PASTURE SYSTEMS FOR MILK PRODUCTION IN QUEENSLAND

INTRODUCTION

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In common with other Australian states and indeed most developed countries the Queensland dairy industry has declined in farm numbers over the last three decades. In the early 1950's there were 25,000 dairy farmers in this state - this number probably exceeds the total number of dairy farmers in Australia today. The current position of the industry in Queensland is sumarized in the following data (Tables l-7) derived from the five dairying regions for the last three financial years. The source of this data is statistics compiled by the Queensland Department of Primary Industries.

TABLE 1 Highest number of farmers in each dairying region for the years 1978-79 to 1980-81

Region	1978-79	1979-80	1980-81	% Variation in 3 years
Far North Coast	299	290	273	-9
Central Qld.	245	241	232	-5
Wide Bay - Burnett	679	581	547	-19
Moreton	926	839	789	-15
Darling Downs	927	871	835	-10
Total	3076	2822	2676	-13

TABLE 2 Total milk produced in each dairying region for the years 1978-79 to 1980-81

Region	1978-79	Million lts 1979-80	1980-81	% Variation in 3 years
Far North Coast	66.1	65.0	67.7	+2.3
Central Qld.	44.3	42.1	42.0	-5.2
Wide Bay - Burnett	104.6	95.4	97.0	-7.3
Moreton	195.6	181.9	171.9	-12.1
Darling Downs	134.5	124.5	118.5	-12.0
Total	545.1	508.9	497.1	-8.2

The fact of the Queensland industry is that total milk production is declining the proportion of market to manufacturing milk is increasing&he demand is increasing and the shortfall is being taken up from the manufacturing milk section. This means the market milk industry will become increasingly vulnerable to seasonal fluctuations. There is a definitive need for total milk production to be increased. The basic question is how suitable to milk production are tropical pastures.

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TABLE 3 Milk paid for at market milk rates in each dairying region for the years 1979 to 1980-81

Region	Million lts 1978-79	1979-80	1980-81	% Variation in 3 years
Far North Coast	32.9	34.5	34.9	+5.9
Central Qld.	35.4	36.2	38.9	+9.7
Wide Bay - Burnett	27.1	39.4	42.5	+56.4
Moreton	98.1	94.7	96.1	-2.0
Darling Downs	42.4	47.7	50.5	+18.9
Total	236.0	252.5	262.7	+11.3

TABLE 4 Range of market milk returns (c per lt) in each dairying region for the years 1978-79 to 1980-81 (annual mean for each association)

Region	Cents/lt for market milk			Mean % inc. over 3 years
	1978-79	1979-80	1980-81	
Far North Coast	19-22	24	29	41
Central Qld.	18-21	20-23	23-26	26
Wide Bay - Burnett	19-21	17-22	24-28	30
Moreton	20-22	21-23	25-28	26
Darling Downs	18-21	20-24	24-28	33

TABLE 5 Range of manufacturing milk returns ($/kg butterfat) in each dairying region for the years 1978-79 to 1980-81 (annual mean for each association)

Region	$ per kg b'fat for manufacture milk			
	1978-79	1979-80	1980-81	Mean % inc over 3 years
Far North Coast	1.65	1.91	2.31	40
Central Qld.	1.20-1.53	1.46-1.90	1.60-2.40	46
Wide Bay-Burnett	1.90-2.35	2.63-3.02	1.84-3.68	30
Moreton	1.70-2.14	2.35-3.96	3.10-3.97	66
Darling Downs	1.50-2.85	1.33-2.62	2.11-3.50	29

TABLE 6 Total Qld butter production (tonnes) and the percentage that is of the butter and allied products used in the State for the three years 1978-79 to 1980-81

Year	Qld butter production tonnes	% Qld produced to Qld used
1978-79	5645	37
79-80	3515	23
80-81	2798	24

TABLE 7 Milk sales within Queensland for the three years 1978-79 to 1980-81

Area	Million (lts) 1978/79	1979/80	1980/81	% Variation in 3 years
South-East Qld				
(i) Brisbane	104.5	107.1	109.1	4.3
(ii) Other	72.1	77.6	82.3	14.1
Central Qld	29.9	31.4	33.2	11.0
Northern Qld	31.2	32.4	32.8	4.9
Total	237.8	248.5	257.4	8.2

(Source Qld Milk Board Annual Report 1981)

EFFECTS OF STOCKING RATE ON MILK PRODUCTION FROM AND DEGRADATION OF GRASS AND LEGUME MIXED PASTURES

R.T. COWAN* and T.M. DAVISON**

POTENTIAL OF GRASS AND LEGUME MIXED PASTURES FOR MILK PRODUCTION

The potential of tropical grass and legume mixed pastures for milk production can be demonstrated from the levels of production attained when these pastures are grazed at low stocking rates. From 1963 to 1970 milk production was measured in a herd of Friesian cows grazing green panic (*Panicum maximum* var. *trichoglume*) and Tinaroo glycine (*Neonotonia wightii* cv. Tinaroo) on the Atherton Tableland, Queensland. The stocking rates varied from 1.0 to 1.3 cows/ha (Cowan *et al.* 1974). These pastures had been established approximately 10 years before measurements of milk production began and the only supplement given to cows was a mix of salt and bone flour. Over 129 lactations the average level of milk production was 4100 1 over 331 days.

