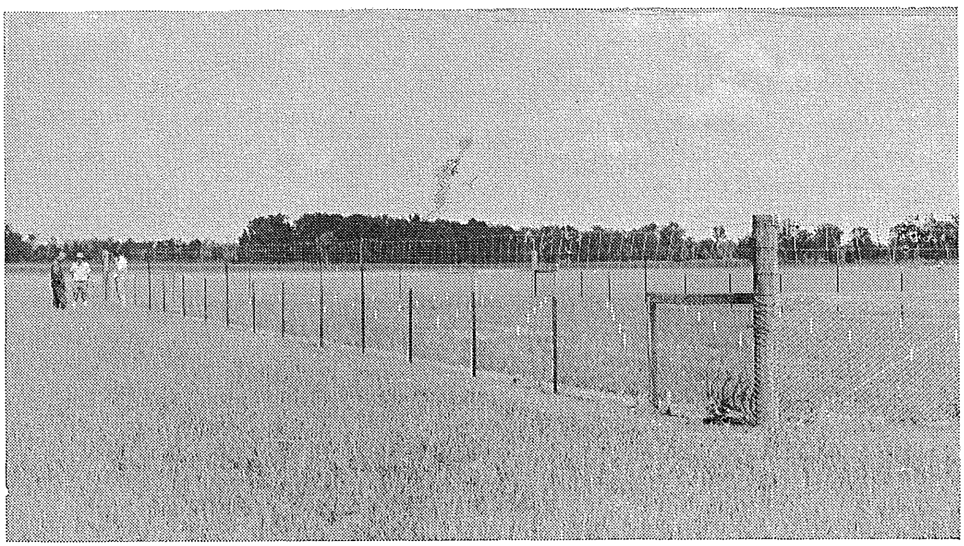
Fertilizer use in the Condamine–Maranoa basin is as yet small. In 1972-73 the total area of application was only 63 635 ha (Australian Bureau of Statistics 1974), less than 1% of the total area and 15% of the total area cultivated.

Approximately 60% of the area receiving fertilizer was in the Millmerran shire, that section of the evaluation area which has the best established pattern of agricultural land use.

Phosphatic fertilizer is principally used in the shires of Inglewood, Millmerran, Tara and Waggamba, while the irrigation areas of Inglewood, Millmerran and Balonne shires use significant amounts of nitrogenous fertilizer. Except in Inglewood and Millmerran shires, the amount of fertilizer applied to pasture is extremely small.

Although there is no initial deficiency of mineral nutrients on brigalow soils which seriously limits pasture growth, the phosphorus status in some cases is marginal (Moore and Perry 1970). Conversion of these lands from forest to pasture or crop, however, will lead to depletion of nitrogen (Isbell 1962).

The practice of fertilizing wheat lands with phosphatic fertilizer is more common in the higher rainfall districts. Although response to phosphatic fertilizer has been reported in drier locations, the economic value of this response is uncertain. There is a stronger case for fertilizer application to forage oats than to grain crops. Nutrient studies centred on the Queensland Wheat Research Institute (Wall *et al.* 1971-72), have revealed deficiencies of phosphorus, sulphur, copper and molybdenum in glasshouse trials and phosphorus and copper in field trials on wheat growing soils.



The screening of Queensland cereal soils for mineral deficiencies involves both glass-house and field trials. This field trial was located on Strathmore property.

Soil conservation

Many of the soils cultivated on undulating country in the study region are prone to erosion. Approximately one-half of all cultivated lands require some protection. Of this proportion, for every 2 ha requiring intensive conservation measures such as contour banks, 3 ha will require only moderate protective practices such as contour cultivation. Current figures indicate that some 14% of this work has been carried out (Queensland Department of Primary Industries, Soil Conservation Branch, Internal Reports).

Grass strips are commonly employed as a soil conservation technique on gently undulating land types.

Of major concern are the solodic soils and these range in texture from sands and sandy loams (Wa13 and Va24 soil associations) to clay loams (Ro4). The former have shallow surface horizons which erode rapidly on disturbance while the latter, although more stable, are agricultural soils which occur on undulating topography. Many of the agricultural soils in the brigalow lands have low erosion risks. Flat often gilgaied lands require little protection other than that provided by sound agronomic practices. However, some of the open grassland soils (MM4) and cleared areas of grey and brown soils of heavy texture (MM1 and MM2) erode readily.

Heijnen (1970) suggests that soil conservation does not necessarily imply contour banks but contour working, contour grass strips, and the occasional key structure to add valuable support to other practices, particularly those favouring soil moisture availability and surface water storage. Machinery is under investigation which will facilitate stubble mulching during the cultivation and planting phases. Its acceptance will depend not only on the reduction of erosion but also on the influence on soil moisture storage and on the amount of dry soil in the seedbed zone. The established practice is to incorporate stubble, by ploughing, at an early stage after harvest to allow breakdown of this material before planting and to present a receptive surface for moisture storage. Subsequent cultivations are carried out with progressively lighter tined equipment with the aim of achieving a shallow, fine and compact seedbed by early winter. In marginal cropping lands where moisture management is the key to cropping success, fallow practices must favour high moisture storage, low moisture loss and the opportunity to plant on a minimum of rain. If essential, soil conservation practices are not compatible with these objectives some soils of high erosion risk may revert to pasture lands.

The development and investigation of suitable crop-pasture rotations would seem opportune. The acceptance of such rotations would depend on a grain producer having sufficient arable land to place a part in pasture while not reducing the area planted to crop and on the availability of suitable pasture species with the ability to establish quickly and be ploughed out easily.

Native pastures

The native pasture species present in the soil-vegetation groups are described in Vegetation. There is little investigation associated with these, although they have provided the basis for animal production for more than a century. The brigalow grazing lands (Group 1) are reported to be of low value (Coaldrake 1970) although their carrying capacity and level of sheep production are moderately high. A large range of annual and perennial herbaceous species combine with a small number of perennial grasses to provide good summer grazing and moderate to poor winter grazing. The flooded open woodlands (Group 2) and undulating grasslands (Group 3) carrying *Astrebla* grasses provide good quality grazing during summer and a useful body of carry-over dry matter, of moderate quality, during winter. All of these groups can benefit from the growth of naturalized annual medics (*Medicago polymorpha* and *M. minima*) in favourable seasons and lend themselves to production systems containing high quality winter forage crops such as oats.

The pastures of the cypress pine-bull oak forests, developed on solodic soils (Group 4) are of low quality and give poor dry matter production. Pastures of the woodland communities (Groups 5, 6, 9 and 10) can provide forage of moderate quality when lightly stocked but low production per unit area. The pastures of the shrublands (Groups 7 and 8) are sparse and, where promoted by clearing, contain mainly poor quality grasses.

No literature considering the future role of these native pastures has been sighted. It is suggested that on Group 1 land forms, where exotic species are available but where the quality of indigenous species is in part satisfactory, native pastures are likely to continue to provide a significant part of the available dry matter in the future. As such, the components which contribute to a high level of animal production and the relationships between species in the whole community should be determined. In Groups 2 and 3, the valuable species are more obvious and their management for continued production should be determined and encouraged. Where native pastures are unable to provide a high level of animal production (Groups 4, 5 and 6), then species replacement, sown pasture productivity and management studies are indicated. In more arid environments (Group 7) where few exotic species are available, the long-term survival of native species should be investigated. Few areas of the last category exist in the study region.

Introduced pasture

Although large areas of the Tara and Waggamba shires were seeded with *Chloris gayana* (Rhodes grass) following brigalow clearing, this species has died out during major droughts and only a small total area of introduced pasture exists in the study area (map 7). A large area of native vegetation has been modified by ring-barking, land clearing, poisoning and/or spraying and some swards and many nuclei of introduced pasture species have established. A trend for increased pasture plantings is evident (table 34), but this will be influenced by conditions in the cattle and grain enterprises of the area.

TABLE 34

AREA (HA) AND PERCENTAGE OF LAND OCCUPIED BY INTRODUCED PASTURE SPECIES AND BY MODIFIED NATIVE VEGETATION IN THE CONDAMINE–MARANOA BASIN

Year	Introduced Pasture	% of Condamine–Maranoa	Modified Native Vegetation	% of Condamine–Maranoa
1960–61	14 000	0·2	3 398 000	46
1961–62	21 700	0·3	3 461 000	47
1962–63	28 900	0·4	3 611 000	49
1963–64	37 300	0·5	3 709 000	50
1964–65	34 200	0·5	3 832 000	51
1965–66	34 300	0·5	3 818 000	51
1966–67	39 400	0·5	3 397 000	46
1967–68	34 600	0·5	3 547 000	48
1968–69	36 500	0·5	3 580 000	49
1969–70	57 900	0·8	3 532 000	48
1970–71	115 200	1·6	N.A.	..
1971–72	71 900	1·0	N.A.	..
1972–73	86 400	1·2	N.A.	..
1973–74	128 304	1·7	N.A.	..

Source: Australian Bureau of Statistics (1960–61 to 1973–74).

Several factors have contributed to the slow increase in the area of introduced pastures on brigalow lands apart from establishment difficulties. While significant areas of brigalow forest were available for development, clearing of these was economically more rewarding than the intensive development associated with introduced pastures. Although the available introduced pasture grasses can provide a means of increasing dry matter production, their growth rhythm is similar to native pastures and during the summer months the quality of the latter is satisfactory. At a site 50 km north of Goondiwindi, native pasture supported liveweight gains in cattle similar to *C. gayana, Panicum maximum* var. *trichoglume* (green panic) and *Sorghum almum* (Columbus grass) but at half the stocking rate and all were superior to *Cenchrus ciliaris* (buffel grass) in a year of moderate rainfall (Coaldrake *et al.* 1969). After a drought, *Chloris gayana* and *S. almum* disappeared while *Cenchrus ciliaris* and *P. maximum* regenerated. Thus it would seem that sown pastures on brigalow lands will not bring cattle to a given marketable weight any quicker than native pastures (they are not superior in quality) but can support a higher stocking rate.

The performance of sheep on *C. ciliaris, P. maximum* and *S. almum* is also reported (Tothill 1972–73). Once again, dry matter production was increased but in a good season rank growth resulted in depressed sheep performance. This was due not only to declining quality in the grasses but also to fewer herbs being able to persist within the system.

In woodland communities on coarse-textured soils, the production and quality of introduced pasture species are superior to that of the major native grasses. As the herbage component is small, greater benefits accrue from the introduction of such species as *C. ciliaris*. In these communities, the traditional development has been by ring-barking and this practice was not conducive to pasture species introduction.

Factors which will stimulate interest in introduced pasture are the decrease in brigalow forest available for clearing, the increase in cattle numbers in the area, the development of eucalypt woodland and the need for a high dry matter carry-over to offset short term moisture deficiencies which are most pronounced on coarse textured soils.

SPECIES TESTING. Although early pasture work was centred on brigalow land, the most intensive species introduction and testing has been carried out on the solodic soils of Group 4. Species included in field trials are: *C. ciliaris* cvv. Biloela and American, *Chloris gayana* cv. Pioneer, *P. maximum* var. *trichoglume* cv. Petrie, *Macroptilium atropurpureum* (Siratro), *M. lathyroides* (phasey bean), *Medicago sativa* (Hunter River lucerne), *Lablab purpureus, Ornithopus sativus* and *O. compressus* (serradella), *Medicago* spp. (annual medics), *Trifolium hirtum* (rose clover), *Macrotyloma uniflorum* (horse gram) and *Lotononis bainesii* (lotononis) (Leslie, Mackenzie and Glasby 1967) and *Cenchrus ciliaris* cvv. Tarewinnabar, Nunbank and Molopo, *Chloris gayana* (Pioneer), *Panicum coloratum* cv. Burnett, *P. maximum* cv. Petrie, *Sorghum almum, Medicago sativa, Macroptilium atropurpureum, Stylosanthes humilis* (Townsville stylo), *Medicago* spp. (annual medics), *Trifolium* spp., *Trigonella* spp. and *Vicia* spp. (vetch) (Russell 1967).

Dry matter production figures are available for *Digitaria decumbens* (pangola grass), *Cenchrus ciliaris* cv. Nunbank, *P. coloratum* cv. Bambatsi, *P. maximum* and *Chloris gayana* cv. Pioneer with applied phosphorus and nitrogen (Russell 1971-72). Although the performance of the *Cenchrus ciliaris* was satisfactory on some sites, Russell (*loc. cit.*) suggests that the species may be unable to replace potassium by sodium in contrast to plants such as *Chloris gayana, D. decumbens* and *Panicum coloratum*. The latter two species are thus more suited to conditions encountered in these solodic soils.

The successful introduction of *Macroptilium atropurpureum* and *Medicago sativa* on *Callitris columellaris* sands following suitable nutrient application is reported (Mackenzie 1966). The testing of an extensive range of temperate legumes (Russell 1969) revealed that *M. truncatula* cvv. Jemalong, Cyprus and Woodside were outstanding in yield, persistence and nitrogen content on a solodic soil where on a gilgaied clay *M. truncatula* cv. Cyprus, *M. littoralis* cv. Harbinger and *M. scutellata* (snail) showed promise.

Introduction species suggested for commercial use in the Roma–Miles region include *Cenchrus ciliaris, P. maximum, Sorghum almum, Chloris gayana, P. coloratum, M. sativa* and annual species of *Medicago* (Paull 1972*a* and *b*).

Some relevant features of the most suitable introduced pasture species are shown below.

BUFFEL GRASS. *Cenchrus ciliaris* is a species of moderate quality but with characteristics which make it the most important introduced pasture species for the Condamine-Maranoa basin. It responds quickly in spring, produces a large volume of dry matter which stands over well for winter use and is drought tolerant. When compared with a range of subtropical grasses, it had a high intake of frosted material because of the absence of leaching of soluble nutrients from the dead tissue (Milford 1960). While it frosts readily, cultivar selection can be used partly to overcome this feature provided low soil nitrogen does not deteriorate the effect (Cameron and Courtice 1965).

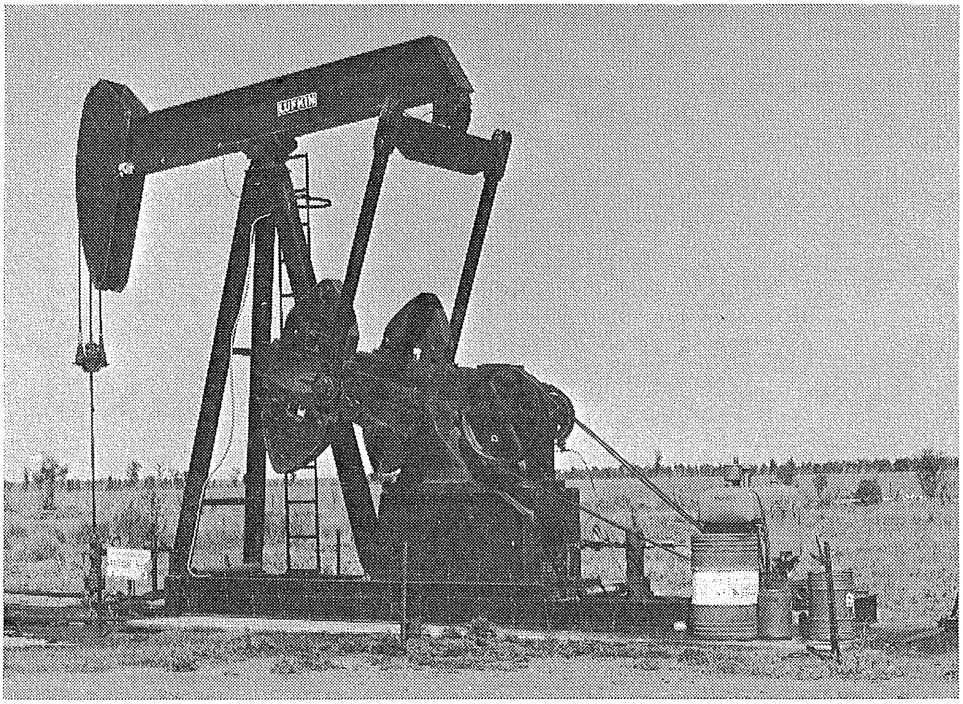
Of a wide range of types available, the shorter growing cultivars such as Gayndah and American are more palatable than the taller growing strains such as Biloela, Boorara, Nunbank and Molopo (Paull 1972*a*). Under experimental conditions, dry matter intake of the West Australian cultivar was higher than that of Biloela (Milford 1960). Differences in the nutritional value of three cuts of *C. ciliaris* cv. Nunbank fed to sheep and cattle are reported (Playne 1970). Voluntary intake by cattle was 2·4 times that for sheep when compared on a metabolic mass basis (that is, per kg $W^{0\cdot75}$ where W = body-weight). Two of the three cuts fed provided less than maintenance requirements for sheep but more than maintenance diets for cattle.

C. ciliaris is difficult to eradicate from cultivation by ploughing (Paull 1972*a*). This treatment can favour colonization under suitable conditions. Consequently, the species may be a poor choice for inclusion in crop-pasture rotations.

GREEN PANIC. On the more fertile soils such as occur in the brigalow lands, *P. maximum* var. *trichoglume* is productive and persistent. Its greater palatability will give it an advantage over *C. ciliaris. P. maximum* is not suited to soils of low nitrogen status such as old cultivations (Paull 1972*a*) but could be of value in a crop-pasture rotation on fertile soils. It does not form a stable pasture mixture with *C. ciliaris* since *P. maximum* is selectively grazed. It is also less tolerant of over-grazing and less drought hardy.

The nutritional value of *P. maximum* is higher than that of *C. ciliaris* or *Chloris gayana* when fed at a young leafy stage (Milford 1960). Its winter intake is also high due to good winter greenness. A long-term cattle grazing trial on a fertile clay soil at Brian Pastures, Pasture Research Station, Gayndah compared the performance of *P. maximum, Cenchrus ciliaris* and *Chloris gayana* with *M.*

Buffel grass will exclude most of the native species.



The discovery of oil in the Condamine-Maranoa basin led to the construction of an oil line from the area to Brisbane. The picture shows a producing well at the Alton field.

sativa as a pasture legume (Young, Fox and Burns 1959). At the end of 9 years when considering such factors as persistence, drought tolerance, response to rain following moisture stress and growth response to brief warm periods during winter, *P. maximum* was considered to be the best grass species (Young and Daly 1967).

RHODES GRASS. An excellent pioneer species, *C. gayana* was planted extensively throughout the brigalow lands as an aid to sucker control. In the southern brigalow, its persistence during drought has been poor and its ability to re-establish has not matched that of *Cenchrus ciliaris* and *P. maximum*. Its ability to colonize rapidly is an advantage and it may complement other slow-to-establish species in this environment. It may again become popular if crop-pasture rotations develop in the area.

OTHER GRASS SPECIES. *Panicum coloratum* is a suitable pasture grass on clay soils in the higher rainfall (>600 mm) sections of the Condamine-Maranoa basin. In other parts of the area, it is suitable for planting on strongly gilgaied soils and on flooded clay soils. Although slow to establish, its persistence is good. Its frost tolerance is greater than that of the other species available for the area.

Sorghum almum is used as a short term pasture species mainly in the south-east parts of the study region. It persists for up to 3 years and, if planted following land clearing, takes advantage of the release of nutrients.

Urochloa panicoides (liverseed grass) is naturalized within parts of the Condamine-Maranoa basin. Material from the collection of this genus at Townsville (Burt 1973-74) could provide useful pasture species.

At the Charleville Pastoral Laboratory, grass introductions indicated for further testing on red earths are *Anthephora pubescens, C. ciliaris, Dactyloctenium giganteum, Eragrostis curvula* and *Schmidtia bulbosa* and also the legume *Stylosanthes mucronata* (O'Donnell, O'Farrell and Hyde 1973). These could be suitable for similar soils in the western parts of the Condamine-Maranoa basin.

LEGUMES. *Medicago sativa* cv. Hunter River is a productive legume on arable lands in the Condamine-Maranoa basin. Plantings, however, are limited by problems of survival and management in grazed pastures. Productive life is short (2 to 4 years) and an experiment to examine the influence of grazing and mowing systems on growth is in progress (Leach 1972-73). Successful use of a *M. sativa* sward on brigalow country has been achieved with sheep in a 'crash grazing' system involving a short grazing period followed by a 6 to 8 weeks spell. Some bloat losses occurred but, because of the low unit value per animal, these were accepted. With cattle, however, similar deaths represent a considerably greater loss and landowners are reluctant to use lucerne in this manner for cattle grazing.

Medicago polymorpha and *M. minima* are naturalized annual medics in the eastern and central parts of the area and their distribution is increasing. The problem of *Medicago* seed in wool detracts from their value. *Medicago* species of improved productivity and with more acceptable seed characteristics are available and Clarkson (1973, 1975, 1976) is studying the growth rate, phasic development and seed production of *M. scutellata* (snail medic), *M. polymorpha* (burr medic), *M. littoralis* cv. Harbinger (strand medic), *M. truncatula* var. *truncatula* cvv. Jemalong and Cyprus (barrel medic), *M. tornata* cv. Tornafield (disc medic), and *M. rugosa* cv. Paragosa (gama medic). As annuals with strong seed survival features, their persistence is assured. They are suitable species for undersowing with winter crops when cultivation is to be returned to pasture. As components of the native pasture they are somewhat unpredictable and are considered as a bonus when suitable conditions foster their development. In a grazing trial comparing introduced grasses on gilgaied clays, sheep grazing treatments containing *M. sativa* or annual *Medicago* spp. showed considerably better performance than those with no legume (Tothill 1972-73); as the soils were not deficient in nitrogen, the benefit from the legumes lay in their ability to provide dietary protein at a time when most other herbage was of poor quality.

Macroptilium atropurpureum cv. Siratro has persisted in the eastern part of the Condamine–Maranoa basin (Russell 1972-73*c*) but low winter temperatures limit its usefulness in the area.

ESTABLISHMENT. Primary producers, extension officers and researchers recognize that the problem of establishment of introduced pasture grasses on cracking clay soils is a major limitation to increased pasture plantings. Successes and failures have resulted from plantings at most times of the year. The clay loams, loams and sands provide less difficult conditions.

The establishment of *Chloris gayana* and *P. maximum* on self-mulching black earths of the Darling Downs has been investigated (Leslie 1960, 1965*a* and 1965*b*). Establishment difficulties are related to the development of a surface crust and a loose layer of soil crumbs beneath this following the cessation of rain. It was concluded that establishment depended on a balance between the rate of germination and emergence and the rate of soil drying.

In mulga shrubland, *Cenchrus ciliaris* has been successfully established and has persisted in certain microhabitats only. These are stump holes, under fallen branches, the margins of contour banks and under the canopies of deep rooted trees (Burrows, Christie and Beale 1968). Ebersohn (1963) suggests that limiting factors to the establishment of introduced species include the indurated soil surface, low soil fertility (available phosphorus and nitrogen status, base levels, and acid soil reaction) and restricted period of moisture availability. Most *Cenchrus* communities grow at a pH range of 7 to 8 and there is evidence to suggest that this plant spreads very slowly or not at all in acid soils (Brzostowski 1962).

SEED PRODUCTION. Properties with relatively pure stands of the popular cultivars of *C. ciliaris* (Gayndah and American) harvest seed for home use and for local sale. Surplus quantities may be disposed of through commercial channels if the market value is high. The greatest production is in Warroo and Balonne shires (table 35) reflecting the interest of some land owners in the 'red' soil areas in the attributes of this grass. In the Waggamba Shire seed of *Sorghum almum* is harvested while a small quantity of *Panicum coloratum* cv. Bambatsi is produced in the Tara Shire.

TABLE 35

PASTURE SEED PRODUCTION FOR THE PERIOD JULY 1973 TO JUNE 1974

Shire	Species	Area (ha)	Yield (kg ha^{-1})	Total (kg)
Inglewood	*Medicago sativa*	80	50	4 000
Millmerran	..	—	—	—
Waggamba	*C. ciliaris* cv. Biloela	280	12	3 360
	C. ciliaris cv. American	60	9	560
Tara	*Panicum coloratum*	20	14	270
Balonne	*C. ciliaris*	—	—	4 000
Warroo	*C. ciliaris* cv. American	100	17	1 700
	C. ciliaris cv. Biloela	50	15	750
	C. ciliaris cv. Gayndah	100	17	1 700

Source: Queensland Department of Primary Industries (1974).

ANIMAL PRODUCTION IN THE CONDAMINE–MARANOA BASIN

Statistics and trends

Both sheep and beef cattle are found throughout the area, with density lessening towards the west (map 7). Dairy cattle are virtually absent and pigs are chiefly present in Millmerran and Tara shires.

In 1972-73, the Balonne Shire carried most sheep, followed by Tara, Waggamba, Warroo, Inglewood and Millmerran (Australian Bureau of Statistics 1974). These statistics are influenced by the size of the shire as well as current land use practices, with Tara changing its relative importance as brigalow forests have been developed to pasture. The greatest number of beef cattle in 1972-73 was depastured in the Waggamba Shire, followed by Tara, Balonne, Warroo, Inglewood and Millmerran (Australian Bureau of Statistics 1974).

In 1972-73, 3 million sheep and approximately 0·6 million beef cattle were depastured within the six shires of the study area (Australian Bureau of Statistics 1974). Sheep numbers since 1950-51 reached a peak of nearly 6 million in 1963-64, followed by a downward trend to the present level. Beef cattle numbers have varied over the same period from 0·2 million in 1958-59 to the peak figure of 1972-73 (figure 14). The rapid increase in beef cattle numbers since 1966–67 reflects the relative movements of market values in the two industries; any effect of the recovery in wool prices during early 1973 had not made itself felt at this date. A fall in beef prices in 1974 is also too recent to be reflected in the statistics. Dairy cattle numbers have declined since the 1940s to a point where dairying has ceased to be of importance. Pig numbers have increased markedly since 1965–66, stimulated by the need to generate income during a period of low wool prices.

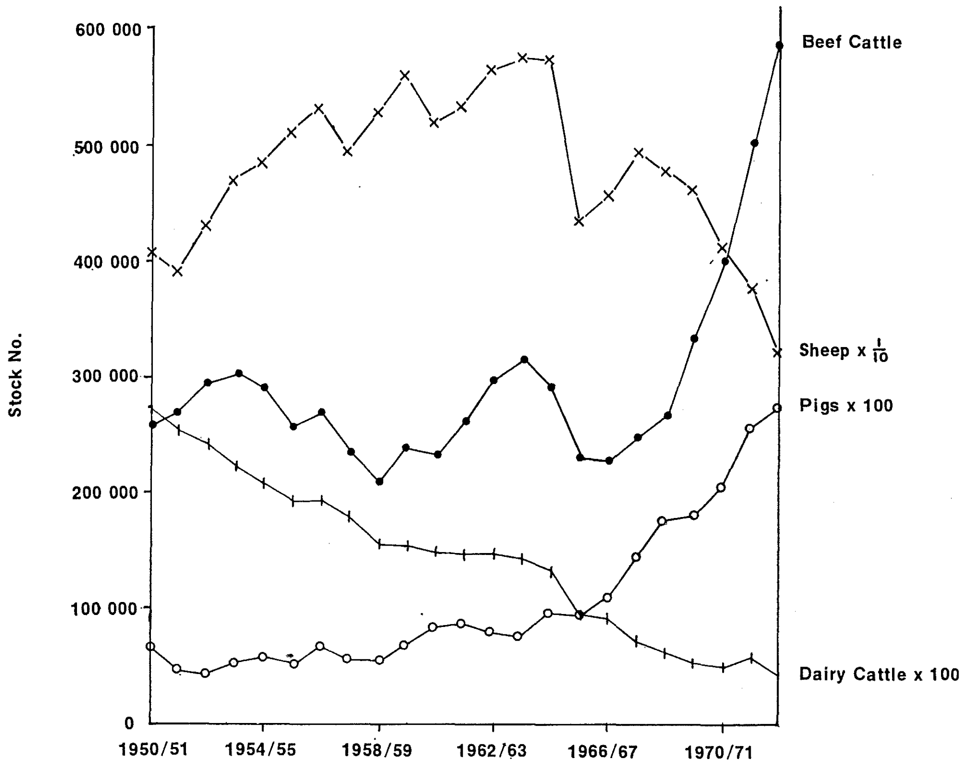


Figure 14.—Changes in livestock numbers from 1950-51 to 1972-73 in the Condamine-Maranoa basin.

Indices have been developed to compare the relative importance of sheep and cattle over time (table 36) and these are expressed as the ratio of sheep numbers to ten times cattle numbers. Changes in the magnitude of the indices reflect the changing pattern of animal production. While sheep were used to defoliate suckers during brigalow development, particularly in the Tara Shire, economic factors, a later stage of development and improved clearing techniques associated with cultivation have removed the need for high sheep numbers. A change in emphasis to beef cattle is reflected in the statistics and this appears to commence about 1967-68. The Balonne Shire has maintained the highest proportion of sheep of the six shires, while Millmerran has maintained the highest proportion of beef cattle. In general, the more western shires have maintained a higher ratio of sheep to cattle than the climatically more favoured shires.

Merino sheep constitute 97·5% of total sheep in the study area (Australian Bureau of Statistics unpublished), which is similar to the figure (97·8%) for Queensland. The predominance of Hereford cattle which comprise 61% of total beef cattle numbers, contrasts strongly with the level of 27% for Queensland (figure 15). Conversely only 10% of cattle in the study region have some proportion of *Bos indicus* blood, compared with an average of 47% for the State. This could in part be accounted for by the tick-free status and the relatively mild climate of the area.

TABLE 36

INDEX OF THE RELATIONSHIP BETWEEN SHEEP AND CATTLE NUMBERS IN SIX SHIRES FOR THE YEARS 1951 TO 1974

Year	Shire					
	Inglewood	Millmerran	Waggamba	Tara	Balonne	Warroo
1950–51 ..	0·70	0·29	1·27	1·53	2·86	2·00
1951–52 ..	0·58	0·33	1·13	1·37	2·71	1·82
1952–53 ..	0·71	0·32	1·19	1·45	2·50	1·62
1953–54 ..	0·69	0·40	1·23	1·48	2·88	1·69
1954–55 ..	0·87	0·54	1·22	1·83	2·88	1·69
1955–56 ..	1·04	0·62	1·42	2·50	3·13	2·00
1956–57 ..	1·07	0·66	1·46	2·47	3·13	1·92
1957–58 ..	1·07	0·80	1·45	2·85	3·29	2·30
1958–59 ..	1·38	0·77	1·76	3·23	4·60	2·67
1959–60 ..	1·18	0·71	1·70	3·21	4·00	2·60
1960–61 ..	1·14	0·56	1·76	2·59	4·00	2·50
1961–62 ..	1·07	0·46	1·61	2·32	3·29	2·00
1962–63 ..	1·00	0·41	1·52	2·30	2·89	2·17
1963–64 ..	1·03	0·44	1·50	2·10	2·89	1·92
1964–65 ..	1·13	0·45	1·63	2·50	3·13	2·00
1965–66 ..	1·22	0·50	1·53	2·11	2·67	2·20
1966–67 ..	1·28	0·41	1·88	2·50	3·17	2·10
1967–68 ..	1·21	0·36	1·70	2·41	3·50	2·30
1968–69 ..	1·17	0·30	1·50	2·00	3·50	1·83
1969–70 ..	1·10	0·23	1·07	1·42	2·75	1·69
1970–71 ..	0·80	0·19	0·76	1·00	1·90	1·25
1971–72 ..	0·63	0·14	0·51	0·71	1·38	0·95
1972–73 ..	0·54	0·11	0·38	0·49	0·97	0·66
1973–74 ..	0·51	0·10	0·39	0·41	0·87	0·58

Source: Derived from Bureau of Census and Statistics figures.
NOTE.—Index = Sheep Numbers ÷ (Cattle Numbers × 10).

Animal productivity

REPRODUCTION—SHEEP. Reproductive rates in sheep vary with soil-vegetation group and with season, and are on average higher for the Condamine–Maranoa basin than for other areas in Queensland. Thus a figure of 61% (derived from Australian Bureau of Statistics data) compares with an average 40% lamb marking for the North Western statistical division, 44% for the Far Western statistical division and 53% for Queensland overall (Weston *et al.* 1970). Similar derived figures show that within the study area average lamb marking percentages tend to decrease from east to west, with Tara being the exception (table 37). A north-south trend is also evident where lamb marking for the Mitchell–Miles–Tara–St. George region is 68% and for the Dirranbandi–Thallon–Goondiwindi area is 77% (Riches 1958).

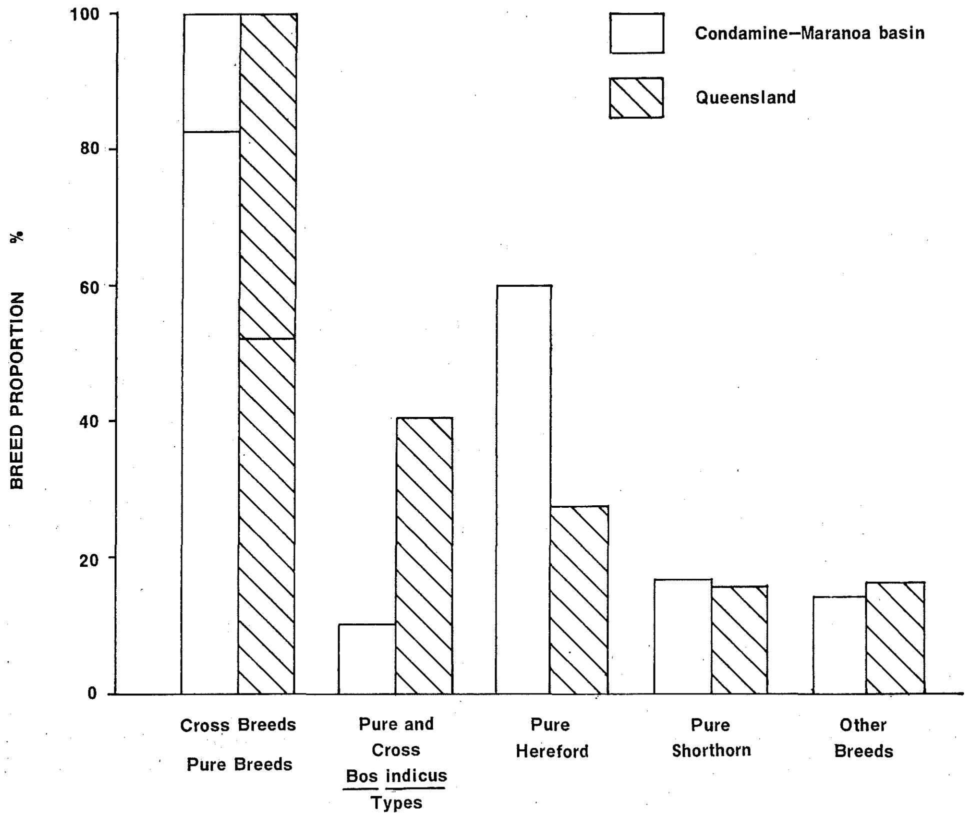


Figure 15.—Comparison of proportions of beef cattle breeds in the Condamine-Maranoa basin and in Queensland at 31 March 1973.

The Flooded Clay—Coolibah Open Woodland (Group 2) west of the Moonie River is some of the best natural sheep-breeding country in Queensland (Allison 1973*a*) and lambing percentages average 95%. The Gilgaied Clay and Clay Loam—Brigalow and Brigalow-Belah Forest (Group 1) following development, and the Undulating Clay–Mitchell Grass Grassland (Group 3) support high breeding rates, averaging between 70 and 90%. Considerably lower figures have been recorded on some brigalow lands in Tara shire.

TABLE 37

LAMB MARKING PERCENTAGES FOR THE CONDAMINE–MARANOA BASIN, BY SHIRES FOR A 23-YEAR PERIOD FROM 1950–51 to 1972–73

Shire	Lamb Marking %	Shire	Lamb Marking %
Inglewood	62·7	Tara	57·7
Millmerran	69·7	Balonne	58·6
Waggamba	63·1	Warroo	57·8

Source: Derived from Australian Bureau of Statistics data.

Lamb-marking percentages on Solodic—Poplar Box-Sandalwood Woodland (Group 5) average 60–70%. On Red Earth—Poplar Box–Mulga Woodland (Group 6) the average lamb marking lies between 50 and 60%, while on Red Earth—Mulga-Eucalyptus Shrubland (Group 7) it lies between 40 and 50% (interview data). This agrees well with the figures of 65% for box-sandalwood country (equivalent to Group 5), 47% for mulga (equivalent to Group 7) and 67% for an undeveloped brigalow community (Murray and Purcell 1967).

Most breeding flocks in the study area have access to more than one soil-vegetation group. In this way, the level of nutrition available to a flock grazing mainly a relatively poor soil-vegetation type may be lifted at critical stages in the reproductive cycle. Although it has not been documented in trials in the study region, producers have claimed that improved nutrition in the form of pasture improvement and cropping can increase lamb-marking averages by up to 20 or 30%. It is of interest to note that in the Queensland wheat-sheep zone as defined by the Bureau of Agricultural Economics, which includes Inglewood, Millmerran and Tara shires, lambing averages (Bureau of Agricultural Economics 1973*b*) significantly ($P < 0.01$) increased between 1951-52 and 1970-71. This coincides with the expansion of area under crop and it might be related to a higher plane of nutrition available from crop residues, forage crops and failed crops.

Interview data suggest that a further cause of reproductive loss is predators, particularly the feral pig. Opinions vary on the damage caused by eaglehawks and foxes although there is little doubt that these take at least the weak lambs. The number of feral pigs is increasing with the expansion of cropping area, crops providing both cover and feed, and many producers are forced to campaign actively against pigs by poisoning, trapping and shooting. The concentration of animals and the lack of cover in the case of ewes and lambs depastured on crop renders them particularly vulnerable to predators.

The harmful effects on reproductive performance of high temperatures experienced by sheep mated in spring have been well documented (Yeates 1953; Moule 1954; Moule and Waites 1963; Smith 1964; Fowler and Dunn 1966; Thwaites 1969; Entwistle 1970). Because of the useful winter rainfall component good nutrition is available to allow autumn mating and this is the common practice in the area.

Double joining of ewes in one season is used sometimes to restock after drought or when a poor lambing has been experienced. The practice does appear to yield about 100% of lambs from the two joinings but is not recommended as a regular husbandry practice by advisory services. Maiden ewes are usually mated at 18 months of age to lamb at 2 years. Ewes are cast for age at about 6 years old.

Fat lamb enterprises in the Tara Shire generally show good reproductive performance with lambings of around 100% or better. Better supervision and good nutrition probably account for this. In the early days of the St. George irrigation area similar enterprises had satisfactory reproduction rates. Predators, chiefly crows, caused some concern particularly with twin lambs, and their control resulted in increased lamb marking percentages (D. M. Allison personal communication).

A major limitation to fat lamb raising is the absence of suitable natural grasses and the consequent dependence on crop for fattening lambs (Coleman 1939). Mating time is adjusted to allow best use of winter crops following an autumn (March to late May) lambing. Fat lambs are then turned off in late winter to early spring before production in the southern states reaches its spring to early summer peak.

REPRODUCTION—BEEF CATTLE. Beef cattle brandings average approximately 80% on all soil-vegetation groups with the exception of Groups 4 and 7. Detailed studies from three properties in the Roma–St. George area showed that pregnancy rates averaging 90% (range 77% to 98%) can be obtained using a November to March mating period (Strachan 1971). Average losses from mid-pregnancy to weaning were 10%. Husbandry recommendations for the area include a restricted mating period aimed at early spring calving and strategic weaning of calves before winter, depending on the condition of breeders and feed availability (Rynne 1969; Strachan and Rudder 1971; Strachan 1971). It is claimed that branding percentages can thus be improved by at least 10% over unrestricted calvings. The major benefit accrues from the strategic weaning which allows breeders to maintain better condition (Strachan 1971). It was estimated in 1974 that about 50% of producers in the Tara brigalow lands and 10% of those in the Warroo forest country (predominantly Group 5) had adopted these recommendations (R. T. Strachan personal communication).

Diseases directly affecting reproduction of cattle have been shown to be present in the area. A survey of 40 properties, including the northern part of the study region, showed that 75% had leptospirosis in their herds, 30% had brucellosis and 20% had vibriosis (Simpson-White 1972). Of the leptospirosis cases reported, the most common infective organism was *Leptospira hyos* (57%) followed by *L. pomona* (30%) and *L. hardjo* (23%). No quantitative local data on the degree of reproductive wastage caused by these infertility diseases have been recorded.

Calving difficulties including dystocia have been shown to occur throughout the major cattle breeding areas of southern Queensland west of the Great Dividing Range, including the Condamine–Maranoa basin (Strachan and Rudder 1971). A survey of dystocia in the Roma district in 1973 recorded an average incidence of 12% for all herds included. While difficult calvings in heifers occur in most breeds, they are more frequent in Poll Hereford and Hereford cattle (table 38). This is in accord with producer experience and opinion as recorded in interviews. The level of dystocia in these breeds and the high proportion of total beef cattle that they constitute (figure 15) indicates that heifer dystocia is a significant cause of reproductive wastage in the area. Interviews in the study area showed that over 60% of producers with an interest in breeding cattle considered heifer dystocias to be a problem. The Roma survey indicated that 73% of producers taking part considered this condition a problem.

Although dystocia appears to occur most frequently in heifers calving at 2 years of age (interview data; Strachan and Rudder 1971), research work indicates that occurrence may be independent of age at first calving (Young 1968). The factors most directly responsible for dystocia in the study region have not been isolated. It has been suggested that contributing factors include an improvement in nutritional condition associated with land development, an improvement in the quality of cattle, increases in certain blood-lines and joining at a younger age. The cause is foeto-pelvic disproportion (Young *loc. cit.*) resulting from one or a combination of factors including plane of nutrition, pelvic size, foetal size (or calf birth-weight), breed of sire and dam, and time of year (Young 1970).

PRODUCTION—SHEEP. Although wool cuts vary little throughout the Condamine–Maranoa basin, they show sensitivity to climatic variation from year to year. Flock average wool cuts, not including wool from lambs, are 4·5 to

5·4 kg per head for most districts, with wethers cutting to 6·4 kg per head. These figures are higher than those given for the study area by the Australian Bureau of Statistics, which range from 3·3 to 4·5 kg per head, but the latter are derived from all classes of animals including lambs. Average wool cuts of 4·4 kg per head for the Mitchell–Miles–Tara–St. George area and 4·5 kg per head for the Dirranbandi–Thallon–Goondiwindi region have been recorded (Riches 1958). Murray and Purcell (1967) give average wool cuts of 4·2 kg per head for poplar box-sandalwood country (Group 5), 3·9 kg per head for brigalow country (Group 1), and 4·0 kg per head for mulga country (including Group 7). Producers on gilgaied brigalow lands (Group 1) report a decline in wool cuts for wethers brought in from western Queensland. These sheep initially cut 5·5 to 6·5 kg per head, but subsequently decline to the district average.

TABLE 38

OCCURRENCE OF DYSTOCIA IN BEEF HEIFERS IN 1973 IN THE NEAR SOUTH-WEST OF QUEENSLAND' INCLUDING TARA AND WARROO SHIRES

Breed	Number of Breeders	% Heifers Assisted to Calve	% Heifers Died	% Calves Died
Poll Hereford	13 921	18	7	10
Hereford	50 843	11	4	7
Shorthorn	1 944	1	2	1
Poll Shorthorn	2 420	3	1	5
Aberdeen Angus	1 368	1	3	4
Santa Gertrudis	1 583	8	2	5
Braford	315	0	0	0
Crossbreds	3 706	7	1	3
Other breeds	801	1	0	1

Source: Queensland Department of Primary Industries (1974).

Other sources of income from wool sheep enterprises include the sale of surplus weaners, cull sheep and cast for age sheep. On Group 2 lands where lambing percentages are very high, the sale of weaner sheep produces a significant part of the property income. Throughout the area, culls and cast for age sheep are sold as fats where possible. These are occasionally fattened on crop or more commonly on crop residue. An average oat crop will support 20 to 25 dry sheep equivalents per hectare for 90 days in the western part of the study area (Armstrong, Oakes and Stirling 1971). These authors estimate that sheep in store condition will fatten in 45 days gaining a total of 6·8 kg or better dressed weight at a liveweight gain of about 0·3 kg per day. Production data describing the effect of oat crop grazing on wool growth are not available.

Carrying capacity is generally heaviest on the clay soils and lightest on the red earths of the mulga country while other red earth and solodic soil types are intermediate (table 39). Figures relate to undeveloped native pasture or improved native pasture only, the area of introduced pasture being minimal (map 7).

The solodic—cypress pine-bull oak country (Group 4) runs one dry sheep equivalent to 4·1 ha in the 'green' or uncleared state. With development, this can be improved to about one dry sheep equivalent to 1·6 ha. Climatically the Group 4 type is favourably situated but its fertility is low, and it is used to a limited extent only in its present form.

The carrying capacity of 'red country' varies between a dry sheep equivalent to 0·6 to 0·9 ha for well developed poplar box-mulga communities (Group 6) and a dry sheep equivalent to 1·1 to 1·2 ha for solodic—poplar box-false sandalwood communities (Group 5). Undeveloped poplar box-mulga communities may carry a dry sheep equivalent to 1·4 to 1·6 ha. The limited areas of introduced pastures on these groups are based almost exclusively on buffel grass. No documented animal production data are available for sheep grazing introduced species on these soil-vegetation groups but trials with ewes grazing *Cenchrus ciliaris* cv. Biloela and *Panicum maximum* var. *trichoglume* cv. Petrie at 0·24 ha and 0·16 ha per ewe are being carried out on brigalow lands at Meandarra (Tothill 1972-73). At Blackall, wethers stocked at a sheep to 0·8, 0·4 and 0·2 ha cut fleeces averaging 4·97, 4·83 and 4·33 kg per head, following the 1972-73 summer (Orr, Payne and Roberts 1973).

The Red Earth–Mulga-Eucalyptus Shrubland (Group 7) supports on the average a dry sheep to 3·6 ha. This stocking rate may actually result in a heavy pressure on better class country (frontage or open grassland) associated with light grazing of poorer *Acacia aneura* country (Ebersohn 1963). *Acacia aneura* provides the most important fodder reserve for sheep on red earths west of the Balonne River. A mature dry sheep can eat 1·4 kg of dry matter of *A. aneura* per day, and at this rate energy consumption is just sufficient for maintenance and protein is ample (Everist, Harvey and Bell 1958). However, for sheep on a sole diet of *A. aneura*, phosphorus content is inadequate, leading to the removal of phosphorus from the skeleton, an eventual fall in blood phosphorus level and a depression of appetite. For this reason, it was recommended that sheep be supplemented with phosphorus during *A. aneura* feeding (Everist, Harvey and Bell *loc. cit.*). It has since been shown that phosphorus supplementation has no observable effect in terms of liveweight gain or wool production unless associated with an energy supplement such as molasses (McMeniman and Little 1974). The vitamin A content of *A. aneura* is adequate for sheep requirements (Gartner and Anson 1966).