EFFECTS OF STOCKING RATE ON MILK OUTPUT

The levels of productivity per unit area from these pastures were assessed in an experiment utilizing stocking rates of 1.3, 1.6, 1.9 and 2.5 cows/ha (Cowan *et al.* 1975). Cows were given a supplement of salt and bone flour and grazed the pastures continually for two years.

There was a linear increase in milk output/ha with increases in stocking rate (Table 1). Milk production per cow decreased linearly.

Despite the increase in output per unit area with increases in stocking rate, a number of problems became evident at stocking rates above 1.6 cows/ha. The cows lost weight at 1.9 and 2.5 cows/ha, and the loss was substantially greater in the second than the first year. There was an acute feed shortage in winter and spring and supplementary feeding was necessary. At this time also these cows produced milk of low solids-not-fat content.

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TABLE 1 Effects of stocking rate on milk output, lactation length and liveweight change of Friesian cows grazing green panic and glycine mixed pastures

	Stocking rate (cows/ha)			
	1.3	1.6	1.9	2.5
Milk yield (kg/ha/year)	4954	5351	6437	8221
Milk yield (kg/cow/year)	3811	3345	3388	3289
Fat yield (kg/ha/year)	187	217	233	293
Lactation length (days)	278	270	255	259
Liveweight change (kg/cow/year)				
- year 1	8	10	-17	-10
- year 2	20	-5	-50	-47

In the pasture the legume component was drastically reduced by stocking rates of 1.9 and 2.5 cows/ha (Table 2). There were linear reductions in the yields of both grass and legume on offer with increases in stocking rate, The rate of reduction was greater for the legume than for the grass and consequently there was a decrease in legume percentage in the sward.

TABLE 2 Effects of stocking rate on the presentation yield and nett dry matter accumulation of a green panic and glycine mixed pasture

	Stocking rate (cows/ha)			
	1.3	1.6	1.9	2.5
Presentation yield				
- grass (kg DM/ha)	1916	1967	1430	1235
- legume (kg DM/ha)	1133	783	355	201
- legume (% DM)	37	28	20	14
Nett dry matter accumulation				
- grass (kg DM/ha/day)	22	27	14	23
- legume (kg DM/ha/day)	20	18	12	7
- weeds (kg DM/ha/day)	0	0	8	6

The data on net dry matter accumulation were collected in autumn (Cowan and Stobbs 1976). They demonstrate that a major effect of increased stocking rate on the pasture is to reduce the rate of growth of the legume. There is an associated increase in the growth of weeds and no change in the rate of grass growth.

The net effect of high stocking was a decline in total pasture productivity. This effect is likely to be exaggerated in trials continued for more than two years, as there will be a continuing net loss of nitrogen from the pasture system and grass growth may eventually decline.

It was recommended that in this environment the stocking rate on mixed pastures of tropical grass and twining legumes should not exceed 1.6 cows/ha.

THE INFLUENCE OF STOCKING RATE AND FERTILIZER ON RESTORATION OF GRASS-LEGUME PASTURES AND MILK PRODUCTION FROM GRASS PASTURE

T.M. DAVISON: R.T. COWAN*and R.K. SHEPHERD***

As demonstrated in the previous paper stocking rates above 1.6 cows/ha led to a marked decline in legume yield, and in a survey of pastures on the Atherton Tableland Spackman(l978) considered that 38% of the improved dryland pastures had maintained a vigorous legume component, 17% had some legume capable of regeneration while 45% were grass swards without legume. In this same survey it was estimated that 70% of dairy farms were stocked at greater than 1.6 cows/ha. On these farms the use of nitrogen fertilizer on grass swards is necessary to maintain the higher stocking rates (Chopping 1976; Cowan and Stobbs 1976).

This paper first demonstrates different methods of regenerating a previously overstocked grass-legume pasture, and secondly it shows how milk yield per ha can be increased by the combination of high stocking rates and nitrogen fertilizer on grass pasture.

REGENERATION OF DEGRADED PASTURE

Methods

From November 1976 to October 1979 two groups of four Friesian cows each grazed four 0.5 ha paddocks of Gatton panic (Panicum maximum cv. Gatton), Tinaroo glycine (Neonotonia wightii cv. Tinaroo) and Greenleaf desmodium (Desmodium intortum) on a one week grazing, three week spelling rotation. The stocking rate was 2.0 cows/ha and pastures received 250 kg superphosphate and 100 kg muriate of potash/ha/year.