TABLE 39

Sheep Carrying Capacities for Soil-Vegetation Groups in the Condamine–Maranoa Basin

Soil-Vegetation Group	Carrying Capacity (ha per dry sheep equivalent)		
	Interview Data	Murray and Purcell (1967)	Allison (1973*b*)
1	0·6	0·5	
2	0·8		1·0–1·2
3	0·6	0·6–1·0	
4	Undeveloped: 4·0 Developed: 1·7		
5	Undeveloped: 2·0 Developed: 1·3	1·6–2·0	
6	2·0		} 2·8–4·0
7	3·6	2·8–4·0	

Most fat lambs in Queensland are produced on the Darling Downs. However, few farms are principally devoted to fat lamb production and this enterprise is more commonly an adjunct to a grain growing enterprise (Ivers and Gordon 1970). In terms of the fat lamb industry, southern Queensland suffers from competition from the southern States where a greater reliability of rainfall and higher quality pastures are an advantage (Ivers and Gordon *loc. cit.*). Areas as far west as Goondiwindi and Surat are theoretically better suited to cross breeding enterprises than to fat lamb production (Moule 1955).

Although fat lambs were originally proposed as one of the likely enterprises for the St. George irrigation area, subsequent experience showed that this form of production did not make the most efficient use of the irrigated land and suffered by comparison with cash crops. The Tara Shire has the greatest proportion of non Merino sheep of the six shires of the project region. Some producers in the Waggamba Shire also run sideline fat lamb enterprises. *Medicago sativa* cv. Hunter River (lucerne) and winter cereals are considered necessary in the production of fat lambs (Coleman 1939).

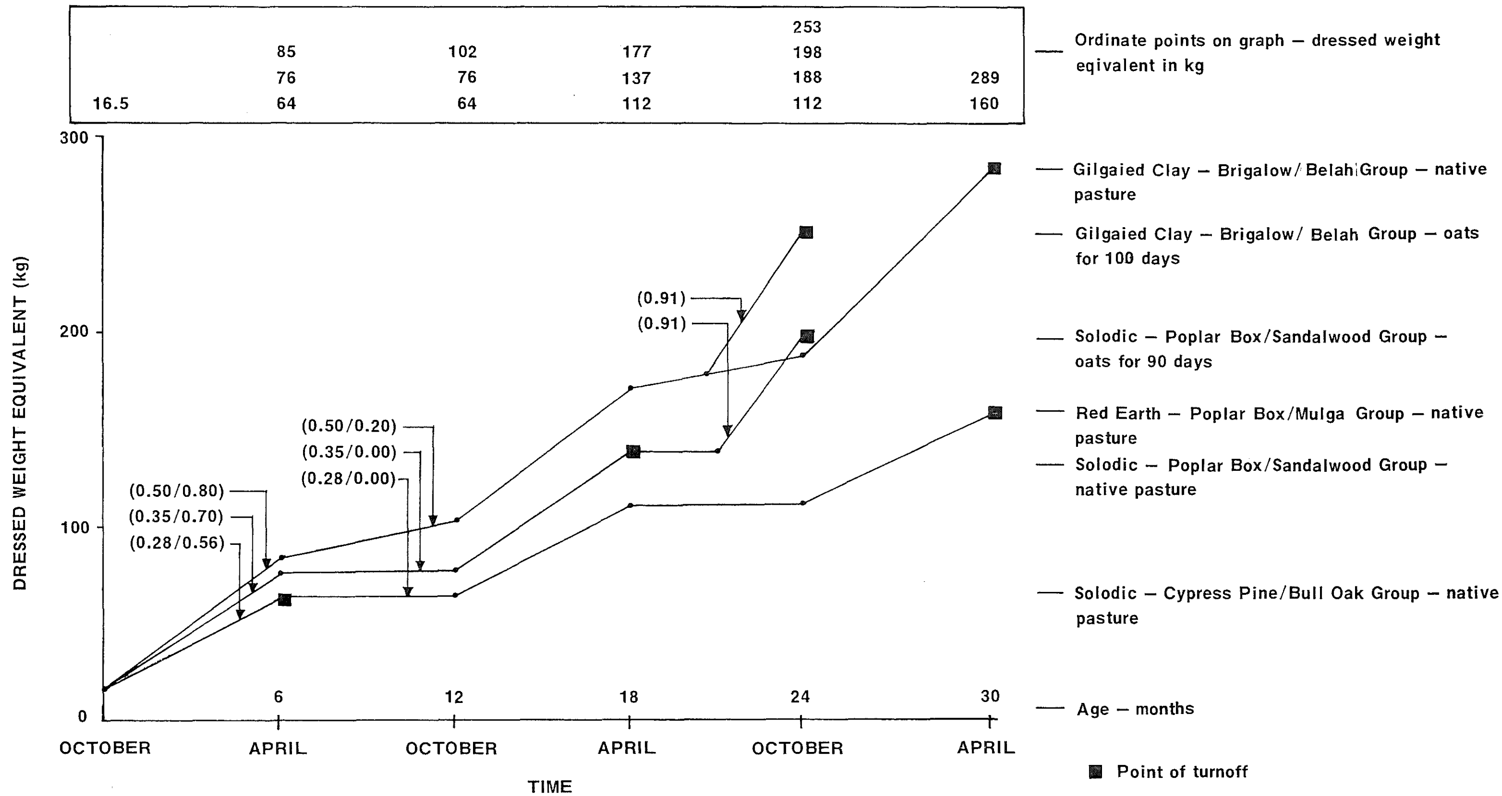
PRODUCTION—BEEF CATTLE. The favourable climate and locality of the study area provide a wide potential range for sources of dry matter, alternatives of turn-off and selection of breed. The choice will depend on current market values and trends, the capability and stage of development of a property, and personal preferences.

Figure 16 compares rates of weight increase of cattle in some representative production systems and illustrates the advantages of the more fertile and higher rainfall soil-vegetation groups. Rapid gains allow an earlier attainment of marketable weights. Thus, although cattle can be fattened in most areas of the Condamine-Maranoa basin, the age of turn-off increases to the west.

Cattle grazing native pasture on the solodic—cypress pine-bull oak forest do not grow well after weaning and consequently are turned off as stores at that time, female replacements being introduced from outside the area. The more fertile clay and clay-loam soils show the best average weight gains from native pasture. These regions also allow most scope for integration of the many dry matter sources with the aim of improving rate of weight gain, increasing stocking rate or reducing susceptibility of the system to drought.

Brigalow in the natural state carries a beast to 12 to 16 ha, while clearing increases this to a beast to 2 to 3 ha (Howard 1961). Interview data suggest a range of carrying capacities of a breeder to 3 ha to a breeder to 6 ha. Carrying capacities decrease to the west, ranging from a breeder to 6 to 12 ha for poplar box-sandalwood (Group 5) and poplar box-mulga (Group 6) communities to a breeder to 24 to 32 ha for mulga-eucalyptus (Group 7) communities. Liveweight gains of 0·45 kg per day average over the whole year have been shown for cattle grazing brigalow community native pasture (Howard 1961) while, during the growing season of these grasses, liveweight gains may reach 1·36 kg per day. Coaldrake and Smith (1967) quote rates of liveweight gain from similar pastures of 1·14 kg per day in spring.

The grazing of forage oats by cattle allows high weight gains at a time when gains on native or introduced pasture may be low or non-existent (Round 1953; figure 16). The practice is important in the study region as animals can be turned off crop as 'fats' some 6 months earlier than if grass fattened. Suitable animals may be purchased when the relationship between 'store' and 'fat' cattle is favourable or more commonly they are bred on the property. The condition of stock depastured on crop will affect the economic outcome of the venture (Bureau of Agricultural Economics and Queensland Department of Primary Industries 1968), light cattle having a greater conversion efficiency than heavy cattle.



* Figures in brackets indicate average daily liveweight gains; the first represents average annual daily liveweight gains, the second average summer or winter daily liveweight gains. These rates are the same for each year of growth. Liveweight gains for oat grazing are also shown.

Figure 16.—Theoretical growth rates of cattle in six production systems.

While crop fattening of cattle is practised throughout much of the region, the benefits to be gained in the western half on coarse-textured soils are comparatively greater than those on the clay soils of higher fertility. On the former, rapid weight gains for a short period on grazing oats allow the production of a fat steer at a time when it is difficult to obtain this type of animal on native pasture. On the open grasslands of Group 3 and on developed brigalow lands, the quality of pasture herbage will often approach that of crop and then the additional benefits are smaller. Although some winter oats are grazed by sheep, cattle graze the major areas and sheep are more often used to clean-up crop residue. In areas of inferior native pasture or when seasonal conditions are poor, the limited crop available may be reserved for bulls, young breeders, weaners and cows.

Cattle grazing oats gain an average liveweight of 0·91 kg per day (Howard 1961). Coaldrake and Smith (1967) report a range of liveweight gains for cattle grazing oats of 0·45 to 1·54 kg per day. Summer forage crops have been shown to support cattle liveweight gains of 0·91 to 1·82 kg per day on brigalow country, but at the same time of year native pasture was shown to support gains of 1·36 kg per day (Howard 1961). Some good use is made of standover sweet sorghum crops during the autumn period. Gains of 0·82 kg per day have been recorded on such a crop when animals were losing weight on native pasture (Howard *loc. cit.*).

Although introduced pastures do not represent a large proportion of the Condamine-Maranoa basin, their area is increasing. They provide a greater quantity of dry matter of equivalent quality to native pastures during the growing season. During winter both *C. ciliaris* and *P. maximum* provide forage of higher value. Because of their bulkiness, they are generally more suitable for cattle than for sheep. Maximum steer liveweight gains of 1·18 kg per day have been reported (Coaldrake *et al.* 1969) for *P. maximum* var. *trichoglume* cv. Petrie, *Chloris gayana* cv. Pioneer and *Cenchrus ciliaris* cv. Nunbank on Group 1 lands. Animal production investigations on introduced and fertilized pastures for Group 4 lands have been initiated (Russell 1973-74).

The increase in area under crop has made available dry matter from failed crops and crop stubble in addition to crops grown specifically for grazing during the autumn, winter and early spring period. There is also a readily available supply of grain for animal consumption. Although there are no large commercial feedlots in the study region, a small percentage of producers interviewed had experimented with concentrate feeding on a small scale. This was done mainly to finish cattle for sale in a dry time.

Animal husbandry

HUSBANDRY—SHEEP. Most producers in the study area seem aware of the benefits of the Mules operation for ewes and, to a lesser extent, wethers. However, it appears that mulesing is one of the first operations to be discontinued or reduced in times of financial difficulty. The proportion who actually carry it out, as indicated by interview data, is about 40%. In the early 1970s, when 39·2% of weaner ewes in Queensland were mulesed, the figure for the Roma and Downs statistical divisions was 57·3% (Anson and McKinnon 1971). There is a trend among producers to mules sheep at lamb-marking time. This gives no apparent depression in later production (Anson, Beasley and McMeniman 1969; Rose, McMeniman and Anson 1972).

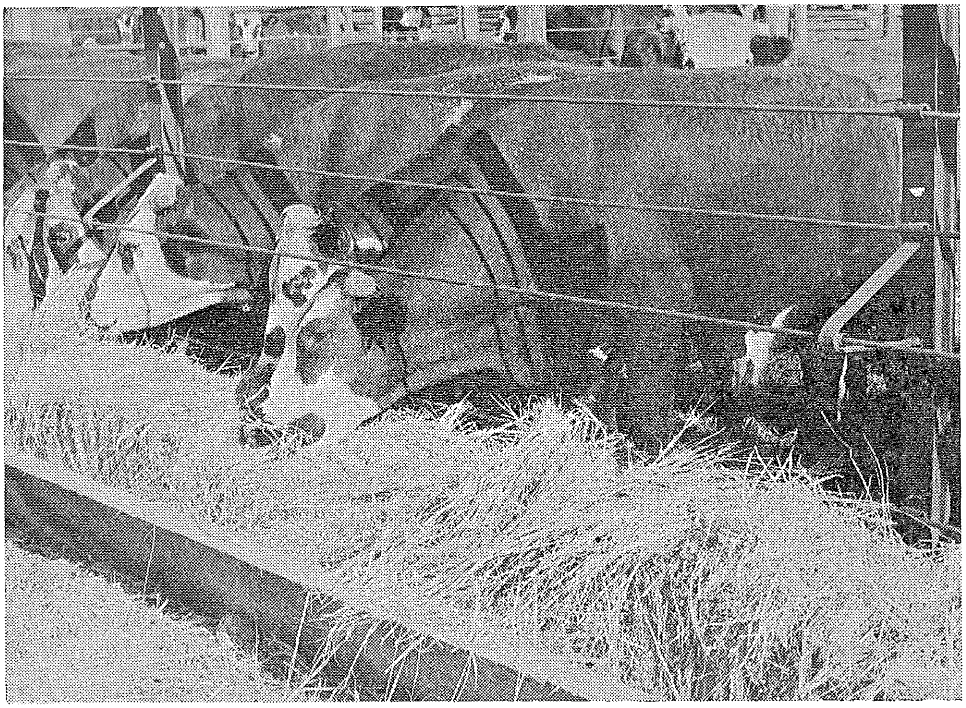
Breeding cattle perform well on buffel grass in a woodland area receiving less than 500 mm of rainfall per annum.

Jetting is another operation that many operators have reduced in an effort to minimize production costs. Retaining the Mules operation in conjunction with crutching and wigging permits jetting to be confined to treatment of observed struck animals. The efficacy of jetting depends largely on correct application methods being employed. Most producers in the study area crutch about 6 months after shearing. Although experimental confirmation is at present unavailable, it is felt that this, in conjunction with mulesing, helps reduce the necessity for jetting for body strike by reducing the fly population.

Shearing is spread over the whole year, its exact timing depending on factors such as non-interference with other enterprises, availability of contractors or avoidance of grass seed problems. Most shearing in the area is carried out by contract.

Internal parasites affect sheep both in summer and winter, and may reach serious proportions when conditions are favourable. On most occasions, infestation is with a single species, allowing the use of narrow spectrum drenches which are considerably cheaper than the broad spectrum varieties (McMeniman and Beasley 1969). In interview, it was ascertained that many producers still drench strategically with a broad spectrum drench going into and coming out of winter, as well as perhaps giving one or two other specific drenches during the year, particularly in summer.

Sheep lice are common in the study area and dipping or spraying after shearing is recommended (Anson and Bell 1971). Because of the difficulty of obtaining a clean muster in some areas and the ease of re-infestation, the effectiveness of lice control measures is often reduced.



Although commercial feedlots such as this are few, opportunistic lots, used for drought feeding and occasional fattening, are not uncommon.

Interview data show that most producers put 2 to 4% of rams to their ewes, commonly all being put in at once but occasionally in two drafts. The mating period is 6 to 8 weeks and ewes are usually either shorn or crutched beforehand. Some mustering of ewes is carried out to improve contact of ewes with rams. Lambs have usually been weaned by the time they are 5 months old. Autumn joining allows lambs to be weaned during a period of flush pasture growth.

HUSBANDRY—CATTLE. The occurrence of lice infestation on cattle appears to have increased over recent years and this could be due in part to the greater movement of cattle and to their general condition during drought years (Queensland Department of Primary Industries 1971*a*). Dipping facilities are not generally available as the entire area falls within the tick-free zone. Lice control is carried out by either spraying or using one of the commercial 'pour-on' preparations. Outbreaks are more obvious when stock are concentrated such as when grazing oat crops.

Internal worm parasites are not considered a major problem of beef cattle in the area, and drenching is restricted to some weaners or to stock going into an intensive feeding situation.

The recommendation of controlled weaning is not fully applied in the study region. Some producers do not control the mating of their cattle and some also allow weaning to occur naturally. District recommendations advocate a strategic weaning program based on the condition of the cow rather than on a set time, but aimed at May to synchronize with the recommended seasonal calving pattern (Strachan 1971; Strachan and Rudder 1971). Among producers who raise cattle 47% indicated that they removed their bulls from the herd for some period of the year.

DROUGHT HUSBANDRY. In the vast majority of producer interviews, concern was expressed over problems of drought. Drought is generally divisible into seasonal drought and long-term drought.

A seasonal feed shortage can occur in winter and spring, despite the bimodal rainfall pattern, because of the limited suite of pasture species able to take advantage of winter soil-moisture. As well, the occurrence of rain and frost during the non-growing season reduces the nutritive value of standover material. Methods of combating this shortage are available and include the introduction of pasture species which make better use of winter moisture or provide a greater bulk of better quality standover material, the use of supplements, and the sowing of winter fodder crops. Among producers interviewed who feed cattle on a fairly regular basis, 66% use molasses-urea mixes, 31% use commercial lick preparations, while 16% supplement with grain and 12% with hay. Smaller proportions use nitrogen sources such as meat-and-bone meal; 82% have some area of cultivation sown to oats. These figures should be viewed in the light of the preceding low rainfall years.

Severe droughts have affected the entire area in recent years such as in 1957 and 1965. It has been suggested that the area suffers a major drought on average one year in every eight, although the period between such occurrences is unpredictable (Queensland Department of Primary Industries 1969*b*). Management strategies for drought have been well reviewed (Campbell 1966; University of New England 1969; Moule 1970). Strategies employed in the Condamine–Maranoa basin to alleviate the effects of drought include—

1. Reduction of stocking pressure by sale or agistment of various classes of stock and withholding of breeding.

2. Scrub feeding. Species most commonly pushed or cut for feeding (particularly for sheep) are *Acacia aneura, A. pendula, Brachychiton populneum, Geijera parviflora, Eucalyptus* spp., *Atalaya hemiglauca* and *Ventilago viminalis*.

3. Supplementary or full hand feeding. Feeding of both sheep and cattle in drought in Queensland has been well documented (Moule 1955; Le Gros 1964; Daly 1966; Gibb 1966; Rowan 1966; Queensland Department of Primary Industries 1969*a*).

4. Economic methods, such as the purchase of drought bonds.

5. No positive action.

Active interest in fodder conservation and hand feeding was stimulated by a sequence of low rainfall years in the late 1960s. Statistics reveal that this interest has waned. In future droughts strategies 1, 2, and 5 are again likely to be most common.

OTHER ANIMAL ENTERPRISES. Pig production forms a profitable sideline enterprise for many producers notably within Millmerran, Inglewood and Tara shires. In Millmerran, most pigs are produced on mixed farms in areas which were predominantly dairies and most of the pigs are produced by a small percentage of farmers. In the Tara Shire, particularly, the increase in pig numbers (figure 6) is partly the result of graziers entering the industry as an interim step during the change over from sheep to cattle in order to maintain a cash flow. To adopt the pig industry as a permanent enterprise, however, requires a large capital outlay for housing and stock. This has not occurred and pig numbers are expected to decline when other enterprises become more profitable.

The Condamine–Maranoa basin, with its relatively favourable conditions for animal production, supports numerous stud stock enterprises. These breed sheep, cattle and horses, and often more than one stud enterprise is represented on a property. Hereford and Poll Hereford studs predominate for cattle as would be expected from the breed distribution statistics. The ready market for stud cattle is indicated by the high proportion of pure-bred to cross-bred cattle in the area compared with Queensland as a whole. Sheep studs are predominantly Merino, although some British breed studs are to be found.

Animal health

INFERTILITY. The extent of testicular abnormalities and reproductive disorders such as epididymitis in rams has not been documented for the area. Work to the west of the region indicates that the frequency of occurrence of ram epididymitis on properties in the Charleville area ranges up to 24%. Brucellosis, vibriosis and leptospirosis have not been demonstrated to be of concern in sheep. Although infertility diseases have been shown to occur in cattle in the study area (Simpson-White 1971) vaccination is not common.

ECTOPARASITES. The most serious ectoparasite of sheep is the blowfly (chiefly *Lucilia cuprina* and *Chrysomia rufifacies*). Severe fly waves are initiated by wet springs, and waves of varying severity occur with wet autumns. The seriousness of the fly problem has been accentuated by the development of insect resistance to chemicals. Increasing resistance has been observed to diazinon, the most commonly used chemical at present, this first being noted in 1965 (Shanahan 1967). The use of mechanical means of reducing breeding grounds of flies, such as mulesing, crutching and wigging, offers some alternative to chemical control. The release of dung burying beetles (*Onthophagus* spp.) throughout Australia is also expected to reduce fly populations.

Sheep lice (chiefly *Damalinia ovis*) occur throughout the study area and most producers dip sheep once a year as a control measure but the severity of the problem appears to be increasing.

The major ectoparasite of cattle is lice (*Linognatus vituli, Damalinia bovis*). Field trials (Queensland Department of Primary Industries 1971*a*) indicate that variability of infestation occurs within a cattle herd. The effect of cattle lice at varying degrees of infestation and at all levels of nutrition is indicated for investigation.

ENDOPARASITES. The commonly encountered endoparasites of sheep are *Haemonchus contortus* (barber's pole worm) and *Oesophagostomium columbianum* (nodule worm). Others include tapeworm (most commonly *Moniezia expansa*) and some lungworm (probably *Dictyocaulus filaria*). Infestations are most severe on Group 2 lands.

Worms have not been demonstrated to be of importance in adult cattle and it is generally recommended to drench only weaners. Worms that occur most commonly are *Haemonchus placei* (barber's pole worm) and *Trichostranglyus sp.* (black scour worm).

METABOLIC AND DEFICIENCY CONDITIONS. Pregnancy toxaemia (hypoglycaemia) is the most common metabolic disease of sheep in the study region. It is brought on by a nutritional check in late pregnancy, a situation likely to apply in late winter-early spring periods just before lambing. Milk fever (hypocalcaemia) also occurs and is brought on by the rise in the plane of nutrition when feeding on lush oats, wheat or barley crops.

Copper deficiency has been suspected in sheep on some brigalow communities, notably in the Tara Shire, where sheep have exhibited the classic 'steely wool' symptom.

Cattle can exhibit bone-chewing which is attributed to phosphorus deficiency. It shows up most quickly in cattle grazing winter cereals. The deficiency also occurs on red earths in the western parts of the area and on solodic soils in the east. There are two studies involving phosphorus in the area to the west of the Condamine–Maranoa basin. These are the Charleville Phosphorus Survey (Weller and Plasto 1973), a survey of faecal phosphorus, and a Phosphorus Supplementation Evaluation (Plasto and Weller 1973) where responses to phosphorus supplementation have been measured. These investigations will add further information on the rôle of phosphorus in cattle management in the area.

The increasing occurrence of grain feeding of cattle has produced cases of associated disorders such as acidosis.

BACTERIAL AND VIRAL DISEASES. Tetanus is widespread in the area, but the need for vaccination can be obviated by reasonable hygiene during operations such as mulesing and marking. Blackleg has been observed to a minor extent only.

Infectious bovine rhinotracheitis and bovine viral diarrhoea have been observed as have occasional cases of the actinomycotic disease lumpy jaw. Ephemeral fever (3-day sickness) occurs about once every 10 years.

Mycotic dermatitis (lumpy wool) of sheep, while not particularly common, is found throughout the area particularly following wet winters and springs.

Contagious ophthalmia (pink eye) of sheep and infectious bovine keratoconjunctivitis (I.B.K.) in cattle are found, particularly in the western part of the area where dry, dusty conditions, grass seed infestations and the presence of bush flies all predispose to the condition.

A condition of cattle that is of particular concern is eye cancer. It has been shown to affect Hereford cattle more commonly than other breeds present in the area (French 1959). Eye cancer is unusual in cattle less than 4 years old and, for this reason, is not often seen in market steers. The disease is conspicuous in breeding cows and bulls. Affected animals must be treated or sold as the condition is fatal if allowed to run its course. Of the producers with an interest in cattle, more than 90% of those interviewed regarded eye cancer as a problem with Hereford cattle, within breeding-herd incidence ranging from 2 to 8%. Exposure to strong sunlight and lack of eye pigmentation are implicated as predisposing factors (French 1959). Most cancers appear to affect the eyelid or eyeball (Hodge 1973) and the incidence of eyeball cancer also has a strong negative correlation with presence of eyelid pigment.