From November 1979 the following treatments were applied to these same paddocks-

A 2 cows/ha with 250 kg superphosphate/ha annually
B 1 cow/ha with 250 kg superphosphate/ha annually
C 1 cow/ha with 500 kg superphosphate/ha annually
D 0 cow/ha with 250 kg superphosphate/ha annually

All pastures received 100 kg muriate of potash/ha annually. The stocking rate was maintained using dry Friesian cows, of 500-700 kg liveweight, grazing the two pasture replicates on a one week grazing, one week spelling rotation. Pasture yield and botanical composition were determined in the same month of summer (S), autumn (A), winter (W) and spring (Sp) between 1977 and 1979 and in A, W and Sp of 1980 and 1981.

Results and Discussion

Legume content descreased from 31% in 1977 to 3% in 1981 at 2.0 cows/ha (Fig.l.) and is consistent with the effects of overstocking (Cowan and Stobbs 1976; Jones 1979). Legume yield in the pasture increased rapidly when the stocking rate was reduced or when stock were removed (Fig. l). With destocking,

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yields returned to the levels of 1977 in six months and at 1 cow/ha in eight months. In subsequent years legume yields have stabilized but legume percentage has increased from 34% in spring 1980 to 44% in spring 1981 for treatments B and C and from 54% to 89% over the same period for destocked pasture.

Doubling the level of super-phosphate made no difference to legume yield, but did increase grass yield by a mean of 290 kg DM/ha at each sampling. Between 1977 and 1979 yields of Tinaroo glycine and Greenleaf desmodium on offer were similar, however by spring 1981, Tinaroo glycine was by far the dominant legume representing 49% of total dry matter on offer across all treatments compared with 0.1% for Greenleaf desmodium.

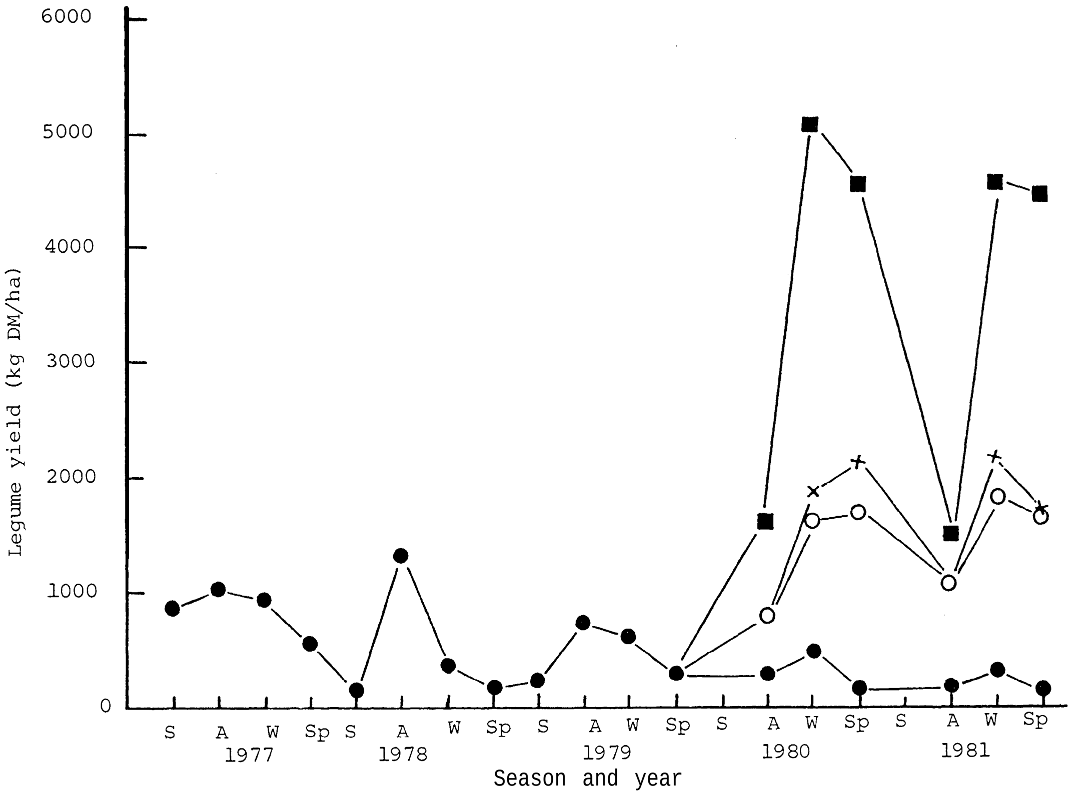

Fig. 1. Legume yields in pastures (● 2 cows/ha and treatment A, ○ treatment B, X treatment C, ■ treatment D)

INCREASING PASTURE PRODUCTION

Methods

From November 1976 to October 1979 a 17 ha area of Gatton panic pasture was divided into 32 paddocks to accommodate a factorial experiment of four stocking rates (2.0, 2.5, 3.0 and 3.5 cows/ha) and at two levels of nitrogen fertilizer (200 and 400 kg N/ha/yr), each with four pasture replicates. The area received 250 kg/ha of superphosphate and 50 kg/ha of muriate of potash annually. Nitrogen fertilizer was applied every 12 weeks with 60% applied in summer and autumn.