PLANT POISONING. The following plants which grow in the study area have been implicated with poisoning of stock. The toxic substances reported from these plants are shown (Everist 1974).

Avena sativa (oats). Nitrate

Cheilanthes sieberi (mulga fern). Radiominatic substances

Datura stramonium (common thornapple). Tropane alkaloides

Eremophila maculata (fuchsia bush). Cyanogenetic glycosides

Euphorbia drummondii (caustic creeper). Cyanogenetic glycosides

Ipomoea calobra (Weir vine). Toxic principle not recorded

Myoporum deserti (Ellangowan poison bush). Sesquiterpenes

Pimelea spp. (rice flowers). Coumarin compounds?

Portulaca oleracea (pigweed). Nitrate and oxalates
Salvia reflexa (mintweed). Nitrate
Swainsona spp. (Darling pea). Toxic principle not recorded.
Trachymene ochracea (wild parsnip). Toxic principle not recorded

Two disorders caused by toxic plants are of particular importance in the Condamine–Maranoa basin. They are—

1. *St. George disease.* This affects significant areas of the shires of Warroo, Waggamba and Balonne. It is a condition of cattle in which they exhibit diarrhoea, oedema, nasal discharge and hydrothorax. Cantello (1969) was the first to link the condition with the genus *Pimelea,* although it had been reported from areas from which this plant had apparently disappeared. It was subsequently shown that inhalation of plant fragments of *P. trichostachya* (spiked rice-flower) will produce the symptoms, and it was hypothesized that the disease in the field can result from ingestion of the plant and/or inhalation of plant fragments (Clark 1971).

2. *Weir vine poisoning. Ipomoea calobra* (Weir vine) is peculiar to a small area in the St. George–Roma district and is confined to red soils with *A. aneura* and/or *Eucalyptus melanophloia* (Everest 1974). It produces 'weiry' symptoms in sheep, including staggers and an apparent unawareness of obstacles. It causes losses through deaths and retarded production, and thus lowers the value of land. The toxic principle has not been isolated, and no antidote is known except to move stock to pasture free of the weed where a large proportion of animals appear to recover without ill effect.

MISCELLANEOUS PRODUCTION IN THE CONDAMINE–MARANOA BASIN

Forestry

Much of the information contained in this section was obtained from officers of the Queensland Department of Forestry.

In 1972-73, 16·6% of the total log cut from Queensland's State Forests was *Callitris columellaris* (white cypress pine) (Queensland Department of Forestry 1973). Approximately half of this came from the study region where it is the major commercial timber. Cypress pine occurs throughout the region on suitable soils but the commercial stands are located mainly in the east (Anon 1967); the western pine is largely of poorer quality being low in height and multi-branched. Twenty timber mills in the area cut cypress pine exclusively.

Cypress pine achieves dominance on solodic soils with a sandy A horizon usually exceeding 30 cm; with a shallower A horizon *Casuarina leuhmannii* (bull oak) assumes dominance (Isbell 1957). Cypress pine achieves its maximum growth on sandy soils with an A horizon of 75 to 90 cm. Such soils are mainly contained in Wa13 and Va24 soil associations (Northcote 1966; Isbell *et al.* 1967) which constitute 70% of the area of State Forests in the six shires.

The total area of State Forests in the Condamine-Maranoa basin, including a few minor timber reserves, is 360 000 ha (table 40). This is 9·3% of the Queensland total and 4·5% of the total area of the six shires. The area carrying some cypress pine in association with other species is much greater, but the area where cypress pine predominates is some 400 000 ha. The total volume of timber is approximately 2 700 000 m^3 with a calculated annual yield of

52 000 m³. The gross area of State Forests is being increased by incorporating suitable forest types at expiry and/or conversion of leases to freehold tenure. Much of this land is released for pastoral use under Special Lease tenure, which usually allows grazing rights only.

TABLE 40

CONDAMINE–MARANOA BASIN CYPRESS PINE STATISTICS

Tenure	Total Area (ha)	Cypress Forest Area (ha)	Total Volume > 59 g.b.h. (m^3)	Calculated Yield per annum (m^3)
State Forest				
Inglewood	86 200	54 229	470 426	8 231
Millmerran	14 569	9 308	66 088	1 292
Waggamba	95 912	60 704	389 619	7 360
Tara	159 854	93 080	806 274	16 192
Balonne	3 642	2 023	9 012	150
Total	360 177	219 344	1 741 419	33 225
Forestry interest				
Inglewood	11 331	4 856	27 036	391
Waggamba	87 414	23 877	141 488	3 124
Tara	28 329	7 284	42 056	841
Balonne	87 009	14 164	60 080	991
Warroo	78 915	12 950	86 816	1 772
Total	292 998	63 131	357 476	7 119
Lease holdings and other Crown lands				
Inglewood	40 874	8 094	21 028	391
Millmerran	3 238	809	4 206	90
Waggamba	89 842	11 736	41 455	901
Tara	22 663	2 428	24 332	481
Balonne	1 081 342	15 378	42 056	631
Warroo	99 959	14 569	70 894	1 893
Total	1 337 918	53 014	203 971	4 387
Freehold lands				
Inglewood	77 701	14 164	103 938	1 893
Millmerran	1 619	405	2 103	30
Waggamba	146 095	13 355	89 820	1 802
Tara	114 933	12 950	77 804	1 592
Balonne	1 005 260	17 402	69 092	1 142
Warroo	106 030	8 094	46 262	1 081
Total	1 451 638	66 370	389 019	7 540
Total				
Crown lands	1 991 093	335 489	2 302 866	44 731
Freehold lands	1 451 638	66 370	389 019	7 540
	3 442 731	401 859	2 691 885	52 271

Source: Queensland Department of Forestry (personal communication).

Forest management in Queensland is almost exclusively carried out by the Queensland Department of Forestry, whereas logging and processing are very largely in the hands of private enterprise (Anon 1967). The Department owns the timber and controls harvesting on the areas of State Forests. Only timber on freehold land or land held under a lease which will ultimately be freeholded may be used or controlled by the owner.

Forest management of cypress pine involves thinning of commercial species and the removal of competing non-commercial species, promotion of regeneration, and the construction of fire breaks and roads to protect and supply access to the timber (Anon 1970*a*). No planting of cypress pine is undertaken, regeneration occurring naturally, particularly where grazing by sheep and rabbits (Johnston 1969) and to some extent cattle is controlled. Cypress pine is extremely susceptible to fire damage (Anon 1970*a*). However, rigid exclusion of fire leads to an accumulation of combustible material which in itself poses a serious fire hazard in the hot dry summer months. This material is burnt under mild temperature conditions. Most forests are protected with systems of lookout towers, aerial observation, fire breaks and mobile fire fighting units. Access roads also constitute fire breaks and blocks of timber are isolated with untreated areas of vegetation which produce less ground cover.

The growth rate of cypress pine can be appreciably increased by silvicultural treatment which consists of thinning out competing pine trees below commercial size and ring-barking and/or poisoning non-commercial species. This is normally applied following logging. Standing timber is measured as circumference of the tree over the bark, 160 cm from the ground, and is referred to as girth breast height (g.b.h.) over bark. Girth increment of treated stands averages 1·26 cm g.b.h. a year compared with 0·63 cm a year for untreated stands. The effect of the interval since silvicultural treatment on girth measurement is shown in table 41.

TABLE 41

AVERAGE ANNUAL GIRTH INCREMENT FOLLOWING SILVICULTURAL TREATMENT OF WHITE CYPRESS PINE (CM AT GIRTH BREAST HEIGHT)

Years Since Treatment	State Forest 154 (Western Creek)	State Forest 328 (Yuleba)	State Forest 302 (Barakula)
0–5	1·40	1·17	1·09
5–10	1·02	0·76	0·91
10–20	0·66	0·79	0·94
> 20	0·56	0·56	0·66
Mean	0·71	0·69	0·76

Source: Queensland Department of Forestry (1973).

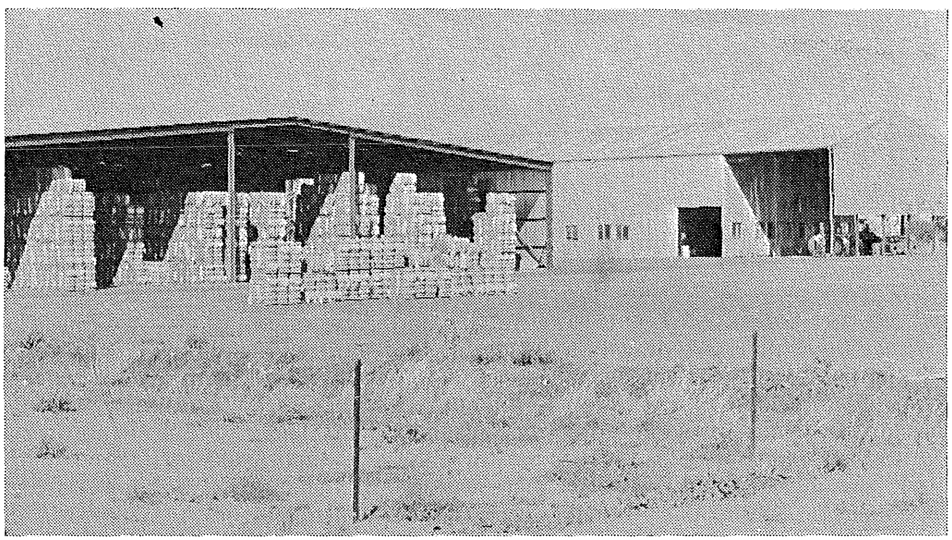
From State Forests, sales of cypress pine are made to sawmillers who are licensed to buy Crown timber. The Department adopts a practice of tree marking for removal of those trees which are over-mature (generally 122 cm g.b.h. over bark) and also those trees down to a lower girth limit of 61 cm whose removal will benefit the remainder of the forest. On some classes of Crown lands no tree marking is practised and areas are logged to a minimum g.b.h. of either 76 cm or 91 cm depending on circumstances. There is no control of logging on land which is in the process of being freeholded or on freehold land. Sustained yields are based on a felling cycle of 20 years.

Cypress pine has an extremely low shrinkage factor, is dressed unseasoned and is commonly used 'green off saw' for building. It is also highly durable and termite resistant. It is the main commercial timber of the inland and as such is important in providing employment (Anon 1970). In the past, the bulk of the sawn output was exported to New South Wales and supplied Sydney with two-thirds of its flooring requirements. There is increasing demand for cypress pine in Queensland in the metropolitan and near coastal areas and the rapidly expanding mineral towns of central Queensland (Queensland Department of Forestry 1973).

With the protection afforded to a large part of the forest estate and the annual treatment of forest, a huge volume of cypress pine is being built up. Most of this is in the smaller girth classes and is retained to build up stock but the total cut will eventually increase (Anon 1970).

Irrigation

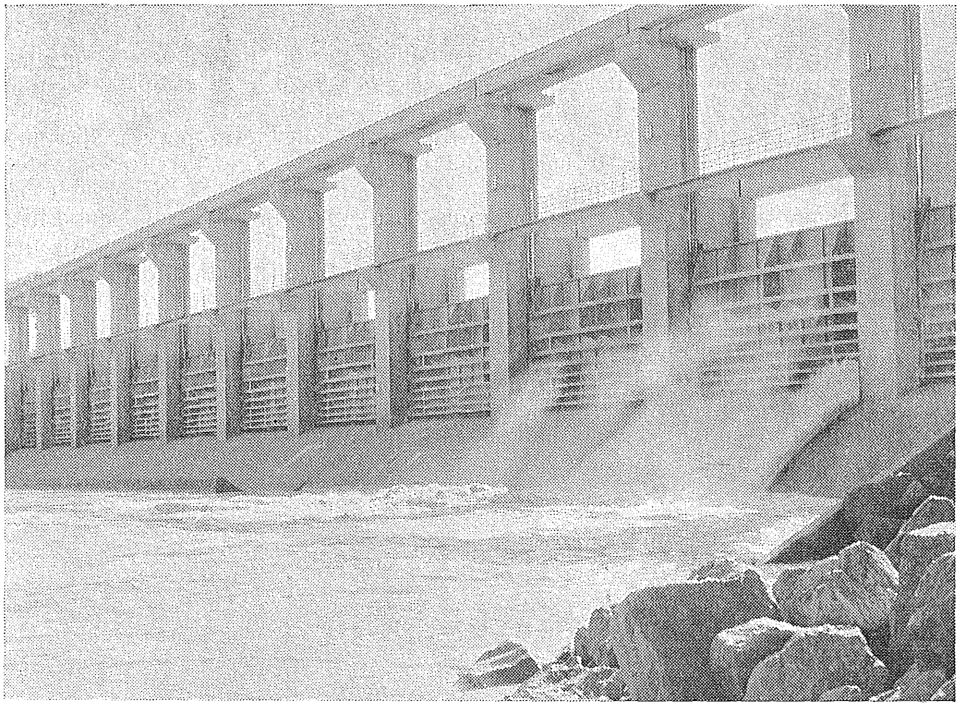
ST. GEORGE IRRIGATION AREA. Irrigation in the St. George area has developed in three phases. In 1953, a weir was completed adjacent to St. George for town water and with some surplus for irrigation. The capacity of this structure was 4 800 Ml. There was little interest in irrigation from the properties adjoining the storage and, in 1957, the storage was increased to 10 000 Ml to provide water for reticulation to an irrigation area 5 km south-east of St. George (van Haeringen and Wegener 1968). Seventeen irrigation farms were established and these bore the brunt of the search for suitable production systems for the area. The third phase of development involved the construction of the E. J. Beardmore Dam, and the associated Moolabah and Buckinbah weirs on Thuraggi Watercourse, completed in 1972. This has an assured annual supply at the storages of 64 000 Ml (Queensland Department of Primary Industries and Irrigation and Water Supply Commission 1967) and has provided the means for further expansion of the irrigation area. In 1975, there were 33 irrigation farms serviced by supply channel and six farms drawing water from the Balonne River or the Thuraggi Watercourse.



Because of the successful production of irrigated cotton at St. George, a cotton gin has been located in the area.

Despite nearly 20 years of irrigation history, some stability of the production system has only recently been achieved. Initially intended to produce cotton, fat lambs and hay for pastoral properties of the region, the irrigation area now produces cotton, soybean, grain sorghum and popcorn. Early attempts at cotton production were unsuccessful and, for a time, fat lambs were the main product. Subsequently intensive grain production was practised. With correct agronomic practices, however, cotton has now become the major crop with

2 840 ha harvested in 1974-75. During the same period, 1 648 ha of soybean, 600 ha of grain sorghum and 32 ha of popcorn were harvested to give a total of 5 120 ha. A cotton ginnery has been established and the area contributes more than 50% of Queensland's cotton production.



Control gates on Beardmore Dam which provides water for the important cotton-producing area at St. George.

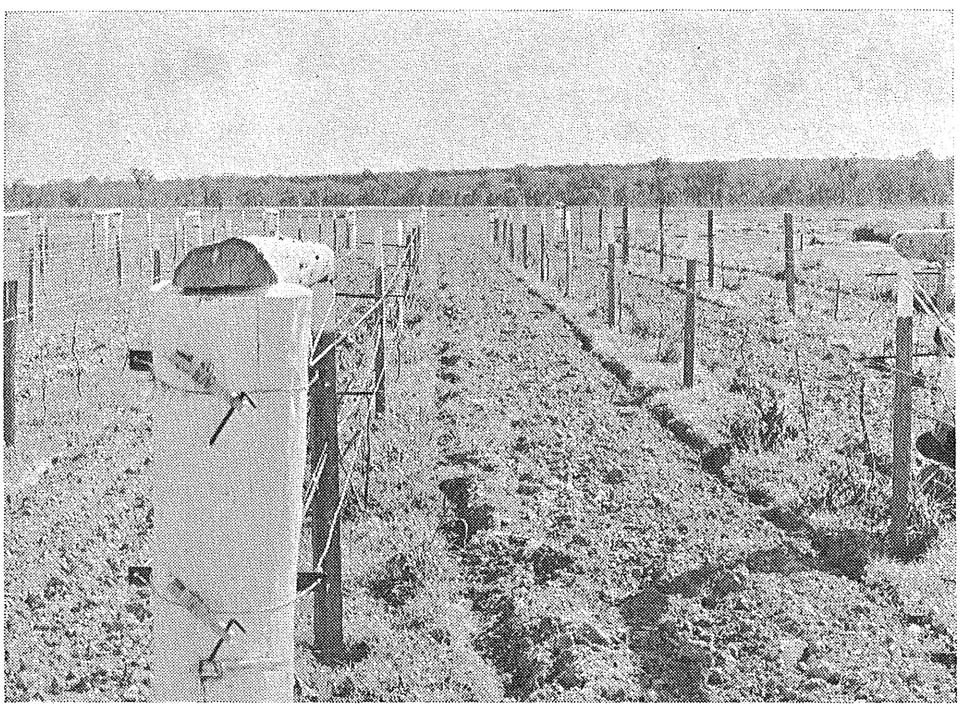
MACINTYRE BROOK IRRIGATION AREA. The Inglewood Shire has a long history of irrigation with water drawn from Macintyre Brook and the Dumaresq River. By the late 1940s, the tobacco industry was well established (Kerr 1971). However, following a record crop return in 1959-60 from approximately 900 ha of tobacco in the Inglewood Shire (Queensland Department of Primary Industries 1970*b*), the industry collapsed because of poor leaf quality (Kerr 1971). This led to the investigation of water conservation on Macintyre Brook to provide for expansion into other crops (Queensland Department of Agriculture and Stock and Irrigation and Water Supply Commission 1963). With the completion of Coolmunda Dam (map 1) in 1968, an assured supply at the storage of 20 000Ml was made available for irrigation on riparian holdings on Macintyre Brook and for a more stable flow in this watercourse.

A steady increase in the area irrigated has occurred since the completion of the dam. In 1974-75, a wide range of crops was grown and the total area irrigated on Macintyre Brook was 1 885 ha. Individual crop statistics were: lucerne 540 ha; barley 220 ha; navy bean 189 ha; cotton 160 ha; tobacco 120 ha; soybean 104 ha; winter forage 100 ha; French beans 92 ha; grain sorghum 80 ha; horticultural crops 45 ha; sunflower 30 ha; pasture 30 ha; pumpkins 25 ha and potatoes 25 ha (G. H. Malcolmson personal communication). However, tobacco is the most valuable crop, returning $1 268 812 from 282 ha for the whole shire in 1974-75 (Queensland Department of Primary Industries 1974-75). The range of crops grown suggests that the area has not yet established generally satisfactory production systems.

DUMARESQ VALLEY IRRIGATION PROJECT. The partly constructed Glenlyon Dam on Pike Creek (map 1) south-east of the study area will lead to the expansion of existing irrigation between this storage and Goondiwindi; an additional 7 000 ha of irrigated land is estimated. The project is a joint venture between the Queensland and New South Wales governments and each will receive half of the assured annual supply of 97 000 Ml. The estimated time of completion of this project is mid 1976.

ON-FARM IRRIGATION DEVELOPMENT. It is difficult to separate the statistics of irrigation in the St. George and Macintyre Brook areas from those of privately developed schemes. It is estimated, however, that the latter would occupy less than 5% of the total area irrigated. Large sections of the Condamine-Balonne and Macintyre Rivers have regulated flows and pumping restrictions apply.

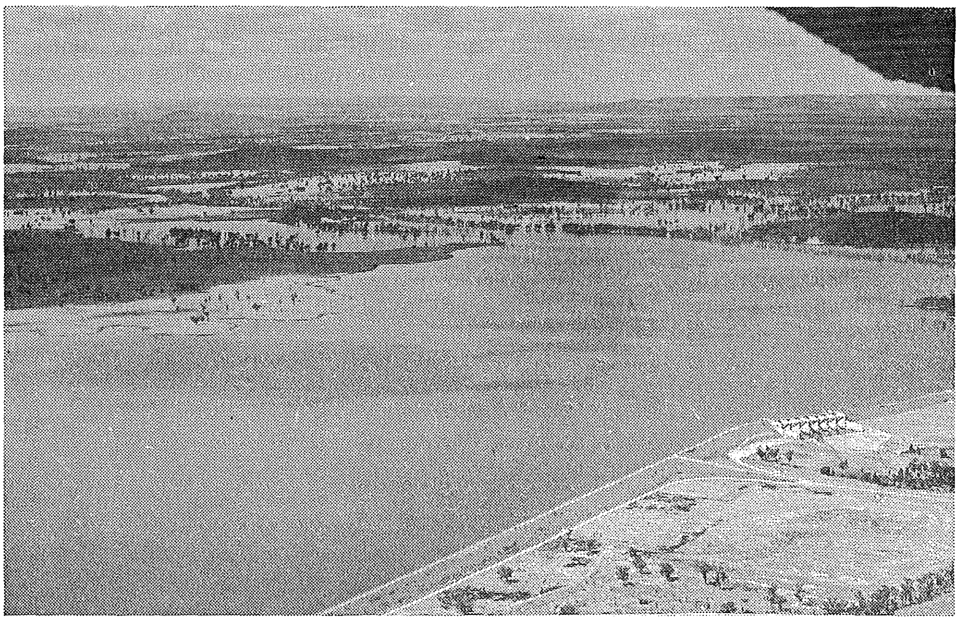
The potential for conventional irrigation from off-stream storages is limited by the flat topography. Even where water harvesting might be possible, interest in irrigation is not great. This might be because of the favourable dry-land cropping environment or because of the presence of Government-sponsored schemes where assured water supplies are available for people interested in intensive production.



Although the productive area is small interest in grapes for table use and wine making is increasing on Macintyre Brook.

Apiculture

The south-eastern section of the study area is an important honey-producing region. Tree flowers provide the major source of nectar in contrast to other areas in the world where ground flora serve this purpose (Blake and Roff 1958). The country west of Goondiwindi is not normally important for honey production, although in favourable seasons *Eucalyptus ochrophloia* (Yapunyah) (Roff 1966*b*), *E. microtheca* (Roff 1966*a*), *E. populnea* and *E. camaldulensis* (Blake and Roff 1958) can give rise to significant qualities of honey. There were 10 resident beekeepers in the study area in 1969-70, and these were responsible for the production of 31 981 kg of honey, mainly in the Inglewood shire.



Coolmunda Dam controls the flow in Macintyre Brook where tobacco is the major product.

ECONOMICS OF PRODUCTION IN THE CONDAMINE–MARANOA BASIN*

In the 25 years to 1973-74, there has been a steady rise in the cost of living as measured by the Consumer Price Index. The gross value of rural production has risen steadily during the same period and at an increasing rate since 1971-72 (figure 17). The gross value of farm income rose significantly from 1971-72 to 1973-74 after remaining steady since World War II, but farm income as a percentage of net national product declined, reflecting the declining importance of agriculture in the Australian economy. The wool industry suffered a recession in the late 1960's and early 1970s with some recovery in 1972-73, while cattle prices rose to unprecedented levels in the same period and slumped in 1974. Wheat prices, being stabilized, have not fluctuated markedly. It is within this broad economic framework that primary production has been carried out in the Condamine-Maranoa basin.

*(Costs and prices shown in this section are those which applied during 1973 unless otherwise stated).