Thirty-two Friesian cows calving between November and January were blocked on the basis of previous milk yield and four cows allocated to each treatment. Cows grazed on a one week grazing, three weeks spelling rotation and stayed in their paddocks the whole year. Hay was given during spring to maintain liveweight gain in dry cows at 0.5 kg/day.

Results and Discussion

Milk yield per ha increased linearly with increasing stocking rate ($P < 0.01$; Fig. 2), from 5870 at 2.0 cows/ha to 8884 kg/ha at 3.5 cows/ha. The difference in milk yield between the low and high nitrogen levels increased each year and was significantly different in 1979 with average milk yields of 2532 and 3132 kg/cow ($P < 0.05$) for the low and high nitrogen treatments.

In Figure 2 we have also collated data from previous stocking rate studies on dryland grass-legume pastures (Cowan et al. 1974; Cowan et al. 1975; Cowan and Stobbs 1976) and the irrigated grass-nitrogen pastures quoted by Chopping et al. (1976). The figure shows that the major effect of increased levels of input of nitrogen and water is to allow an increase in stocking rate. The net result is a linear increase in milk output with increasing stocking rate from 4100 kg/ha at 1.0 cow/ha on grass-legume pasture to 19,850 kg/ha at 7.9 cows/ha on irrigated grass-nitrogen pasture. However the figure gives no indication of the stability of different pasture systems at higher levels of stocking, the need for dry season supplementation or the effect of liveweight gain or loss on subsequent lactations.

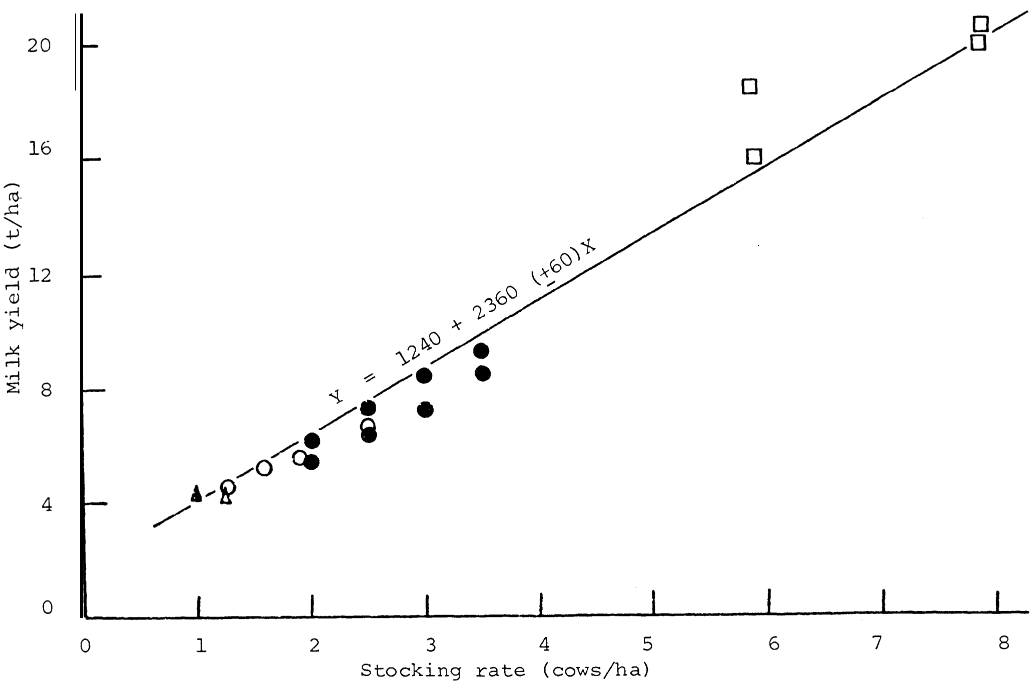

Fig. 1. Relationship between stocking rate and milk output in various pasture systems (▲, ○ grass-legume pastures; ● nitrogen fertilized grass pasture; □ nitrogen fertilized and irrigated grass pasture)

IRRIGATED PASTURE SYSTEMS FOR MILK PRODUCTION IN QUEENSLAND

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INTRODUCTION

The need to increase farm milk output continuously to maintain economic viability, and the increasing emphasis on more stable milk production throughout the year to service market milk requirements, has lead to a rapid increase in the use of irrigation for milk production on Queensland dairy farms. In response to this industry trend the Queensland Department of Primary Industries in 1970 initiated major irrigated dairy pasture research programme at Ayr Research Station (lat. 19 36'S, long. 147 23'E, alt. 13 m.) on the dry tropical coast of North Queensland. Most of the experimental results discussed in this paper refer either to trials carried out at this research station or to associated "on farm" trials conducted on commercial irrigation properties throughout Queensland.