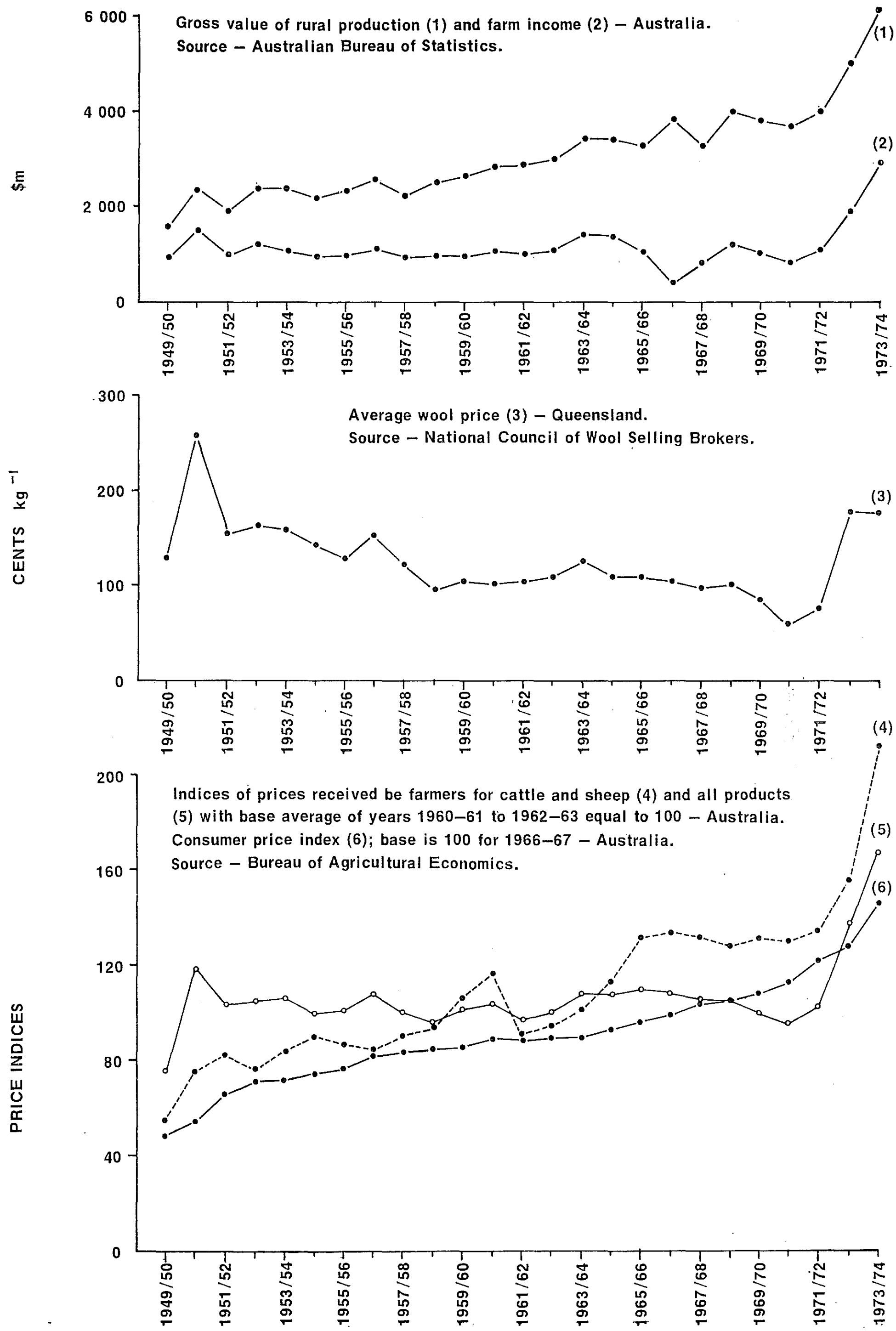


Figure 17.—Trends in primary production.

Marketing trends and forecasts

The following discussion is based on material presented at the National Agricultural Outlook Conferences, particularly that of 1973, except where otherwise indicated.

In 1971-72, Queensland supplied 9·5% of the Australian wool clip (Australian Year Book 1973) which, in turn, constituted one-third of the world's wool; one-quarter of the value of the Queensland clip was produced in the Condamine-Maranoa basin. After the decline in wool values, prices were stabilized in 1970 by the support buying of the Australian Wool Commission at a level of 35c per pound greasy wool. Subsequently a figure of 250c per kg for clean wool of 21 micron was established. Auction demand increased in 1972 enabling the commission to dispose of accumulated stocks and, in 1972-73, the price of greasy wool rose sharply to a level double that of the previous season. Although there was some subsequent fall in the market, prices are expected to remain satisfactory in the short term because of the continued decline in supply.

Australia is the world's biggest exporter of beef and during the period of this study supplied 50% of total beef imports to the U.S.A. and 80% of Japan's beef imports. The strong demand for beef on the world market led to high prices which coincided with the recession in the wool industry. As in other areas, this led to a considerable growth of the beef cattle industry at the expense of wool production. This trend has to some extent been reversed in the light of the fall in beef prices during 1974 and the more stable wool market.

The six shires of the study area produce 19% of Queensland's wheat harvest, Queensland producing on average 8.5% of the Australian total. Introduction of wheat delivery quotas in 1969-70 was designed to reduce the area of wheat planted. However, the local effect of this was largely masked by seasonal conditions. An important advantage of wheat growing for the primary producer is that wheat prices are stabilized, thus reducing price uncertainty and allowing more reliable estimation of future cash flows.

Because of the high level of trade in wheat and the depletion of stocks during 1972-73, an expansion of wheat output is expected in both Australia and overseas producers. Overall prospects will depend on the degree of this response by the major producing countries (Bureau of Agricultural Economics 1973*a*). As in the past, variations in seasonal conditions will continue to exert a marked effect on production and world trade.

The output of coarse grains (grain sorghum, barley, oats and maize) is expected to continue to expand in the major exporting countries. In the developed countries, rapid expansion in the use of feed grains is occurring. At present, half Australia's feed grain production is consumed domestically and this proportion is expected to increase with expansion of intensive livestock industries. Therefore grain sorghum and barley should increase in importance provided the demand from livestock industries continues.

Sunflower oilseed production has increased significantly in the study area since 1968-69, reflecting the expansion in oilseed production in Australia in general.

Credit and indebtedness

The total gross rural indebtedness in Australia more than doubled in the 10 years to 1970-71, remaining steady thereafter to 1973-74. Net indebtedness (gross indebtedness minus farmers' holdings of liquid assets) in this period increased nearly tenfold (Bureau of Agricultural Economics 1974). The ratio of debts to assets more than doubled in the 10 years to 1970-71 and subsequently fell again with increases in farmers' holdings of liquid assets. Within Queensland, 32·2% of the total debts of primary producers in 1971 were 'hard core' debts (those taking longer than 24 months to repay) as opposed to 13·8% of this type of debt for the rest of Australia (Trezise 1971).

The Condamine-Maranoa basin is divided into 'pastoral' and 'wheat-sheep' zones as defined by the Bureau of Agricultural Economics (Bureau of Agricultural Economics 1973*b*). Although pastoral zone properties have a considerably higher level of debt than properties in the wheat-sheep zone, the average debt per property in the Condamine-Maranoa basin is at a similar level to the wheat-sheep zone properties (table 42). In the face of extensive timber treatment and agricultural development, this situation reflects the greater income earning capacity of the study area.

TABLE 42

INDEBTEDNESS OF PRODUCERS BY INDUSTRY FROM VARIOUS SOURCES

Industry-Sector	Region	Year	Average Debt per Property $	Equity of Average Property %
Sheep industry .. (1)	Queensland pastoral zone ..	1964–70 ..	28 207	81·6
	Queensland wheat-sheep zone	1964–70 ..	8 920	91·8
Sheep industry .. (2)	Condamine–Maranoa ..	1952–67 ..	9 126*	91·6
Beef industry .. (3)	Australia	1962–65 ..	9 100	93·2
Beef industry .. (4)	Condamine–Maranoa ..	1964 ..	10 384	96·5
Wheat industry .. (5)	Australia	1967 ..	13 600	89·9
	Queensland	1967 ..	17 100	83·5
Wheat industry .. (6)	Condamine–Maranoa ..	1967 ..	52 800	81·2
Pastoral house clients (7)	Inglewood Shire	1972 ..	49 857	50
	Warroo Shire	1972 ..	53 646	73
	Tara Shire	1972 ..	47 231	60
	Waggamba Shire	1972 ..	56 958	69
Government source (8)	Condamine–Maranoa—all ..	1972 ..	66 435	58
	Condamine–Maranoa—sheep	1972 ..	66 677	58
	Condamine–Maranoa—beef ..	1972 ..	66 932	60
	Condamine–Maranoa—mixed cereals and animals	1972 ..	66 030	57

Source: (1) Bureau of Agricultural Economics (1969*a* and 1973*c*); (2) Bureau of Agricultural Economics, unpublished data for 17 properties in Condamine–Maranoa basin; (3) Bureau of Agricultural Economics (1970); (4) Bureau of Agricultural Economics, unpublished data on five beef properties in Tara, Millmerran and Waggamba shires; (5) Bureau of Agricultural Economics (1969*b*); (6) Bureau of Agricultural Economics, unpublished data on two wheat properties in Tara Shire; (7) Pastoral House, unpublished data; (8) Government Source, unpublished data.

NOTE.—* Debt imputed at 6·25%.

Average debt per sheep property in the study area increased during the years of declining wool prices. In south-west Queensland, it rose from $18 965 in 1962-63 to $32 672 in 1967-68 (Haug and Hoy 1970). The average net indebtedness of sheep properties in the Queensland pastoral zone rose from $8 747 in 1960-61 to $31 117 in 1969-70 (Bain and Waring 1971).

In 1964, beef properties in the Condamine-Maranoa basin showed low levels of debt similar to the average for Australian beef properties. By 1972, the level of equity of these producers had dropped considerably as had properties involved with other enterprises (table 42). Differences in average indebtedness between properties of the three major classifications were small.

Indebtedness levels for wheat properties in the study area were higher in 1967 than the average for Queensland or Australian wheat farms. This was, in part, a result of the recent expansion of the area sown to grain crops and, in part, the variable yields obtained from grain crops.

Profitability of enterprises in the Condamine–Maranoa Basin

Data on the profitability of producers in the study area have been obtained largely from those recording with the Queensland Department of Primary Industries Farm Management Accounting Service. The number of participants in this service has fluctuated during the period 1966-67 to 1972-73 reaching a maximum of 32 in 1970-71. The years 1968-69 and 1972-73 were the most profitable, whereas 1970-71 was a year of loss (table 43). However, properties in the area have shown large differences in average net income. Most estimates of the profitability of the various enterprises have been prepared in the form of gross margins.

TABLE 43

AVERAGE NET INCOME PER PROPERTY, WITH NUMBER OF PROPERTIES IN BRACKETS, FOR INDIVIDUAL RECORDING GROUPS OF THE QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES FARM MANAGEMENT ACCOUNTING SERVICE AND FOR THE CONDAMINE–MARANOA BASIN

Year	Karara Group (sheep–beef) (west of Warwick)	Dirranbandi Group (grazing) (south-west of region)	Condamine–Maranoa Basin
1966–67	9 944 (10)	—	9 858 (11)
1967–68	9 275 (4)	—	5 923 (7)
1968–69	17 029 (4)	—	17 890 (12)
1969–70	2 190 (7)	12 601 (9)	7 989 (21)
1970–71	−1 950 (7)	−5 147 (5)	−1 389 (32)
1971–72	4 664 (7)	6 826 (5)	6 547 (25)
1972–73	—	—	17 943 (26)

Source: Clift and Moorhouse (1969), Moorhouse (1970*a*, 1970*b*, 1971, 1972, 1973) and unpublished data from the Queensland Department of Primary Industries Farm Management Accounting Service.

SHEEP AND WOOL PRODUCTION. Traditionally, sheep have been the major income earner in the Condamine-Maranoa basin, but low product values during the late 1960s caused a swing to cattle-raising to bolster income and to further diversify production (McKay 1973). More recent price trends have restored some confidence in the wool industry. The returns to capital and management achieved negative values in 1957-58 and 1958-59, a period of low rainfall, and in 1965-66, a major drought occurrence (table 44). In comparison with the sheep industry in Queensland's pastoral zone, the study region generally has smaller returns and less severe fluctuations in returns, while the wheat-sheep zone appears more stable again. A calculation which assumes that the non-sheep expenses equal the non-sheep returns and that the residual expenses are directly attributable to the sheep enterprise, has been employed to determine a break-even price of wool production. When compared with the average price received for greasy wool in Queensland, only on the two major drought occasions did the returns for wool fail to cover the calculated break-even cost of production (table 44). In keeping with pastoral zone and wheat-sheep zone properties, it is likely that the break-even cost of production may not have been realized on several occasions since 1966-67 when the study area data terminated. By way of a comparison, the break-even cost of production for greasy wool calculated for six properties located just to the east of the study area was shown to be $105 \cdot 2$c kg^{-1} for the period 1969-70 to 1972-73 (Thompson 1973).

TABLE 44

SHEEP INDUSTRY PROFITABILITY FOR THREE AREAS AS DETERMINED BY RETURN TO CAPITAL AND MANAGEMENT (RET. C AND M) ($) AND BREAK-EVEN COST OF PRODUCTION (B.C.P.) (CENTS KG^{-1}) (2) COMPARED WITH THE AVERAGE WOOL PRICE (CENTS KG^{-1})

Year	Qld Pastoral Zone		Qld Wheat-Sheep Zone		Condamine–Maranoa (1)		Average Wool Price Q'land (unscoured)
	Ret. C and M	B.C.P.	Ret. C and M	B.C.P.	Ret. C and M	B.C.P.	
1957–58	2 668	107·34	..	..	−1 672	135·98	120
1958–59	1 550	86·43	..	..	−886	92·92	93
1959–60	14 316	75·12	..	..	2 845	92·71	105
1960–61	5 916	79·38	..	..	870	92·74	98
1961–62	5 728	77·84	..	..	2 708	88·57	100
1962–63	10 070	81·10	..	..	4 022	87·02	111
1963–64	17 245	82·11	9 998	..	7 158	86·80	124
1964–65	798	99·26	3 564	76·85	3 641	93·63	105
1965–66	−9 800	130·34	2 600	97·36	−2 603	123·49	107
1966–67	7 468	89·17	7 195	63·50	7 765	57·21	103
1967–68	6 086	98·59	4 666	63·75	..	..	96
1968–69	13 833	78·33	4 276	68·69	..	..	100
1969–70	−1 489	95·87	1 269	91·67	..	..	83
1970–71	−920	..	−23	..	..	..	61

Source: Bureau of Agricultural Economics (1962, 1965, 1967, 1969*a*, 1973*c*).

Notes: (1) Bureau of Agricultural Economics, unpublished data on 17 properties in the Condamine–Maranoa basin.
(2) For explanation of B.C.P. calculation see text.

TABLE 45

SUMMARY OF ESTIMATED PROFITABILITY OF WOOL PRODUCTION IN THE CONDAMINE–MARANOA BASIN

—	Group 1 and 3	Group 2	Group 4	Group 5	Group 6
Enterprise gross margin (EGM) per ewe ($)	12·51	11·22	—	13·34	12·56
EGM per sheep shorn ($)	4·60	5·38	3·34	4·15	4·03
EGM ($ ha^{-1})	7·28	6·37	2·00	2·94	1·81
EGM less labour per sheep shorn ($)	3·64	4·58	2·26	3·08	2·97
EGM less labour ($ ha^{-1})	5·76	5·65	1·36	2·18	1·33

Source: Summary based on appendix 8.

Gross margins per sheep shorn are highest for the Group 2 lands and lowest for Group 4 lands which carry dry sheep only (table 45). Profitability per sheep shorn is primarily affected by wool cuts and reproductive rates, flocks on Group 2 lands having high proportions of ewes, high lambing percentages and heavy fleeces. Highest gross margins per hectare are recorded for Groups 1, 2 and 3 with Groups 4, 5 and 6 considerably lower, reflecting the higher productivity of the heavier soils. Inclusion of the cost of labour per sheep carried did not alter the ranking.

In south-west Queensland, ewe flocks have been shown to be more profitable than wether flocks if lamb-marking percentages are about 40 (Anson and Mawson 1969). In central-western Queensland, ewe flocks have been shown to be more profitable when wool prices are about 252c kg^{-1} while below this change-over value, wether enterprises were more profitable (Campbell 1974). The change-over value was sensitive to the assumed price for sheep.

BEEF PRODUCTION. During the depression in the wool industry, with its nadir in 1970-71, beef production increased in importance in the study area. While high beef prices helped to maintain this status when wool values recovered, the effect of the fall of beef prices in 1974 was not clear at the time of writing. Trends towards substituting cattle for sheep in pastoral zones were based on pastoralists' assessments of relative profitabilities rather than on a desire to decrease risk, and may have even increased the variability of the income of the average property (McKay 1973). Beef cattle production has a lower labour requirement than sheep raising. Also, since cattle operations in the study area are not as critical with respect to timeliness as sheep operations, a cattle enterprise is more compatible with cropping than is wool growing.

In comparison with the average beef property in Queensland, beef properties in the Condamine–Maranoa basin on average are larger, have bigger herds, higher returns to capital and management and higher net farm incomes per hectare (table 46).

TABLE 46

CHARACTERISTICS AND PROFITABILITY OF BEEF PROPERTIES FOR THE AREAS INDICATED

Region	Condamine–Maranoa (1)	Queensland (2)
Area of property (ha)	19 226	12 721
Capital ($)	295 998	99 132
Cattle carried	1 993	862
Turn-off rate (%)	54·4	32·7
	$	$
Farm output—beef	40 247	13 994
—other	12 782	4 144
—total	53 029	18 138
Total costs	27 090	10 104
Operator's allowance	1 765	1 765
Return to capital and management	24 174	6 269
Net farm income per ha . .	1·26	0·49

Source: (1) Bureau of Agricultural Economics, unpublished data.
(2) Bureau of Agricultural Economics (1970).

Notes.—(1) This data is the average of five properties in the Condamine–Maranoa, two in Tara, two in Millmerran and one in Waggamba.
(2) All data are average for the period 1962–63 to 1964–65.

Since pastoral enterprises have a comparatively low level of directly related fixed expenses, the enterprise gross margin reflects the contribution of that enterprise. The gross margins show the clay soils of the brigalow lands and grasslands to be the most productive and the cypress pine-bull oak solodics the least productive (table 47).

TABLE 47

SUMMARY OF ESTIMATED PROFITABILITY OF BEEF ENTERPRISE IN THE CONDAMINE–MARANOA BASIN ($)

——	Groups 1 and 3		Group 4	Group 5		Group 6
Pasture type	Native pasture	Native pasture plus oats	Native pasture	Native pasture	Native pasture plus oats	Native pasture
Enterprise Gross Margin (EGM) per breeder	85·06	74·56	20·05	39·86	51·12	39·10
EGM per beast equivalent	43·84	46·02	14·96	25·23	32·35	21·25
EGM per ha	6·74	7·08	0·60	2·52	3·23	0·85

Summary based on appendices 9 and 10.

Cattle on native pastures may, at best, gain weight slowly during winter; the use of forage oats at this time will add appreciably to total annual weight gains (Coaldrake *et al.* 1969). On Groups 1 and 3, forage oats will allow fat cattle to be marketed 6 months earlier and increased profit will result not only from the sale of animals during a period when they are scarce but also from an increase in breeder numbers. On a hypothetical 100-cow herd, approximately 16 extra breeders can be carried (appendix 11). In the study region, cattle for crop fattening are normally bred on the property. These may be increased with purchased steers and in a few cases, when the store-fat price relationship is satisfactory, crop fattening of purchased cattle is practised as a separate enterprise.

A definite financial advantage accrues from the integration of oats crops into a cattle breeding enterprise where it is possible to grow crops on a high frequency. Appendix 10 shows that the gross margin per hectare increases from $6.74 to $7.08 where brigalow land cattle are fattened on oats at 24 months as compared with fattening on pasture at 30 months. Similarly, crop-fattened cattle on poplar box-sandalwood country (Group 5) return a gross margin of $3.23 as compared with $2.52 for cattle sold as store steers 6 months earlier.

When considering the specialist crop-fattening enterprise (appendix 12), the importance of a high stocking rate and an extended grazing period become apparent. When stocking rate was decreased from a beast to 0·4 ha to a beast to 0·8 ha and grazing time from 100 days to 90 days the gross margin per beast decreased from $17.50 to $7.24. Thus, while a specialist enterprise may be profitable on the highly productive Group 1 and 3 lands, it is unlikely to be so on the Group 5 lands.

CROPPING. The large expansion of area sown to wheat in the Condamine-Maranoa basin since 1957-58 makes the region a significant contributor to Queensland's total production. Although variable, the returns from wheat have added an avenue of diversification open to only a relatively small part of pastoral Queensland. An average of 48% of wheat produced in the area is of prime hard grade.

A wheat delivery quota scheme was introduced in Australia for the 1969-70 season after a record carry-over of wheat from the previous season. In Queensland, this has not yet been filled, and climatic conditions have exerted the major production control. However, delivery quotas did cause a shift in production, primarily to coarse grains and oilseeds (Bureau of Agricultural Economics 1973*a*). Favourable prices for other crops have aided this shift (Roberts 1971). In the Condamine-Maranoa basin, a further influence on production patterns was the trend towards diversification.

A wide range of types and sizes of machinery was found to be employed by wheat growers in the Downs and Roma statistical divisions (Hamilton 1966*a*). The speed of operation and frequency of cultivation also varied considerably (Hamilton 1966*b*). Time spent in machinery operations was excessive, and increased investment in machinery, coupled with decreased expenditure on repairs, was suggested (Hamilton 1967). Profitability of wheat growing in the area is influenced by efficiency of machinery use (Harrison 1968) and the level of investment in plant and machinery (Queensland Department of Agriculture and Stock and Queensland Council of Agriculture 1959).

Total machinery operating costs per hectare have been calculated for a range of hypothetical farming scales from a small producer with 300 ha of cultivation to a large producer with 1 000 ha (appendix 13). Cultivation and planting costs range from \$14.69 ha^{-1} for the small producer to \$10.50 ha^{-1} for the large producer for winter crops requiring an average of five operations. For summer crops and forage oats which require an average of only four operations, the range is \$13.25 to \$9.62. These figures suggest that there are some economies of size, although each farming equipment combination will have an optimum operating area. With these figures and the estimation of harvesting and storage costs (appendix 13), a calculation of the profitability of wheat growing can be made (table 48). Net return per hectare for the large producer is twice that of the small wheat grower.

The break-even yield of 0·84 t ha^{-1} provides a minimum return for a small wheat grower. This is consistent with the break-even yields of 0·74 t ha^{-1} (Stirling and Campbell 1973) and 0·81 t ha^{-1} (Tomes 1971) reported for the area. The average expected yield of the area ranges from 1·1 t ha^{-1} (Australian Bureau of Statistics 1958-59 to 1969-70) to 1·04 t ha^{-1} planted (Queensland State Wheat Board data). This adequately covers the break-even yields and returns a margin to management. Low income years associated with poor grain yields will impose hardship on grain growers, particularly in the early years of establishment.

Growers plant some crops in the summer season, despite the lower probability of success, in an attempt to maximise the use of machinery. Grain sorghum and sunflower are the main summer cash crops. Although at times high, prices for these crops are subject to wider fluctuations than those operating for wheat. Based on average yields and expected prices, the profitability of summer grain crops is generally less than that for wheat; of the summer crops, sorghum is more profitable than sunflower (table 49). An additional return from grain sorghum is the grazing value of the stubble. This may allow the crop to give higher returns than wheat but the fluctuations in grain yield limit the area planted.

Of the winter grain crops, seed oats is the most profitable, but the area planted is limited because of the strict weed-free market requirement. The potential for barley growing will depend on expansion in the feed-lotting industry, but on current trends this appears unlikely.

TABLE 48

SUMMARY OF ESTIMATED PROFITABILITY OF WHEAT GROWING IN THE CONDAMINE–MARANOA BASIN

Item	Small Producer (300 ha)	Large Producer (1 000 ha)
First advance for f.a.q. wheat ($ t⁻¹)	44·10	44·10
Average prime hard payment ($ t⁻¹) (1)	2·21	2·21
Discounted balance of proceeds ($ t⁻¹) (2)	4·10	4·10
Gross proceeds ($ t⁻¹)	50·41	50·41
Freight and levy expenses ($ t⁻¹) (3)	14·06	14·06
Net on-farm proceeds ($ t⁻¹)	36·35	36·35
Net on-farm proceeds per ha planted ($) (4)	37·62	37·62
Production expense ($ ha⁻¹)		
cultivation and planting	14·69	10·50
seed—28 kg ha⁻¹ at $110 t⁻¹ (5)	3·08	..
—28 kg ha⁻¹ at $36.75 t⁻¹	..	1·03
harvesting (6)	6·08	3·62
overheads (rates, rents, admin.) (7)	1·50	1·50
storage	0·13	0·13
miscellaneous equipment (8)	5·00	5·00
Total production expense per ha planted ($)	30·48	21·78
Net return per ha planted ($)	7·14	15·84
Net return per t harvested ($)	6·90	15·30
Break-even price ($ t⁻¹)	43·50	35·10
Break-even yield (t ha⁻¹)	0·838	0·599

Source: Summary based on appendix 13.

Notes.—(1) The prime hard payment is $4.41 t^{-1} and is applied to approximately 50% of production from the area.

(2) Based on the average Australian f.a.q. price for the period 1949–50 to 1972–73 being $48.88 t^{-1} and the deferred payments discounted at 8% for 2 years.

(3) The maximum freight is $8.86 t^{-1}, the hail levy is $2.20 t^{-1} (1972–73) and 50 km road cartage to the depot is costed at 6 cents t^{-1} km^{-1}.

(4) Based on the State Wheat Board average of 10 years for the Condamine–Maranoa basin of 1·035 t ha^{-1}.

(5) The small producer buys seed. An opportunity cost is shown for seed which a large producer would retain.

(6) Allowance is made for only 81·1% of the area planted to be harvested. A small producer would employ a contract harvester at $7.50 ha^{-1} whereas a large producer would own a harvester.

(7) Stirling and Campbell (1973).

(8) Based on equipment outlined in Anon (1970*b*) and using standard depreciation, interest, repair, lubrication and shelter rates (Queensland Department of Primary Industries 1970*a*).

Forage cropping requires only a small capital investment compared with grain cropping. The major forage crop grown is oats for cattle grazing and this has a high success rate. In good seasons, preference is given to fattening while, in poor seasons, the crop is used to maintain the condition of breeding stock and young animals. Forage oat crops usually require four cultivation operations. Using this as a basis, a value for cultivation, planting and seed of $18.32 ha^{-1} has been employed in budget exercises (appendix 16). In comparison, the cost of establishment of a forage sorghum crop is $17.06 ha^{-1}.

TABLE 49

SUMMARY OF NET RETURN FOR VARIOUS CROPS ($ HA⁻¹)

Crop	Wheat	Grain Sorghum	Grain Sorghum plus Stubble Grazing	Sunflower	Barley	Oats for Seed
Small producer ..	7·14	2·04	7·73	−2·32	4·95	15·33
Large producer ..	15·84	10·38	16·07	6·02	12·18	22·56

Source: Summary based on appendicies 14, 15, 17 and 18 and table 48.

The gross margins shown previously for crop fattening of beef compare favourably with the net returns for grain cropping, assuming no significant differences in enterprise fixed costs. However, price variations in 1974 favoured grain cropping.

The gross margin for 5·7 ha of tobacco grown with irrigation on Macintyre Brook is \$2 073 ha^{-1} for a yield of 1 400 kg ha^{-1} and a price of 243c kg^{-1} (Kerr 1971). Share farming is common and the share farmer usually pays the landowner 22·5% of gross proceeds for the use of his land and equipment.

On tobacco farms in the Inglewood-Texas area, other enterprises constitute a larger proportion of total farm activities than on similar farms in other tobacco areas of Australia. It is the only such area in which livestock receipts exceed 10% of total farm receipts (Bureau of Agricultural Economics 1973*d*). The region has been shown to be one of low tobacco yields and low returns to capital and management compared with other tobacco areas in Australia (Bureau of Agricultural Economics *loc. cit.*).

PIGS. Although normally of minor importance in the study area, pigs became a profitable sideline enterprise for some producers in the period of low wool prices during 1967 to 1972. An average gross margin per sow of \$234 has been calculated for intensive units (Fullerton 1971), but as most units in the study area are semi-intensive the gross margins would be less than this.

HORTICULTURE. The main horticultural crops in the area are grapes and apricots. Grapes are grown chiefly for table use but some go into local wine production. These crops are grown in the irrigation areas of the Macintyre Brook. In 1972, there were 19 ha of grapes in the three border shires, with an average yield of 2 722 kg ha^{-1} (Australian Bureau of Statistics 1972–73). Minor areas of other horticultural crops, such as citrus fruits, are also grown under irrigation. An advantage of producing grapes in the study area is that it can supply table grapes for the metropolitan market an average of 2 weeks earlier than the Stanthorpe district.

A vineyard costs a total of about \$2 500 ha^{-1} to establish. This includes \$370 ha^{-1} for cleared, irrigated land, \$280 for crop establishment and \$1 850 for trickle irrigation and trellising. Trickle irrigation costs about \$500 ha^{-1}, and increases yield and water use efficiency. Full production is achieved in 5 years with a light commercial crop in year 4, at which time a peak debt of \$3 000 is incurred (Cant 1970). Average yield is half a case per vine with 1 700 to 2 000 vines ha^{-1}.

One man can look after 2 ha and vines can be expected to bear for 30 years. The variable costs are \$250 ha^{-1} plus \$1.02 per case of grapes and marketing costs are 10·25c per dollar of gross return. Gross margins of \$834 ha^{-1} for grapes and \$1 033 ha^{-1} for apricots have been calculated (Alcock 1968). Apricots have an advantage over grapes in that their period of high labour requirement at picking time does not clash with that of the tobacco crop. However, grapes transport better and have an alternative outlet in pressing for wine production.

Resource allocation and enterprise combinations

Budget exercises have considered the production of wool, beef and wheat as individual enterprises. Few such situations exist in the Condamine–Maranoa basin, and most landowners have diversified into two or more types of production. This section considers the outcome of combining enterprises in proportions which are indicated by interview data.

Gross margins have been extensively used in the Condamine–Maranoa basin to compare enterprises for extension purposes (appendix 19). They are limited, however, in their usefulness for intra-farm analysis since they do not allow for the interplay of the scarce resource. Linear programming is the basic method used to attempt to optimize gross margins subject to the limiting resources. However, this technique also has deficiencies. Activities requiring high capital input can be selected over low capital input enterprises when the gross margins of the former are greater. The resultant farm plan can be sub-optimal, being biased towards capital intensive enterprises such as cropping as compared with livestock. The technique also fails to indicate the best path over time to reach the 'optimum plan' as it largely ignores investment and financing decisions. Multi-period analysis can convert the static farm plan into a dynamic one but requires a much larger matrix and this limits the application of the analysis.

In using the linear programming technique, Egan (1968) expressed the gross margins as units of labour and area. Different rankings can be obtained depending on the common unit used. If the limiting resource is land such as on a small property and gross margins are expressed per hectare, cropping is the most profitable enterprise. However, if the limiting resource is labour, which may occur on a large property, gross margins expressed per unit of labour rank pastoral enterprises above cropping enterprises. This illustrates the need for linear programming to clarify and indicate optimum enterprise combinations with respect to the available resources in a potential multi-enterprise situation.

The technique has already been used in the Condamine–Maranoa basin. Hamilton and Egan (1969) found that the most profitable farm plan under the given restrictions for a Glenmorgan property puts major emphasis on wheat and beef fattening. They suggested that a wide diversity of profitable combinations of enterprises was possible in the region and the general increase in the district towards wheat, fodder crops and beef production was economically sound.

Rickards and McCarthy (1966) allowed for the heterogeneity of soil types in their farm plan of a Goondiwindi property. They were interested more in the methodology of linear programming and did not include labour as a restraint. For northern New South Wales, Powell and Hardaker's (1968) optimum farm plan showed that wheat was the most profitable farm activity with livestock restricted to the non-arable land. The area also had a wide range of viable alternatives.

Some enterprises are complementary at certain levels of input of the resources and, in addition, a spread of risk is achieved by combining enterprises on a single property. The main enterprises which are climatically suited to the area are sheep breeding for wool and animal turn-off, beef breeding for the whole range of beef products from yearling to fat bullocks, and cropping for winter forage and grain and summer forage and grain in decreasing order of reliability. In the east, cropping, sheep and cattle enterprises can all occur on the same property. In the predominantly pastoral areas to the west, sheep and cattle occur on the same properties, the proportion of each depending on such factors as vegetation type, development stage of the property, relative profitability, market trends and tradition.

Returns for the dominant enterprises of sheep and cattle favour the cattle enterprise on a return to capital and management per hectare basis (table 50).

In considering the relative profitability of enterprise combinations, six commonly encountered enterprise groupings are examined (table 51). Gross returns have been calculated using average expected costs for properties of similar size, type and production from the Farm Management Accounting Service of the Queensland Department of Primary Industries for the last 2 years. The absolute level of these figures will vary but the approximate relationship between the six property types will be more constant.

TABLE 50

COMPARATIVE PROFITABILITY OF SHEEP AND CATTLE ENTERPRISES IN THE CONDAMINE–MARANOA BASIN

Industry	Sheep (1)	Sheep (1)	Beef (2)
Period	1952–53 to 1966–67	1962–63 to 1964–65	1962–63 to 1964–65
Return to capital and management ($)	4 595	4 940	24 174
Return to capital and management ($ ha^{-1}) ..	0·97	1·05	1·26

Sources: (1) Unpublished Bureau of Agricultural Economics data for 17 sheep properties in the Condamine–Maranoa basin.

(2) Unpublished Bureau of Agricultural Economics data for five beef properties in the Condamine–Maranoa basin.

The analysis suggests that the properties located on clay soils (Groups 1, 2 and 3), especially those with cropping will be very profitable. While wheat is the most profitable crop, the fattening of cattle on forage oats will increase profits to a small extent. The landholder with a large area of wheat shows highest returns per hectare while pastoral properties located on coarse textured soils (Groups 5 and 6) shows the lowest. Some increased profit results from cattle fattening on forage oats (Group 5) and this will be enhanced by the benefits to other classes of stock. It can be assumed that the profitability of Group 7 properties will approximate that of Group 6. Despite diversification into several enterprises, the returns for a Group 4 property are low.

ACKNOWLEDGEMENTS

The authors are indebted to Dr. J. P. Ebersohn and the late Dr. G. R. Moule for the original concept and initiation of this project. Finance was provided by the Australian Wool Research Trust Fund and the Queensland Department of Primary Industries.

Guidance and technical criticism were afforded by a management committee which consisted at various times of Dr. J. P. Ebersohn, Mr. D. G. Cameron, Mr. C. P. Hamilton and Mr. J. Gibb. The technical assistance of Mr. W. H. Ritter is also gratefully acknowledged.

The scope of this project precludes individual mention of many of the people who contributed. In this context, the authors would like to acknowledge the help of various officers and members of staff of the following organisations: the Queensland Department of Primary Industries both in Brisbane and in the field; C.S.I.R.O. (Cunningham Laboratory, Brisbane; the Division of Land Use Research, Canberra; Ian Clunies Ross Animal Research Laboratory, Prospect); the University of New England; the Bureau of Agricultural Economics; the Australian Bureau of Statistics; the Bureau of Meteorology, Brisbane; and the Irrigation and Water Supply Commission, Queensland. Thanks are due specifically to the Division of Land Utilisation of the Queensland Department of Primary Industries for preparation of the maps which appear in this report.

Finally, the authors would like to thank the many primary producers who contributed with their time, experience and hospitality during the course of the project.

TABLE 51

CHARACTERISTICS AND ESTIMATED OPERATING PROFITS OF COMMONLY-ENCOUNTERED ENTERPRISE COMBINATIONS IN THE CONDAMINE–MARANOA BASIN

—	Groups 1 and 3 (small wheat producer)		Groups 1 and 3 (large wheat producer)	Group 2	Group 4	Group 5		Group 6
Area (ha)	2 800		4 000	4 000	6 000	8 000		10 000
Stocking rate (ha per d.s.e.)	0·6		0·6	0·8	1·6	1·3		2·0
Pasture type	Native pasture	Native pasture plus oats	Native pasture	Native pasture	Native pasture	Native pasture	Native pasture plus oats	Native pasture
Ewe number	800	800	—	1 500	—	1 000	1 000	1 000
Wether number	600	600	—	—	1 800	1 368	1 368	1 261
Breeding cattle numbers	150	174	274	100	140	150	150	90
Total cattle numbers (1)	354	345	543	236	217	288	288	200
Cultivation area (ha)	300	370	1 000	80	150	120	120	—
Wheat area (ha)	220	150	660	—	80	—	—	—
Wheat yield (t ha^{-1})	1·035	1·035	1·035	—	1·035	—	—	—
Oats area (ha)	—	70	120	40	—	80	80	—
Grain sorghum area (ha)	60	60	120	—	40	—	—	—
Grain sorghum yield (t ha^{-1})	1·014	1·014	1·014	—	1·014	—	—	—
Forage sorghum area (ha)	20	20	40	40	30	40	40	—
Sunflower area (ha)	—	—	60	—	—	—	—	—
Sunflower yield (t ha^{-1})	—	—	0·342	—	—	—	—	—
Lambing (%) (2)	72 (80)	72 (80)	—	81 (90)	—	63 (70)	63 (70)	58 (65)
Branding (%)	80	80	80	80	70	75	75	70
Wool cuts per head (kg)—								
rams	7·0	7·0	—	7·0	—	7·0	7·0	7·0
ewes	4·5	4·5	—	5·0	—	4·0	4·0	4·0
wethers	5·5	5·5	—	—	4·5	5·0	5·0	5·0
weaners	1·5	1·5	—	2·0	—	1·5	1·5	1·5
Wool produced (kg)	8 702	8 702	—	12 098	8 100	12 983	12 983	12 373
Sale sheep—								
c.f.a. wethers	93	93	—	—	288	219	219	202
c.f.a. ewes	128	128	—	240	—	160	160	160
cull weaner wethers	155	155	—	608	—	—	—	—
cull weaner ewes	75	75	—	209	—	49	49	24
Replacement wethers	—	—	—	—	414	—	—	—

TABLE 51—continued

CHARACTERISTICS AND ESTIMATED OPERATING PROFITS OF COMMONLY-ENCOUNTERED ENTERPRISE COMBINATIONS IN THE CONDAMINE-MARANOA BASIN—*continued*

—	Groups 1 and 3 (small wheat producer)		Groups 1 and 3 (large wheat producer)	Group 2	Group 4	Group 5		Group 6
Area (ha)	2 800		4 000	4 000	6 000	8 000		10 000
Stocking rate (oa per d.s.e.)	0·6		0·6	0·8	1·6	1·3		2·0
Pasture type	Native pasture	Native pasture plus oats	Native pasture	Native pasture	Native pasture	Native pasture	Native pasture plus oats	Native pasture
Sale cattle with dressed weight or equivalent in brackets (kg)—								
c.f.a. cows	22 (210)	26 (210)	41 (210)	15 (210)	21 (190)	22 (190)	22 (190)	13 (190)
weaners	—	—	—	—	70 (65)	—	—	—
cull heifers	30 (92)	35 (92)	55 (92)	20 (92)	—	27 (68)	27 (68)	13 (59)
18–24 month steers (3)	—	—	—	—	—	54 (140)	54 (198)*	31 (161)
18–24 month bullocks (3) ..	—	66 (250)*	104 (250)*	—	—	—	—	—
24–30 month bullocks	57 (289)	—	—	38 (289)	—	—	—	—
Value of wool ($) (4)	10 886	10 886	—	15 135	10 133	16 242	16 242	15 479
Value of sheep sales ($) at $8 per wether and $6 per ewe	3 202	3 202	—	7 558	2 304	3 006	3 006	2 720
Cost of replacement sheep	384	384	—	720	3 312	480	480	480
Value of cattle sales ($) at 72·41 kg^{-1} dressed weight	17 272	18 233	28 725	11 565	6 184	9 830	12 098	5 958
Value of crop ($) (5)	14 238	14 238	41 915	—	6 029	—	—	—
Total proceeds ($)	45 214	46 175	70 640	33 538	21 338	28 598	30 866	23 677
Total costs ($) (6)	24 416	24 934	36 026	17 104	11 949	20 298	21 914	13 733
Operating profit ($)	20 708	21 241	34 616	16 434	9 389	8 300	8 952	9 944
Operating profit ($ ha^{-1})	7·40	7·59	8·65	4·11	1·67	1·04	1·12	0·99

Notes: (1) Total cattle estimated as the average of the maximum and minimum numbers carried during the year.
(2) Lambing % figures are based on interview data, the value shown in brackets, with an allowance for one complete failure in every 10 years.
(3) Those animals marketed with an asterisk (*) are marketed off oats.
(4) Wool price taken as 125·1c kg^{-1} (appendix 8).
(5) Crops are valued at $50.41 t^{-1} for wheat, $45 t^{-1} for grain sorghum and $95 t^{-1} for sunflower.
(6) Costs have been estimated from similar properties in the Condamine–Maranoa basin involved in the Farm Management Accounting Service of the Queensland Department of Primary Industries.

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APPENDIX 1

Summary of Property Interview Data for the Major Soil-Vegetation Groups (a)

Property Characteristic	Soil-Vegetation Groups						
	1	2	3	4	5	6	7
Major soil type(s)	CC20, Ro4	CC17	MM4	Va24	Oc21	My3, My5	My1, My4
No. of property interviews where soil-vegetation group predominated	36	4	6	6	15	14	3
No. of times soil-vegetation group was encountered	54	18	8	11	28	25	4
Average property area (ha)	3 287	3 137	5 482	3 690	7 685	10 341	15 243
Properties with cultivation	29	2	5	4	12	6	*(b)
Average cultivation area (ha)	651	486	592	432	574	310	*
Average wheat area (ha)	573	283 (1) (c)	328	425 (2)	474	221 (4)	*
Average wheat yield (t ha^{-1})	1·25	1·08 (1)	1·33 (2)	1·41 (1)	1·08 (4)	0·81 (1)	*
Average oats area (ha)	174	—(d)	152	152 (2)	150	101	*
Successful oat crops (%)	92	*	91	100 (1)	90	92	*
Average grain sorghum area (ha)	174	101 (1)	132 (2)	*	277 (3)	*	*
Average forage sorghum area (ha)	91 (3)	—	81 (1)	—	56	81 (2)	*
Properties growing barley (e)	5/9	1/1	3/4	3/3	2/2	2/2	*
Properties growing sunflower (e)	4/13	1/1	1/2	1/1	0/1	*	*
Average farming experience (years)	14	7 (1)	16 (3)	11 (2)	13	10 (4)	*
Properties with sown buffel grass (e)	17/22	0/4	1/3	4/4	5/9	9/9	2/2
Properties with other species sown (e)	19/20	0/4 (d)	0/1	4/4	4/5	4/4	2/2
Average no. of sheep on properties carrying sheep	3 550	4 100	6 017	4 500	5 000	4 108	—
Average lamb marking (%)	81	80	80	*	80	75	—
Average wether wool cut per head (kg)	5·2	5·0	5·3	4·2	5·1	4·8	—
Properties employing mules operation (e)	6/9	2/2	5/6	2/5	4/7	4/5	1/1
Most common time of joining	Autumn	Autumn	Autumn	*	Autumn	Autumn	Autumn
Average no. of cattle (breeders) on properties carrying cattle	246	—	185	200	355	108	175 (1)
Average calf branding (%)	84	86	82	77	82	87	86 (1)
Controlled mating practised	7/13	0/1	1/3	1/5	7/9	2/8	—
Reports of eye cancer in Hereford cattle	7/7	1/1	3/3	5/5	6/6	4/6	1/1
Reports of dystocia in heifers (all breeds)	6/9	1/1	1/3	1/3	3/6	4/8	—
Reports of infertility disease in cattle	6/6	0/1	0/1	1/2	2/4	2/4	—
Properties which supplement with liquid urea-molasses mixture	10/16	1/1	1/6	3/4	7/9	9/11	1/1
Properties which supplement with commercial blocks	3/16	0/1	2/6	1/4	4/9	5/11	1/1
Properties with major fodder reserve	4	1	2	2	2	1	—
Average no. of labour units (permanent males) employed	2·3	2·0	2·1	1·7	1·8	2·0	1·5 (3)

Notes: (a) Groups 8, 9 and 10 are too small to appear in this classification. (b) * indicates a characteristic which is not applicable to the soil-vegetation group. (c) A number in brackets indicates the number of reports of a characteristic on which the average value is based, when that number is less than five. (d) indicates a situation where no specific statistics are available. (e) All "proportion" characteristics are expressed as the number of positive reports of a characteristic over the number of producers who offered an opinion on that characteristic.

APPENDIX 2

SEALED AND TOTAL ROAD (KM) IN SIX SHIRES

Year	Inglewood		Millmerran		Waggamba		Tara		Balonne		Warroo		Sealed Road %
	sealed	total	sealed	total	sealed	total	sealed	total	sealed	total	sealed	total	
1967	135	2 007	156	1 770	64	2 858	220	2 087	198	3 251	113	1 674	6·5
1968	151	2 007	164	1 770	145	2 906	235	2 087	219	3 256	135	1 701	7·6
1969	161	2 007	179	1 770	153	2 940	280	2 087	251	3 256	142	1 526	8·6
1970	185	2 007	185	1 770	217	2 940	291	2 087	262	3 272	158	1 526	9·5
1971	192	2 007	193	1 770	269	2 939	303	2 087	286	3 272	169	1 526	10·4
1972	200	2 007	193	1 770	295	2 939	340	2 094	338	3 272	188	1 526	11·4
1973	216	2 007	193	1 770	335	2 939	375	2 094	407	3 285	182	1 526	12·6

Source: Australian Bureau of Statistics (1968 to 1974).