PRODUCTION FROM TROPICAL PASTURES

Early work at Ayr showed that irrigated tropical grass - nitrogen (N) pastures are capable of rivaling or surpassing temperate pastures in levels of milk produced per hectare, with acceptable per cow production levels (Chopping et al. 1976). In a milking study which ran for three complete lactations Friesian cows grazing irrigated pangola grass (Digitaria decumbens) fertilized with 56 kg N/ha/month and stocked at 5.9 or 7.9 cows/ha (unsupplemented) averaged 15988 and 19851 kg milk/ha/year respectively during the last two years. Cows at identical stocking rates but supplemented with 3.6 kg molasses/cow/day averaged 22068 and 25163 kg milk/ha/year at 5.9 and 7.9 cows/ha respectively (Table 1).

Table 1. Effect Of Stocking Rate and Supplement Level on per Hectare Milk Production, Milk Composition, Lsctrtion Length and Cow Liveweights for Friesian Cows Grazing Irrigated Pangola Grass over Three Lactations

Treatment		Milk/ha Co. Variance Corrected			Fat % (uncorrected)			Lactation Length Days			Post Calving		Kg.
	Year	70/71	71/72	72/73	70/71	71/72	72/73	70/71	71/72	72/73	70/71	71/72	72/73
*Low SR	Plus Mol.	30384	22468	22667	3.6	3.3	3.3	333	296	310	507	501	531
Low SR	Nil Mol.	23186	17597	14019	3.9	3.7	3.8	328	299	244	517	456	457
High SR	Plus Mol.	26552	25417	24910	3.4	3.1	3.4	310	274	291	497	529	497
High SR	Nil Mol.	21337	19714	19988	3.6	3.3	3.5	275	286	260	537	428	443

* Stocking rate Low = 5.93 - High = 7.90 cows/ha*, Molasses = 3.6 kg/cow/day

The use of irrigation and nitrogen fertilizer on tropical pastures has not eliminated the problem of marked seasonal fluctuations in pasture dry matter production. Results from a plot trial (Chopping unpublished data) in which irrigated pangola grass was fertilized with seven levels of nitrogen showed that summer pasture yields were three to six times winter yields (Fig. 1). Since reduced cool season pasture feed supply is the major nutritional problem facing Queensland dairy farmers, irrigated pasture research since 1975 has concentrated on ways of improving paddock feed supply during this problem period.

The effect of management strategies such as rotational **grazing** and

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strategic increases in applied nitrogen on milk production from irrigated tropical pastures during winter have been studied (Chopping et al. 1978). Results showed that both a six paddock rotation compared to continuous grazing and doubling the winter application of nitrogen fertilizer from 56 to 112 kg N/ha/month failed to increase milk production (Table 2). Rotational grazing actually reduced milk production in those periods when paddock feed was abundant because it reduced the animals potential to graze selectively.

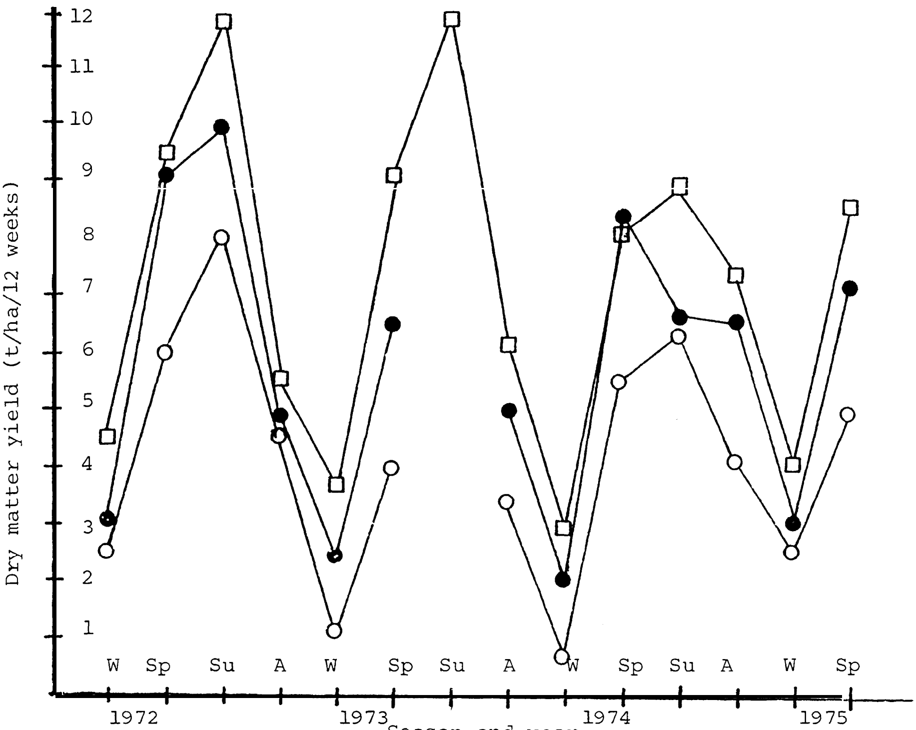

Fig. 1. Seasonal fluctuations in the dry matter production of irrigated, nitrogen fertilized pangola grass in North Queensland (o 2 week cutting interval, ● 4 week, ◻ 6 week)

Table 2. Effect of Grazing and Fertilizer Management on Milk Production (kg/cow/day) from Irrigated Tropical Pasture.

		Grazing Management			Nitrogen Fertilizer Regime			
		Continuous	Rotational	LSD 5%	672 kg N/ha/ year even	672 kg N/ha/ year Strategic	896 kg N/ha/ Year Strategic	LSD 5%
17.5.76	27.6.76	9.1	8.2	0.7*	8.6	8.8	8.5	0.9
28.6.76	20.9.76	7.4	7.3	1.0	7.2	7.9	7.0	1.2
21.9.76	End	6.7	4.5	2.6	4.4	6.0	6.4	3.2
Total Period		7.9	7.1	0.9	7.3	7.8	7.2	1.1

* P< 0.05 End = End of lactation

PRODUCTION FROM TEMPERATE PASTURES

The strategy which has gained rapid industry acceptance on irrigation farms since 1976 for helping to fill the cool season feed shortage is the use of annually sown areas of ryegrass and clovers. An indication of the rapid industry adoption of such pastures can be gauged from the changing situation on dairy farms on the Atherton Tablelands in North Queensland. Prior to 1976 no farms in this area were growing annual ryegrass or clover pastures. In 1981, 55 of 69 irrigation farms were growing significant areas of these pastures (Davison pers. comm.).

Experimental work between 1974 and 1976 (Chopping and Clem unpublished data) had shown that even in tropical environments, annually sown areas of irrigated ryegrass or clovers provide improved grazing compared with irrigated tropical pastures during winter and spring. A grazing study (Chopping et al. 1982) quantified the milk production potential of these pastures at between 10,000 and 16,000 litres of milk per hectare over a 165 day period. Compared to tropical pastures receiving the same fertilizer and irrigation inputs ryegrass and clover pastures increased milk output by 1770 and 3555 litres of milk per hectare respectively. Milk production advantages to ryegrass and clover pastures on most Queensland dairy farms are even greater than those recorded at Ayr since most farms are located in areas where cool season effects on tropical and sub tropical pasture growth are greater than occur on the tropical coast. The milk production advantage to clover compared to ryegrass pasture is due to quality rather than yield differences between the species (Goodchild et al. 1982). Goodchild measured a difference in winter of 6.6 digestibility units between the species when grown in North Queensland.

In addition to quality, clover pastures have two other advantages compared with ryegrass pastures. Firstly they have a lower overall cost of production and secondly they can remain productive over a longer season. In Queensland annual ryegrass pastures provide grazing only to the end of spring. With adequate irrigation clover pastures can warrant intensive management through summer and autumn and where plant population remain sufficiently high even for a second year. The above advantages to clover compared to ryegrass pastures have to be weighed against disadvantages which include bloat worry, slower establishment compared to ryegrass when planted in April and May, more difficult weed control and a sensitivity to acid soils.

In 1980 and 1981.a number of grazing trials have been conducted on commercial dairy farms throughout Queensland to compare milk production from annual clover and ryegrass pastures. Murray and Chopping (1982) reported the results of one of these trials which was conducted on a Central Queensland property (Table 3). In this trial ryegrass and clover areas were planted in April and stocked at identical rates over the period July to November inclusive. Results showed that clovers were slower to establish than ryegrass and produced less pasture dry matter and milk to the end of July. In August clovers produced identical milk yields per cow and per hectare compared to ryegrass despite clover pasture yields being only 69% of ryegrass pasture yields. From September to November clover matched ryegrass in pasture yield but produced significantly more milk. Over the period July to November cows produced an average 0.7 litres milk/cow/day more while grazing clovers compared with ryegrass with a lower cost of production for clover pastures. Similar comparative results between ryegrass and clover pastures have been obtained in other areas (Chopping, unpublished data).