APPENDIX 3

STATIONS, FACILITIES, DISTANCES AND FREIGHT RATES (WOOL) FOR RAILWAY LINES WITHIN AND PROVIDING SERVICES TO THE CONDAMINE–MARANOA BASIN

South Western Line

Station	Livestock Yards	km from Roma Street	Cost per Bale $	Station	Livestock Yards	km from Roma Street	Cost per Bale $
Oman-ama . .	—	351	2.51	Toobeah	CPS	502	2.61
Cooba-da-mana . .	CPS	359	2.51	Welltown . .	—	517	2.61
Coolmunda . .	—	365	2.52	Bungunya . .	CPS	523	2.61
Inglewood . .	CPS	372	2.52	Lalaguli	—	531	2.61
Whetstone . .	CPS	389	2.52	Talwood	CPS	544	2.61
Yelarbon	CPS	409	2.52	Gradule	CPS	570	2.67
Gibinbell	—	417	2.52	Daymar	CPS	592	2.67
Kurumbul . .	CPS	430	2.52	Thallon	CPS	605	2.67
Kildonan . .	S	439	2.52	Tawarri	—	616	—
Mooroobic . .	—	447	2.52	Dunwinnie . .	PS	626	2.87
Goondiwindi . .	CPS	457	2.52	Noondale . .	—	631	2.87
Hunter	—	462	2.61	Limebush . .	—	632	—
Callandoon North	—	468	2.61	Hawkston . .	—	637	2.87
Carbuckey . .	—	475	2.61	Noondoo . .	CPS	649	2.87
Gooray	CPS	486	2.61	Bonathorne . .	—	658	2.87
Nula	—	496	2.61	Dirranbandi . .	CPS	668	2.87

Glenmorgan Line

Station	Livestock Yards	km from Roma Street	Cost per Bale $	Station	Livestock Yards	km from Roma Street	Cost per Bale $
Kumbarilla . .	CS	288	2.73	Southglen . .	CPS	344	3.07
Weranga	—	301	2.87	Cabawin	—	351	3.10
Goranba	CS	315	2.94	The Gums . .	CPS	359	3.15
Perthton	—	319	2.98	Hannaford . .	CPS	370	3.18
Tara	CPS	330	3.04	Meandarra . .	CPS	388	3.22
Tulagrie	—	336	3.04	Glenmorgan . .	CPS	409	3.29

Cecil Plains Line

Station	Livestock Yards	km from Roma Street	Cost per Bale $
Nangwee . .	PS	245	2.45
Horrane . .	—	251	2.48
Cecil Plains	CPS	254	2.52

Millmerran Line

Station	Livestock Yards	km from Roma Street	Cost per Bale $
Pampas . .	CPS	230	2.45
Yandilla . .	CPS	237	2.52
Millmerran	CPS	248	2.61

Texas Line

Station	Livestock Yards	km from Roma Street	Cost per Bale $
Inglewood . .	CPS	372	2.52
Magee . .	—	401	2.52
Mundoey . .	—	415	2.52
Texas	CPS	426	2.52

Source: Queensland Railways Department (1970).
Legend: C—Cattle yards.
P—Pig yards.
S—Sheep yards.

APPENDIX 4

Distribution of Schools and Pupils in Six Shires in 1973

Item	Inglewood	Millmerran	Waggamba	Goondiwindi Town	Tara	Balonne	Warroo	Total
Government schools	6	2	9	2	9	6	1	35
Non-government schools	2	1	0	1	1	2	0	7
Primary pupils	634	610	312	787	601	895	114	3 953
Secondary pupils	250	237	2	403	191	174	43	1 300

Source. Australian Bureau of Statistics (1974).

APPENDIX 5

Public Hospital Facilities in Six Shires and Record of Activity for 1972–73

Item	Inglewood	Millmerran	Waggamba	Goondiwindi Town	Tara	Balonne	Warroo	Total
Establishments	2	1	0	1	2	4	1	11
Beds, excluding maternity	47	16	—	60	17	93	15	248
Beds, maternity	16	7	—	16	7	16	4	66
In-patients treated	1 424	396	—	1 548	459	2 278	298	6 403
Out-patients treated	1 442	2 487	—	3 711	2 056	4 540	1 299	15 535

Source. Australian Bureau of Statistics (1974).

APPENDIX 6

AREA OF CROPS GROWN (HA) IN SIX SHIRES, AVERAGED FOR 1969–70 TO 1972–73 INCLUSIVE

Item	Inglewood	Millmerran	Waggamba	Tara	Balonne	Warroo	Total
Wheat	8 922	35 486	89 708	47 889	17 391	5 863	205 259
Forage Oats (1)	5 669	10 091	16 679	17 845	8 609	4 509	63 402
Grain Sorghum	1 250	15 932	8 581	12 399	2 351	1 668	42 181
Barley	1 390	15 566	1 983	2 539	1 313	332	23 123
Forage Sorghum	780	2 541	7 633	7 006	1 998	1 106	21 065
Sunflower	372	2 345	449	1 085	296	100	4 647
Millet and Panicum	105	2 487	578	1 066	15	36	4 287
Hay—Lucerne	1 240	229	316	371	186	28	2 370
Other	91	206	555	425	49	122	1 448

Source: Australian Bureau of Statistics (1969–70 to 1972–73).

Note: (1) This figure includes the small proportion of wheat planted for green fodder.

APPENDIX 7

AVERAGE WHEAT YIELD ($t\ ha^{-1}$ PLANTED) AND AREA HARVESTED (%) BASED ON STATE WHEAT BOARD DEPOTS

Depot	Yield	Area Harvested
Cecil Plains (16)	1·35	88·9
Millmerran	1·10	82·0
Yandilla	1·32	86·4
Inglewood	0·93	76·9
Texas	0·89	72·9
Bungunya (16)	0·75	79·6
Goondiwindi	1·00	81·4
Yelarbon	1·00	82·7
Glenmorgan	1·00	73·3
Meandarra	0·92	82·1
Tara	0·88	79·9
The Gums	0·93	80·8
Dalby	1·26	87·9
Miles	1·09	82·5
Roma	0·77	71·2
Norwin	1·37	89·7
Average	1·04	81·1

Source: State Wheat Board, Queensland.

Note: Depot averages for 17 years unless indicated by bracketed figure.

APPENDIX 8

BUDGETS OF THE PROFITABILITY OF WOOL PRODUCTION ON SIX SOIL–VEGETATION GROUPS IN THE CONDAMINE–MARANOA BASIN, BASED ON STANDARDISED FLOCK SIZES

Soil–Vegetation Groups	Groups 1 and 3	Group 2	Group 4	Group 5	Group 6
(a) Stock Reconciliation Statement					
Basic flock (prior to lambing):					
rams	30	30	—	30	30
wethers	723	—	1 000	1 368	1 261
breeding ewes	1 000	1 000	—	1 000	1 000
maiden ewes	247	247	—	247	247
Total	2 000	1 277	1 000	2 645	2 538
Additional sheep at shearing: (1)					
weaner ewes	360	405	—	315	290
weaner wethers	360	405	—	315	290
Total sheep shorn	2 720	2 087	1 000	3 215	3 118
Dry sheep equivalents (dse) carried per year (2)	2 923	2 113	1 000	3 639	3 474
% Lamb marking (3)	72 (80)	81 (90)	—	63 (70)	58 (65)
% Mortality per year	7	7	7	7	7
% Breeding ewes in flock	50	78	0	38	39
Replacement stock required (bred or purchased) per year					
rams	6	6	—	6	6
wethers	166	—	230	315	290
ewes	266	266	—	266	266
Sale sheep: (4)					
cull weaner ewes (potential culling rate %)	94 (26)	139 (34)	—	49 (15)	24 (8)
cull weaner wethers	194	405	—	—	—
c.f.a. rams	6	6	—	6	6
c.f.a. ewes	160	160	—	160	160
c.f.a. wethers	116	—	160	219	202
Total	570	710	160	434	392

APPENDIX 8—continued

Soil–Vegetation Groups	Groups 1 and 3	Group 2	Group 4	Group 5	Group 6
(b) Budget					
Wool cuts per head (kg):					
rams	7·0	7·0	—	7·0	7·0
ewes	4·5	5·0	—	4·0	4·0
wethers	5·5	—	4·5	5·0	5·0
weaners	1·5	2·0	—	1·5	1·5
Operations (5)	S, MF, 4D, 2J, C, M	S, MF, 4D, 2J, C, M	S, 2D, 1J, C	S, MF, 3D, 2J, C, M	S, MF, 3D, 2J, C, M
Total wool produced (kg)	10 878	8 065	4 500	12 983	12 373
Revenue from wool ($) (6)	13 608.38	10 089.32	5 629.50	16 241.73	15 478.62
Revenue from sheep sales ($) (7)	4 040.00	5 214.00	1 280.00	3 042.00	2 756.00
Total revenue from sheep ($)	17 648.38	15 303.32	6 909.50	19 283.73	18 234.62
Enterprise variable costs ($): (8)					
shearing	1 904.00	1 460.90	700.00	2 292.50	2 182.60
crutching	300.00	191.55	150.00	396.75	380.70
mulesing	43.20	48.60	—	37.80	34.80
drenching	520.00	332.02	200.00	608.35	583.74
jetting	236.00	168.20	50.00	296.00	282.80
stock sale commission	161.60	208.56	51.20	121.68	110.24
yard dues	45.60	58.72	12.80	34.72	31.36
wool sale costs	816.50	605.36	337.77	974.50	928.72
stock transport	71.25	91.75	20.00	54.25	49.00
wool transport	257.63	192.20	106.50	308.95	292.12
wool packs	187.50	140.00	77.50	225.00	212.50
stock replacement:					
rams	480.00	480.00	—	480.00	480.00
wethers	—	—	1 840.00	—	—
stock assessment	40.00	25.54	20.00	52.90	50.76
lamb marking	72.00	81.00	—	63.00	58.00
Total enterprise variable costs ($)	5 135.28	4 084.40	3 565.77	5 946.40	5 677.34
Enterprise gross margin (EGM) per 1 000 sheep ($)	12 513.10	11 218.92	3 343.73	13 337.33	12 557.28
EGM per sheep shorn ($)	4.60	5.38	3.34	4.15	4.03
EGM per ewe ($)	12.51	11.22	—	13.34	12.56
EGM per dse carried ($)	4.28	5.31	3.34	3.67	3.61
Stocking rate (dse per ha)	1.7	1.2	0.6	0.8	0.5
EGM ($ ha^{-1})	7.28	6.37	2.00	2.94	1.81
Labour costs ($) (9)	2 600.00	1 660.10	1 085.11	3 438.50	3 299.40
EGM per 1 000 sheep less labour ($)	9 913.10	9 558.82	2 258.62	9 898.83	9 257.88
EGM less labour per sheep shorn ($)	3.64	4.58	2.26	3.08	2.97
EGM less labour per dse ($)	3.39	4.52	2.26	2.72	2.66
EGM less labour ($ ha^{-1})	5.76	5.65	1.36	2.18	1.33

Source: Information extracted from interview data.

Notes: (1) The maximum number of sheep are carried at shearing time and sale sheep are sold " off-shears ".

(2) Dry sheep equivalents (dse) carried for the year are calculated on the following basis: ram—2·0 dse; dry ewe—1·0 dse; wether—1·0 dse; ewe and lamb to 5 months—1·7 dse; replacement weaner carried for remaining 7 months—0·9 dse; maiden (1 year old) ewe—1·0 dse. Adapted from Molnar (1961).

(3) Lamb marking percentage is estimated from typical values suggested by producers, which are shown in parenthesis, with an allowance for one failure in every 10 years.

(4) Wethers are cast for age (c.f.a.) at 5 to 6 years old, and ewes are cast for age after five lambings.

(5) S—shearing; MF—mulesing, females only; D—drenching (4D—four drenchings); 2J—one dip " off shears " and one jetting; C—crutching; M—marking.

(6) Wool price taken as 125·1c kg^{-1} for greasy wool, based on the average price received at Brisbane sales over the period 1949–50 to 1973–74.

(7) Sheep are sold " off shears " at $8 for wethers and $6 for ewes and c.f.a. rams.

(8) Enterprise variable costs for the wool enterprise are based on the following contract or commercial values: shearing—70c per head shorn; crutching—15c per head carried; mulesing—12c per ewe lamb; drenching—10c per head carried per drench for a broad spectrum drench (two per annum) and 3c per head per drench for a narrow spectrum drench; jetting—5c per head per operation; marking—10c per lamb, to cover rings, dusting powder and tetanus vaccination; wool packs—$2.50 per 145 kg of wool; wool sale charges—6% of gross proceeds; stock sale commission—4% of gross proceeds; yard dues—8c per head; stock transport—50 km at 50c per km per 200-sheep trailer; wool transport—50 km at 6c t^{-1} km^{-1} by road to rail head, rail at $3 per bale; ram replacements—rams are bought at $50 each, have a 5 year working life, and are run with ewes at a rate of 3%; stock assessment—2c per head.

(9) Based on a figure of one man year required for 2 440 sheep (McKay 1973) and a wage of $61.10 per week. It is assumed that for wether flocks 20% more sheep can be handled.

APPENDIX 9

Stock Reconciliation Statement for 100-Cow Herd

Soil-Vegetation Group	Groups 1 and 3		Group 4	Group 5		Group 6
Pasture type	Native pasture	Native pasture + oats	Native pasture	Native pasture	Native pasture + oats	Native pasture
Turn-off (1)	fat bullock	fat bullock	weaner	store steer	fat steer	store steer
Age	30 mth	24 mth	7 mth	18 mth	24 mth	30 mth
Opening total (January)	279	241	193	233	233	260
bulls	3	3	3	3	3	3
cows—mated (2)	100	100	100	100	100	100
calves (3 mths)	80	80	70	75	75	70
yearlings (15 mths)	58	58	20	55	55	53
steers (27 mths)	38	—	—	—	—	34
Sales—						
total	73	73	65	69	69	63
weaners	—	—	50	—	—	—
steers	—	—	—	36	36	34
cull heifers (sold at 12 mths)	20	20	—	18	18	14
bullocks	38	38	—	—	—	—
cows c.f.a.	15	15	15	15	15	15
Deaths (2)—						
total	7	7	5	7	7	7
cows	4	4	4	4	4	4
calves	2	2	1	2	2	2
yearlings	1	1	—	1	1	1
Residual (after deaths and sales)	196	158	120	154	154	187
Average of maximum and minimum numbers	236	198	155	192	192	222
Branding percentage	80	80	70	75	75	70
Closing total (December)	279	241	193	233	233	260
bulls	3	3	3	3	3	3
replacement heifers (mated)	19	19	19	19	19	19
cows	81	81	81	81	81	81
calves (2 mths)	80	80	70	75	75	70
yearlings (14 mths)	58	58	20	55	55	53
2 year old steers (26 mths)	38	—	—	—	—	34
Total dry sheep equivalents (3)—						
opening	2 296	1 916	1 590	1 865	1 865	2 161
residual	1 587	1 321	1 090	1 303	1 303	1 528
mean	1 942	1 619	1 340	1 584	1 584	1 844
Mean dse per breeder	19·4	16·2	13·4	15·8	15·8	18·4

Notes: (1) The weight division between steers and bullocks is 225 kg.

(2) The breeder herd has six age groups and 3% mortality with 19 replacement heifers required and 15 c.f.a. cows.

(3) Based on dry sheep equivalents for the following classes of stock:

cow—10 dse

steer or bullock—10 dse

yearling—7 dse

weaner—6 dse

APPENDIX 10

Budgets of the Profitability of Beef Production on Four Soil-Vegetation Groups in the Condamine–Maranoa Basin (Based on 100-cow Herd Outlined in Appendix 9)

Soil-Vegetation Group	Groups 1 and 3		Group 4	Group 5		Group 6
Pasture type	Native pasture	Native pasture + oats	Native pasture	Native pasture	Native pasture + oats	Native pasture
Turn-off	30 mth fat bullocks	24 mth fat bullocks	7 mth weaners	18 mth store steers	24 mth fat steers	30 mth store steers
Enterprise proceeds ($) (1)—						
weaners	—	—	2 353.33	—	—	—
steers	—	—	—	3 571.26	—	—
cull heifers	1 332.34	1 332.34	—	886.30	886.30	598.11
2 year old bullocks	7 952.07	6 878.95	—	—	5 161.38	3 963.72
cows c.f.a.	2 280.92	2 280.92	2 063.69	2 063.69	2 063.69	2 063.69
Total enterprise proceeds ($)	11 565.33	10 492.21	4 417.02	6 521.25	8 111.37	6 625.52
Enterprise variable expenses per annum ($)—						
veterinary costs (2)	138.00	119.00	95.00	115.00	115.00	128.50
supplementary feeding (3)	300.00	300.00	540.00	300.00	300.00	300.00
commission (4)	462.61	419.69	176.68	260.85	324.45	265.02
yard dues (5)	22.99	22.99	20.47	21.73	21.73	19.84
cartage (50 km at 50c per km per truck) (6)	82.95	76.04	54.17	66.35	71.87	65.62
stock assessment (7)	38.64	33.32	28.60	32.20	32.20	35.98
bull replacement (8)	360.00	360.00	360.00	360.00	360.00	360.00
cost of oats crop required (9)	—	278.46	—	—	395.71	—
labour (10)	1 654.54	1 426.74	1 139.00	1 378.78	1 378.78	1 540.64

APPENDIX 10—continued

BUDGETS OF THE PROFITABILITY OF BEEF PRODUCTION ON FOUR SOIL-VEGETATION GROUPS IN THE CONDAMINE-MARANOA BASIN (BASED ON 100-COW HERD OUTLINED IN APPENDIX 9)—continued

Soil-Vegetation Group	Groups 1 and 3		Group 4	Group 5		Group 6
Pasture type	Native pasture	Native pasture + oats	Native pasture	Native pasture	Native pasture + oats	Native pasture
Turn-off	30 mth fat bullocks	24 mth fat bullocks	7 mth weaners	18 mth store steers	24 mth fat steers	30 mth store steers
Total enterprise variable expenses ($)	3 059.73	3 036.24	2 411.92	2 534.91	2 999.74	2 715.60
Enterprise gross margin (EGM) ($) ..	8 505.60	7 455.97	2 005.10	3 986.34	5 111.63	3 909.92
EGM per cow ($)	85.06	74.56	20.05	39.86	51.12	39.10
EGM per beast equivalent ($) ..	43.84	46.02	14.96	25.23	32.35	21.25
Carrying capacity	1 beast equivalent per 6·5 ha	1 beast equivalent per 6·5 ha	1 beast equivalent per 25 ha	1 beast equivalent per 10 ha	1 beast equivalent per 10 ha	1 beast equivalent per 25 ha
EGM ($ ha^{-1})	6.74	7.08	0.60	2.52	3.23	0.85

Notes: (1) Valued at the price of 72·41c kg^{-1} dressed weight for the year 1973–74. This figure was projected from actual Cannon Hill prices over the period 1958–59 to 1972–73.

(2) Veterinary charges are 50c per head carried.

(3) Supplementary feeding is assumed at 120 days of supplementation with urea-molasses at 3c per adult head per day and 365 days of phosphorus supplementation at 0·5 cents per adult head per day for Group 4 cattle and for all other cattle 100 days of urea-molasses supplementation at 3c per adult head per day.

(4) Commission of 4% of gross proceeds of cattle sales.

(5) Yard dues at Cannon Hill are 31·5c per head.

(6) Calculated on a truck crate holding 22 bullocks, 24 light bullocks, 26 steers or 30 weaners.

(7) The stock assessment figure for 1973–74 was 14c per head carried.

(8) Three per cent bulls for 5 years' working life at initial cost of $800 each with a residual value of $200.

(9) The stocking rate on oats crop is one beast to 0·4 ha on Groups 1 and 3 and one beast to 0·6 ha on Group 5. Only male sale cattle are fattened. The cost of establishment is $18.32 per ha (appendix 16).

(10) Based on a figure of one man year required for 530 cattle (McKay 1973) and a wage of $61.10 per week.

(11) Based on appendix 9.

APPENDIX 11

Calculation of the Extra Breeders Which Can be Run as a Result of a 6 Month Earlier Turn-off of Cattle by Oat Cropping on Group 1 and 3 Lands (1)

(a) Total annual dry sheep equivalents (2) for turn-off at 30 months off native pasture

Stock	Numbers (3)	dse Demand per Month												Annual Total
		J	F	M	A	M	J	J	A	S	O	N	D	
Calves	78	—	—	—	—	—	—	—	—	468	468	468	468	1 872
Yearlings ..	77	462	462	462	462	462	462	462	462	399	399	399	399	5 292
2 year olds ..	57 (4)	399	399	399	399	399	399	399	399	380	380	380	380	4 712
2·5 year olds ..	38	380	380	380	—	—	—	—	—	—	—	—	—	1 140
Cows	100	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	12 000
													Total	25 016

(b) Total annual dry sheep equivalents (2) for turn-off at 24 months off oats

Stock	Numbers (3)	dse Demand per Month												Annual Total
		J	F	M	A	M	J	J	A	S	O	N	D	
Calves	78	—	—	—	—	—	—	—	—	468	468	468	468	1 872
Yearlings ..	77	462	462	462	462	462	462	462	462	399	399	399	399	5 292
2 year olds ..	57 (4)	399	399	399	399	399	133 (5)	133 (5)	133 (5)	—	—	—	—	2 394
Cows	100	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	12 000
													Total	21 558

Excess dse available if marketed 6 months earlier

= 25 016 − 21 558

= 3 458

dse per breeder run under earlier turn-off system

= 215·58

∴ extra breeders possible to run under earlier turn-off system

$$= \frac{3\,458}{215{\cdot}58}$$

= 16

Notes: (1) Based on stock reconciliation numbers of appendix 9.

(2) Based on dry sheep equivalents for the following classes of stock:

cow—10 dse, weaner—6 dse (until 12 months of age), yearling—7 dse (until 24 months of age), steer—10 dse.

(3) This allows for deaths at start of the calendar year. Also see stock reconciliation statement (appendix 9), for stock numbers.

(4) In September, 20 cull heifers and steers if applicable are sold and the replacement heifers go into the breeder herd and the c.f.a. cows are sold.

(5) Steers introduced to oat crop. It is assumed that the oats area is an insignificant area of the property and thus calculations of the area removed for grazing are not needed. Stock being fattened are also removed from the grazing requirements of the property.

APPENDIX 12

BUDGET ON CATTLE FATTENING ON FORAGE OATS ($)

Soil-Vegetable Groups	Groups 1 and 3		Group 5	
Performance	0·91 kg live-weight gain per day		0·91 kg live-weight gain per day	
Period of oats grazing	100 days		90 days	
Stocking rate	1 beast per 0·4 ha	1 beast per 0·6 ha	1 beast per 0·6 ha	1 beast per 0·8 ha
Value of sale stock (1)	157·73	157·73	154·28	154·28
Value of brought-in stock (2)	108·91	108·91	108·91	108·91
Enterprise proceeds	48·82	48·82	45·37	45·37
Average expected enterprise proceeds (3)	43·94	43·94	40·83	40·83
Enterprise variable expenses per beast—				
oats crops ($18.32 per ha) (4)	7·33	10·99	10·99	14·66
interest (10% for 6 mths)	5·45	5·45	5·45	5·45
veterinary expenses (50 cents per head)	0·50	0·50	0·50	0·50
commission (4% of gross)	6·31	6·31	6·17	6·17
transport (2 trips of 50 km at 50 cents per 50 km per truck)	2·27	2·27	2·27	2·27
losses (1% of sale stock)	1·58	1·58	1·54	1·54
labour (5)	3·00	3·00	3·00	3·00
Total exterprise variable expenses per beast	26·44	30·10	29·92	33·59
Enterprise gross margin per beast	17·50	13·84	10·91	7·24
Enterprise gross margin per ha of oats	43·75	23·07	18·18	9·05

Notes: (1) Stock are sold when fat at 72·41cents per kg dressed weight at a dressing percentage of 53.
(2) Stock are brought in at 320 kg liveweight and valued at 72·41 cents per kg dressed weight at a dressing percentage of 47.
(3) This allows for a complete crop failure once every 10 years.
(4) For cost of establishment of a forage oat crop see appendix 16.
(5) Based on a figure of one man year handling 530 cattle (McKay 1973) and a wage of $61.10 per week.