Recent trial results (Chopping, unpublished data) have shown that the late autumn/winter performance of annual clover pasture relative to ryegrass pastures is improved as planting date is brought forward. Results in Table 4 show the effect of a 5 week delay in planting date, from early April to mid May on pasture dry matter production to the end of winter for Tama ryegrass and a number of clover varieties as measured in a plot trial conducted in south east Queensland in 1980. Despite only a 34% increase in the length of the growing season for the earlier planted plots pasture yields of Tama ryegrass were increased by 78% and of three subterraneum clover varieties by an average 104%.

Table 3. Winter-spring milk and pasture production from annual irrigated ryegrass and clover pasture in Central Queensland

Treatment	Rotation 2 10/7 → 2/8	Rotation 3 3/8 → 26/8	Rotation 4 27/8 → 19/9	Rotation 5 20/9 → 13/10	Rotation 6 14/10 → 6/11	Rotation 2 → 6 10/7 → 6/11
			Milk production l/cow/day			
Ryegrass (R)	15.4a	15.9a	14.7a	12.9a	10.7a	13.9a
Ryegrass/Clover (R/C)	15.5a	16.5a	15.6b	13.0a	11.8b	14.5b
Clover (C)	13.9b	16.1a	16.0b	14.6b	12.5b	14.6b
			Pasture Production kg/ha			
Ryegrass	1869	2387	1739	1706	1648	9349
Ryegrass/Clover	882	1722	2726	1316	1567	8213
Clover	632	1642	1797	1650	1699	7420

Means in the same column with the same subscript are not significantly different

TABLE 4 Effect of planting date on the cumulative dry matter production of ryegrass and clover varieties to the end of winter in south-east Queensland

Species	Planting date	Pasture dry matter yield (kg/ha) 10/4/80	14/5/80
Lolium multiflorum	cv. Tama	8397	4717
Trifolium subterraneum	cv. Clare	7314	3706
	cv. Bacchus Marsh	6505	3110
	cv. Seaton Park	5061	2426
Trifolium repens	cv. Ladino	5550	1497
	cv. Haifa	5044	2102

Kemp (1975) from work in Northern New South Wales found that the winter performance of Clare subterraneum clover improved relative to Wimmera ryegrass as planting date was brought forward from April 24 to March 3. Pre April plantings of ryegrass in Queensland have proved unreliable because high ambient temperatives can cause severe seedling loss, and are not generally recommended. Current work has indicated that March plantings of Clover and medic varieties are successful and do make the late autumn/winter performance of clovers comparable to that from ryegrass.

CONCLUSION

Accounting data collected from commercial farms in Queensland (Oliver and Busby 1980) show that variable costs of milk production are lowest on those farms which rely mainly on paddock feed for milk production. Variable costs of production increased as farm expenditure on purchased feeds increased. It would seem desirable that as farmers seek to increase farm milk output and reduce seasonal fluctuations in milk supply they do so by seeking mainly to increase the supply of paddock feed, As described in other papers in this contract, concentrates can effectively and economically be used to increase per cow production levels above those attainable from paddock feed alone and help to fill gaps in paddock feed supply. If costs are to be minimized concentrates should not be used as the basis of feed supply on Queensland dairy farms.

Irrigation is certain to play an ever increasing role in providing more paddock feed, especially cool season feed on Queensland farms. Milk production studies on nitrogen fertilized tropical grass pastures in North Queensland have shown tropical areas can match other areas for profitable milk production. The area sown to annual ryegrass and/or clover pastures is likely to increase further. On farms with limited irrigation area ryegrass is likely to remain the most important winter pasture source because of its highly flexible management possibilities. On farms where irrigation area is less restricted the use of annual or biennial clover or medic based pastures is likely to increase. Already on the Atherton Tableland the percentage of irrigation farmers using substantial areas of clovers has increased from nil in 1976 to 43 in 1981.

On both dryland and irrigation farms the use of nitrogen fertilizer on grass pastures will continue to increase. Such pastures allow farm stocking rates and milk production to increase while maintaining stable pasture systems.

MILK RESPONSES TO SUPPLEMENTATION UNDER TROPICAL PASTURE FEEDING SYSTEMS

T.M. DAVISON: R.T. COWAN** and G.D. CHOPPING**

Grain and molasses are the cheapest and most widely available energy supplements and considerable work has been done in Queensland to determine the milk responses when they are fed to dairy cows. Other work on the responses to maize silage, meat and bone meal and mineral supplements are also reported.

SUPPLEMENTATION AND PASTURE AVAILABILITY

In experiments over the whole lactation and where a set level of grain has been fed, the responses both in Queensland and other tropical areas, have nearly all been 1.0 kg milk/kg supplement (Moberly 1966; Colman and Kaiser 1974; Cowan *et al.* 1977). However the response at any time within the lactation has been shown to vary from 0.3 kg/kg during adjustment to ration, to 0.6 kg/kg during periods of high pasture availability (> 2500 kg DM/ha) and up to 1.7 kg/kg during periods of low pasture availability (< 2500 kg DM/ha) (Cowan *et al.* 1977). At very low pasture yields the response after four weeks to feeding 3 kg/day of maize was found to be 1.0 kg/kg, compared to 0.3 kg/kg for cows grazing abundant pasture (Cowan and Davison 1978).