APPENDIX 13

The Influence of Size of Equipment on Total Cropping Costs per Hectare (1)

(a) Machinery Characteristics and Cultivation and Planting Costs (2)

Estimated annual capacity (ha)	300	500	700	1 000
Tractor—				
price ($)	3 675	9 840	10 920	12 500
engine (kW)	45·5	73·8	95·4	111·1
drawbar (kW)	37·9	52·9	79·0	88·7
$l\ h^{-1}$ (3)	13·6	19·6	24·6	29·6
Plough	16 disc	20 disc	2 x 14 disc	2 x 18 disc
price ($) (4)	2 740	3 260	5 640	6 320
Cultivator	21 tine	29 tine	2 x 21 tine	2 x 25 tine
price ($) (4)	1 539	2 324	3 578	4 714
Planter	20 run	24 run	2 x 20 run	2 x 24 run
price ($) (4)	2 881	3 180	6 262	6 860
Wideline	. .	701 cm	823 cm	1 036 cm
price ($)	. .	2 364	2 580	2 942
Total investment ($)	10 835	20 968	28 980	33 336
Average investment ($ ha^{-1})	36·12	41·94	41·40	33·34
Fixed costs ($) (3)—				
plough	460·32	547·68	947·52	1 061·76
cultivator	250·86	378·81	583·21	768·38
planter	441·98	454·74	895·47	980·98
wideline	. .	385·33	420·54	479·55
tractor	893·02	2 391·12	2 653·56	3 037·50
Total fixed costs ($)	2 016·18	4 157·68	5 500·30	6 328·17
Rate of operation (ha h^{-1}) at speeds shown				
ploughing at 5 km h^{-1}	1·30	1·62	2·27	2·92
cultivating at 6·5 km h^{-1}	1·77	2·44	3·54	4·21
planting at 8 km h^{-1}	2·42	2·90	4·84	5·81
widelining at 8 km h^{-1}	. .	4·77	5·60	7·05
Total time (h) (5)	862	996	974	1 132
Fuel cost at 5·7 cents l^{-1} ($)	668·22	1 112·73	1 365·74	1 909·91
Casual labour cost at $2 per hour	1 724	1 992	1 948	2 264
Total cultivation and planting costs ($)	4 408·40	7 262·41	8 814·04	10 502·08
Total wheat cultivation and planting costs ($ ha^{-1})	14·69	14·52	12·59	10·50
Total oats and summer crop cultivation and planting costs ($ ha^{-1}) (5)	13·13	13·25	11·63	9·62

Notes: (1) Based on 75% winter and 25% summer crops.

(2) Prices based on Shearer ploughs, cultivators and planters and Napier widelines as at November 1973. Tractor prices based on appropriate models at the same date.

(3) Queensland Department of Primary Industries (1970*a*)

(4) Price includes O'Phee double hitch at $500 where applicable.

(5) Normal operations for wheat are one ploughing, three cultivations and one planting. For oats and summer crops one less cultivation is carried out. Operating efficiency is assumed at 85%.

APPENDIX 13—(continued)

(b) Harvesting Costs

Item	P.T.O. Header	Auto Header	Auto Header
Width (cm)	427	427	610
Speed (km h^{-1}) (1)	5·3	7·2	7·2
Harvesting rate at 90% efficiency (ha h^{-1})	2·04	2·77	3·95
Area capacity of harvester (ha) (2)	400	500	800
Fuel use (l h^{-1}) (3)	19·6	15·9	22·7
New price ($)	7 200	11 500	15 000
Total fixed costs ($) (3)	1 390	2 219	2 895
Hours worked	196	180	203
Casual labour at $2 per hour ($)	392	360	406
Fuel at 5·7c l^{-1} ($)	219	163	263
Total harvesting costs ($)	2 001	2 742	3 564
Total harvesting costs ($ ha^{-1})	5·00	5·48	4·46
Area of break-even on contract harvesting at $7.50 per ha (ha)	233	344	434
Total harvesting costs ($ ha^{-1}) for summer crops (4)	5·38	5·75	4·66

Notes: (1) Hamilton (1966*a*)

(2) Based on an approximation of harvesting rate x 200 from Wegener (1969), Anon (1970*b*), and Stirling and Campbell (1973).

(3) Queensland Department of Primary Industries (1970*a*)

(4) Assuming summer crops take 25% longer to harvest.

(c) Cost of Permanent " On-Farm " Storage

Item	Quantity
Average production (t ha^{-1})	1·076
Assumed storage requirement at 25% of production (t ha^{-1}) (1)	0·269
Cost of permanent ' on-farm ' storage at $9.55 per t ($ ha^{-1}) (2)	2·570
Cost of ' on-farm ' storage at 5% depreciation (cents ha^{-1})	13

Notes: (1) Anon (1970*b*)

(2) Average cost for steel silos erected.

APPENDIX 14

SUMMARY OF PROFITABILITY OF GROWING GRAIN SORGHUM

Item	Small Producer (300 ha)	Large Producer (1 000 ha)
Gross proceeds ($ t^{-1})	45·00	45·00
Freight expenses ($ t^{-1}) (1)	11·86	11·86
Net ' on-farm ' proceeds ($ t^{-1})	33·14	33·14
Net ' on-farm ' proceeds ($ ha^{-1}) (2)	33·60	33·60
Production expense ($ ha^{-1})—		
cultivation and planting (3)	13·25	9·62
seed (3·5 kg ha^{-1} at 66c kg^{-1})	2·31	2·31
harvesting (4)	9·37	4·66
overheads (rates, rents, admin., etc.) (5)	1·50	1·50
storage (see appendix 13)	0·13	0·13
miscellaneous equipment (5)	5·00	5·00
Total production expense ($ ha^{-1})	31·56	23·22
∴ net return ($ ha^{-1})	2·04	10·38
Break-even price ($ t^{-1})	43·96	34·76
Break-even yield (t ha^{-1})	0·952	0·701

Notes: (1) Based on a maximum freight rate of $8.86 per t and road freight of 50 km at 6c t^{-1} km^{-1}.
(2) Based on a 10-year average yield of 1·014 t ha^{-1} (Australian Bureau of Statistics 1958–59 to 1969–70).
(3) Based on only four operations for summer crops and weighted for the proportion of fixed costs (see appendix 13).
(4) A small producer will employ contract harvesters and a larger producer will own a harvester. crops take 25% longer to harvest.
(5) As for wheat profitability—see notes (7) and (8) of table 48.

APPENDIX 15

SUMMARY OF PROFITABILITY OF GROWING SUNFLOWER

Item	Small Producer (300 ha)	Large Producer (1 000 ha)
Gross proceeds ($ t^{-1})	95·00	95·00
Freight expenses ($$t^{-1}$) (1)	11·86	11·86
Net ' on-farm ' proceeds ($ t^{-1})	83·14	83·14
Net ' on-farm ' proceeds ($ ha^{-1}) (2)	28·43	28·43
Production expense ($ ha^{-1})—		
cultivation and planting (3)	13·25	9·62
seed	1·50	1·50
harvesting (4)	9·37	4·66
overheads (4)	1·50	1·50
storage (see appendix 13)	0·13	0·13
miscellaneous equipment (4)	5·00	5·00
Total production expense ($ ha^{-1})	30·75	22·41
∴ net return ($ ha^{-1})	−2·32	6·02
Break-even price ($ t^{-1})	101·78	77·39
Break-even yield (t ha^{-1})	0·370	0·269

Notes: (1) Based on a maximum freight rate of $8.86 per t and road freight of 50 km at 6c t^{-1} km^{-1}.
(2) Based on a 10 year average yield of 0·342 t ha^{-1} (Australian Bureau of Statistics 1958–1959 to 1969–70).
(3) Based on only four operations for summer crops and weighted for the proportion of fixed costs (see appendix 13).
(4) As for wheat profitability—see notes (7) and (8) of table 48.

APPENDIX 16

SUMMARY OF COST OF ESTABLISHMENT OF FORAGE CROPS

(a) Oats

Item	$ ha^{-1}
Cultivation and planting (1)	13.25
Seed (28 kg ha^{-1} at $110 per t)	3.08
Superphosphate (10 kg ha^{-1} at $49.20 per t " on-farm ") (2)	0.49
Overheads	1.50
Total establishment expense	18.32

(b) Sorghum

Item	$ ha^{-1}
Cultivation and planting (1)	13.25
Seed (3·5 kg ha^{-1} at 66c kg^{-1})	2.31
Overheads	1.50
Total establishment expense	17.06

NOTES:

(1) Cultivation and planting expenses are based on four operations for a small producer.

(2) Based on Australian Bureau of Statistics (1958–59 to 1969–70) data for the Condamine–Maranoa basin.

APPENDIX 17

SUMMARY OF PROFITABILITY OF GROWING BARLEY

Item	Small Producer (300 ha)	Large Producer (1 000 ha)
Gross proceeds ($ t^{-1}) (1)	30.18	30.18
Freight expenses ($ t^{-1}) (2)	3.00	3.00
Net ' on-farm ' proceeds ($ t^{-1})	27.18	27.18
Net ' on-farm ' proceeds ($ ha^{-1}) (3)	35.17	35.17
Production expense/ha ($ ha^{-1})—		
cultivation and planting (4)	14.69	10.50
seed (28 kg ha^{-1} at $50 per t)	1.40	1.40
harvesting (5)	7.50	4.46
overheads (rates, rents, admin., etc.) (5)	1.50	1.50
storage (see appendix 13)	0.13	0.13
miscellaneous equipment (5)	5.00	5.00
Total production expense ($ ha^{-1})	30.22	22.99
∴ net return ($ ha^{-1})	4.95	12.18
Break-even price ($ t^{-1})	26.35	20.77
Break-even yield (t ha^{-1})	1.11	0.846

NOTES:

(1) Assuming that feed barley is grown, the average price received bulk at the grower's siding over the period 1960–61 to 1969–70 was $30.18 per t (Queensland Barley Board).

(2) Road freight to siding is for 50 km at 6c t^{-1} km^{-1}.

(3) On the basis of barley yielding 25% more than wheat a figure of 1·294 t ha^{-1} is used.

(4) Five operations carried out as for wheat.

(5) As for wheat profitability—see notes (7) and (8) of table 48.

APPENDIX 18

SUMMARY OF PROFITABILITY OF GROWING OATS FOR SEED

Item	Small Producer (300 ha)	Large Producer (1 000 ha)
Gross proceeds (\$ t^{-1}) (1)	88.00	88.00
Freight expenses (\$ t^{-1}) (2)	3.00	3.00
Net ' on-farm ' proceeds (\$ t^{-1})	85.00	85.00
Net ' on-farm ' proceeds (\$ ha^{-1}) (3)	56.78	56.78
Production expense (\$ ha^{-1})—		
cultivation and planting (4)	14.69	10.50
seed (28 kg ha^{-1} at \$110 per t)	3.08	3.08
grading and pickling (\$9.20 per t)	6.15	6.15
harvesting (4)	7.50	4.46
bagging (28c per 55 kg bag)	3.40	3.40
overheads (rates, rents, admin., etc.) (4)	1.50	1.50
storage (see appendix 13)	0.13	0.13
miscellaneous equipment (4)	5.00	5.00
Total production expense (\$ ha^{-1})	41.45	34.22
∴ net return (\$ ha^{-1})	15.33	22.56
Break-even price (\$ t^{-1})	65.05	54.23
Break-even yield (t ha^{-1})	0.488	0.403

NOTES:

(1) This assumes only 80% of oats harvested is actually sold as seed.

(2) Oats seed is sold locally so a freight charge of 6c t^{-1} km^{-1} for 50 km is charged.

(3) Based on the 13-year average yield for oats for the six shires of 0·668 t ha^{-1} (Australian Bureau of Statistics 1960–61 to 1972–73).

(4) As for wheat profitability—see notes (7) and (8) of table 48.

APPENDIX 19

SUMMARY OF GROSS MARGINS DATA FOR THE CONDAMINE–MARANOA BASIN ($)

Region/Area		Glenmorgan	Inglewood Shire	Macintyre Brook
Reference		Hamilton and Egan (1969)	Q.D.P.I. (1970*b*)	Kerr (1971)
Code and Enterprise	Unit			
1. Wheat	ha	90.49	56.71	37.44
2. Barley	ha	35.26		38.50
3. Oats for seed	ha	26.98		
4. Sorghum	ha		39.86	15.20
5. Sunflower	ha			
6. Safflower	ha	41.93		
7. Linseed	ha			
8. Navy beans	ha		86.11	
9. Canary seed	ha			
10. Millet	ha			
11. Cow pea	ha			
12. Wethers	wether	4.73	2.69	
13. Fat lambs	ewe	9.58		
14. Breeding—sheep	ewe			
15. Breeding—cattle	cow	56.90	85.00–70.51	
16. Pigs—intensive	sow			
17. Pigs—semi-intensive	sow			
18. Crop fattening	ha			
19. Grapes	ha			
20. Apricots	ha			
21. Tobacco	ha			2 073.17
Irrigated				
22. Wheat	ha		126.00	38.18
23. Sorghum	ha		166.57	32.05
24. Lucerne	ha		321.92	185.97
25. Navy beans	ha		246.70	155.18
26. Barley	ha			48.21
27. Linseed	ha			
28. Canary seed	ha			
29. Maize	ha			
30. Soybean	ha			
31. Sunflower	ha			
32. Cotton	ha			

APPENDIX 19—(continued)

SUMMARY OF GROSS MARGINS DATA FOR THE CONDAMINE–MARANOA BASIN ($)—*continued*

	Waggamba Shire	Waggamba and Balonne	Waggamba Shire	Tara Shire	Millmerran Shire	Millmerran Brigalow Soils
	Q.D.P.I. (1971*c*)	McNee (various)*	McNee and Alcock (1971)	Q.D.P.I. (1971*a*)	Q.D.P.I. (1970*c*)	Q.D.P.I. (1970*c*)
Code						
1.	53.89		38.25	30.64		43.98
2.	13.64		11.19	20.56		28.66
3.	20.81		20.19	9.76		89.45
4.	27.90	27.90	27.28	15.81		
5.	44.26	43.64	43.64	46.92		27.13
6.	19.94		19.32			
7.						50.95
8.						
9.	24.86		24.24			38.05
10.	9.76		9.14	22.71		9.56
11.	17.52					21.65
12.	2.95			2.08	2.70	
13.				4.71		
14.	6.86				7.20	
15.	64.16–39.63			62.19–53.64		46.48
16.				315.00		
17.				170.00		
18.			13.71			
19.						
20.						
21.						
22.					89.70	
23.					108.25	
24.						
25.						
26.					82.88	
27.					88.96	
28.					77.84	
29.					109.17	
30.					133.01	
31.					54.66	
32.					178.36	

* McNee, D.A.K. (1970*a*), [1970*b*], (1971), (1972).

APPENDIX 19—(continued)

SUMMARY OF GROSS MARGINS DATA FOR THE CONDAMINE–MARANOA BASIN ($)—*continued*

	Millmerran Solodic Soils	Northern N.S.W.	Warroo Shire	Horticulture and My Soils	Waggamba
	Q.D.P.I. (1970*c*)	Powell and Hardaker (1968)	Q.D.P.I. (1971*c*)	Alcock (1968, 1972)	Pollard and Alcock (1971)
Code					
1.		54.41	58.41		
2.	15.81		15.72		
3.	65.36	21.32	57.20		
4.		18.68	34.59		
5.					
6.		106.77			
7.		113.32			
8.					
9.					
10.	0.77				
11.	20.51				
12.		2.75	2.23		
13.		5.70			
14.		6.19	4.55	5.35	
15.	38.78	59.35–24.61	79.78	35.60	
16.					
17.					
18.					24.86–21.05
19.				832.73	
20.				1 032.88	
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					

APPENDIX 20

Botanical and Common Plant Names

Botanical name	Common name
Abutilon oxycarpum	a flannel weed
Acacia aneura	mulga
Acacia aprepta	Miles mulga
Acacia cambagei	gidyea
Acacia catenulata	bendee
Acacia conferta	..
Acacia cunninghamii (probably *A. crassa*)	black wattle
Acacia excelsa	ironwood
Acacia farnesiana	mimosa bush
Acacia harpophylla	brigalow
Acacia microsperma	bowyakka
Acacia mollissima	..
Acacia omalophylla	yarran
Acacia oswaldii	nelia
Acacia pendula	myall
Acacia shirleyi	lancewood
Acacia spectabilis	Kogan wattle
Acacia stenophylla	river myall
Acacia victoriae	gundabluey
Ancistrachne uncinulata	hooky grass
Angophora costata	rusty gum
Angophora floribunda	rough-barked apple
Angophora melanoxylon	..
Anthephora pubescens	..
Apophyllum anomalum	broom bush
Aporuellia australis	..
Argemone mexicana	Mexican poppy
Argemone ochroleuca sp. *ochroleuca*	Mexican poppy
Aristida caput-medusae	many-headed wire grass
Aristida jerichoensis	wire grass
Aristida leichhardtiana	..
Aristida leptopoda	white spear grass
Aristida ramosa	..
Astrebla elymoides	hoop Mitchell grass
Astrebla lappacea	curly Mitchell grass
Astrebla pectinata	barley Mitchell grass
Astrebla squarrosa	bull Mitchell grass
Atalaya hemiglauca	whitewood
Atriplex muelleri	annual saltbush
Atriplex semibaccata	creeping saltbush
Avena fatua	wild oat
Avena ludoviciana	wild oat
Avena sativa	common oat
Bassia birchii	galvanized burr
Bassia convexula	copper burr
Bassia diacantha	..
Bassia quinquecuspis	prickly roly-poly
Bassia tetracuspis	brigalow burr
Bauhinia carronii	bauhinia
Bothriochloa decipiens	pitted blue grass
Bothriochloa bladhii	forest blue grass
Brachychiton populneum	kurrajong
Cadellia pentastylis	ooline
Callitris columellaris	cypress pine
Calotis hispidula	bogan flea
Canthium oleifolium	myrtle tree
Capparis mitchellii	wild orange
Carex rhytidocarpa	a sedge
Carissa ovata	currant bush
Carthamus lanatus	saffron thistle
Cassia circinnata	..
Cassia nemophila	butter bush, birds-eye
Casuarina cristata	belah
Casuarina luehmannii	bull oak
Cenchrus ciliaris	buffel grass
Cheilanthes distans	rock or mulga fern
Cheilanthes sieberi	rock or mulga fern
Chenopodium trigonon	fishweed
Chloris divaricata	slender chloris
Chloris gayana	Rhodes grass
Chloris truncata	windmill grass
Chrysopogon fallax	golden-beard grass
Commelina lanceolata	..
Cyperus bifax	downs nut-grass
Dactyloctenium giganteum	giant button grass
Dactyloctenium radulans	button grass
Datura stramonium	common thorn-apple
Dichanthium sericeum	Queensland blue grass
Digitaria brownii	silver spike grass
Digitaria decumbens	pangola grass
Diplachne parviflora	..
Disphyma australe	..
Dodonaea attenuata	a hop-bush
Dodonaea boroniifolia	a hop-bush
Dodonaea cuneata	hop-bush
Dodonaea viscosa	sticky hop-bush
Emex australis	spiny emex
Enchylaena tomentosa	ruby saltbush
Enneapogon gracilis	a bottle-washer grass
Enteropogon acicularis	curly windmill grass
Eragrostis curvula	African love grass
Eragrostis elongata	clustered love grass
Eragrostis eriopoda	woollybutt grass
Eragrostis lacunaria	purple love grass
Eragrostis leptostachya	paddock love grass
Eragrostis parviflora	weeping love grass
Eragrostis setifolia	neverfail grass
Eremocitrus glauca	limebush
Eremophila bignoniiflora	creek wilga
Eremophila glabra	black fuchsia
Eremophila maculata	fuchsia bush
Eremophila mitchellii	sandalwood
Eriochloa pseudoacrotricha	early spring grass
Erodium cygnorum	crowfoot
Eucalyptus camaldulensis	river red gum
Eucalyptus dealbata	tumble-down gum
Eucalyptus drepanophylla	narrow-leaved ironbark
Eucalyptus eugenioides	white stringybark
Eucalyptus exserta	a mallee, bendo
Eucalyptus intertexta	forest gum
Eucalyptus largiflorens	black box
Eucalyptus maculata	spotted gum
Eucalyptus melanophloia	silver-leaved ironbark
Eucalyptus microcarpa	green-leaved box
Eucalyptus microtheca	coolibah
Eucalyptus ochrophloia	yapunyah

APPENDIX 20—continued

Eucalyptus orgadophila	mountain coolibah
Eucalyptus pilligaensis	Mallee box
Eucalyptus populnea	poplar box
Eucalyptus saligna	Sydney blue gum
Eucalyptus terminalis	western bloodwood
Eucalyptus tereticornis	Queensland blue gum
Eucalyptus tessellaris	carbeen
Eucalyptus thozetiana	mountain yapunyah
Eucalyptus trachyphloia	brown bloodwood
Eulalia fulva	silky browntop
Euphorbia drummondii	caustic weed
Flindersia maculosa	leopardwood
Geijera parviflora	wilga
Heterodendrum diversifolium	scrub boonaree
Heterodendrum oleifolium	boonaree
Hibiscus sturtii	..
Hovea longifolia	purple bush pea
Ipomoea calobra	Weir vine
Iseilema membranaceum	small Flinders grass
Jasminum lineare	..
Lablab purpureus	lablab bean
Leptochloa digitata	cane grass
Lotononis bainesii	lotononis
Macroptilium atropurpureum	Siratro
Macroptilium lathroides	phasey bean
Macrotyloma uniflorum	horse gram
Maireana brevifolia	cotton bush
Malvastrum spicatum	malvastrum
Marsilea drummondii	nardoo
Maytenis cunninghamii	..
Medicago littoralis	strand medic
Medicago minima	small woolly burr medic
Medicago polymorpha	burr medic
Medicago rugosa	gama medic
Medicago sativa	lucerne
Medicago scutellata	snail medic
Medicago tornata	disc medic
Medicago truncatula	barrel medic
Melaleuca bracteata	river tea tree
Melaleuca lanceolata	black tea tree
Melichrus urceolatus	..
Monachather paradoxa	mulga oat grass
Muehlenbeckia cunninghamii	lignum
Myoporum deserti	Ellangowan poison bush
Opuntia aurantiaca	tiger pear
Opuntia inermis	common prickly pear
Opuntia stricta	spiny prickly pear
Opuntia tomentosa	tree pear

Ornithopus compressus	serradella
Ornithopus sativus	serradella
Panicum coloratum	..
Panicum decompositum	native millet
Panicum maximum var. *trichoglume*	green panic
Paspalidium caespitosum	brigalow grass
Paspalidium constrictum	belah grass
Paspalidium globoideum	shot grass
Paspalidium gracile	slender panic
Paspalidium jubiflorum	Warrego summer grass
Phyllanthus sp.	..
Pimelea pauciflora	poison pimelea
Pimelea simplex	..
Pimelea trichostachya	spiked rice-flower
Plantago varia	lamb's tongue
Plumbago zeylanica	..
Portulaca oleracea	pigweed
Rapistrum rugosum	turnip weed
Rhagodia nutans	berry saltbush
Rhagodia parabolica	..
Salsola kali	soft roly-poly
Salvia reflexa	mintweed
Schmidtia bulbosa	..
Senecio platylepsis	..
Sida brachypoda	..
Sida spinosa	spiny sida
Silybum marianum	variegated thistle
Sisymbrium orientale	mustard
Sorghum almum	Columbus grass
Sporobolus caroli	fairy grass
Sporobolus mitchellii	creeping rat's-tail grass
Stipa verticillata	slender bamboo grass
Stylosanthes humilis	Townsville stylo
Stylosanthes mucronata	..
Swainsona spp.	Darling pea
Tetragonia tetragonioides	New Zealand spinach
Thellungia advena	coolibah grass
Themeda australis	kangaroo grass
Thyridolepis mitchelliana	mulga grass
Trachymene ochracea	wild parsnip
Trianthema portulacastrum	giant or black pigweed
Trifolium hirtum	rose clover
Trigonella spp.	..
Tripogon loliiformis	five-minute grass
Urochloa panicoides	liverseed grass
Ventilago viminalis	vine-tree
Vicia spp.	vetch
Xanthium spinosum	Bathurst burr

(Received for publication December 1975)

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S. R. HAMPSON, Government Printer, Brisbane