When cows were given 3.6 kg grain/day over the first 50 days of lactation there was a large response in milk yield over the total lactation. The full lactation response ranged from 3.1 kg/kg at 1.3 cows/ha to 0.4 kg/kg at 2.5 cows/ha (Cowan *et al.* 1975). This result shows the residual milk response to giving grain during early lactation will be large if pasture supply is adequate, as it was at 1.3 cows/ha, but will be small if, as happened at 2.5 cows/ha, there is insufficient pasture on offer during mid and late lactation to allow the cow to maintain her level of production.

The response to supplement is highly dependent on the length of feeding as well as the level of pasture availability (Fig.1). In Figure 1 we see the

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response to grain and molasses is 0.1 - 0.4 kg/kg in week one and rises to 1.0 kg/kg between four and sixteen weeks after the start of feeding depending on pasture availability. When pasture on offer is high (> 3000 kg DM/ha) the response starts at a lower level and rises at a much slower rate. This response with time has important implications in the use of short term or latin-square feeding experiments with dairy cows.

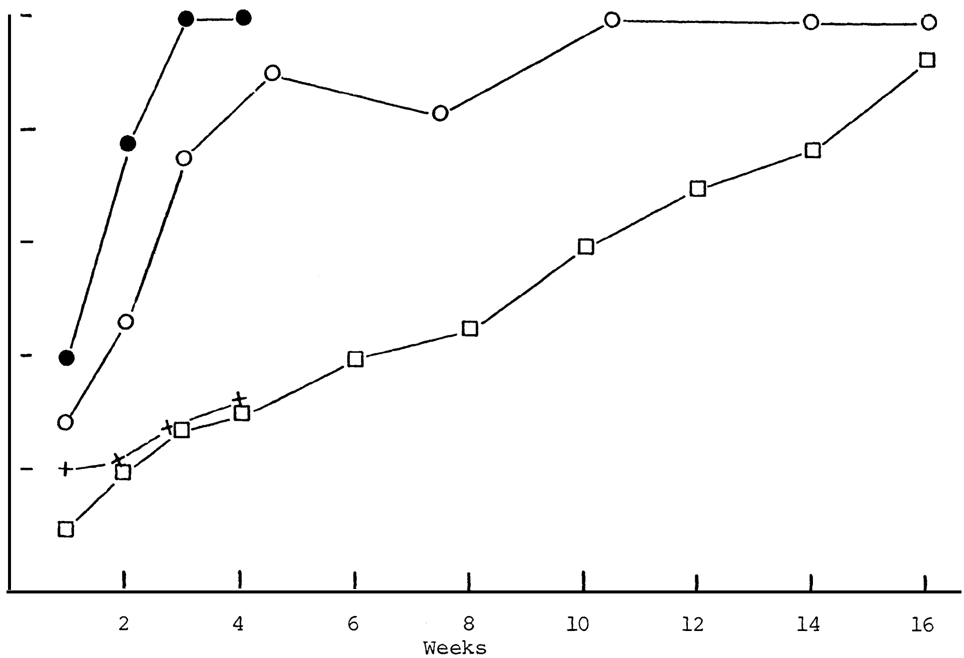

Fig. 1. Milk yield response with time to molasses and grain at different levels of pasture on offer (● grain, low pasture yields; o molasses, moderate pasture yield; □ grain, moderate pasture yield; X grain, high pasture yield)

In recent work (Davison, unpublished data) cows were given 3.3 and 6.7 kg maize/day over the first 90 days of lactation and milk yield responses were 1.3 and 0.4 kg/kg respectively. This indicated that cows fed the high level of grain consumed insufficient protein from pasture to enable them to fully utilize the energy supplement. This contrasts with the linear response in milk yield obtained when cows were fed 0, 2, 4 or 6 kg/day of a maize and soybean concentrate (Cowan et al. 1977).

GRAIN VERSUS MOLASSES

The average response in milk yield to molasses in long term feeding work has been shown to be 0.7 kg/kg (Chopping et al. 1976; Chopping et al, 1980), with a linear increase in milk yield up to 3.6 kg molasses/cow/day (Chopping et al, 1980). Davison and Cowan (1978) gave equivalent amounts of molasses (3.0 kg/day) and maize (2.4 kg/day) on a dry matter basis, at high and low levels of pasture on offer. There was no difference in milk yield between the supplements at either level of pasture on offer.

SILAGE

Maize silage is an appropriate supplement to pasture during periods of pasture shortage. Cows grazing tropical pastures were given low (3 kg DM/day) or high (7.5 kg DM/day) levels of silage with or without meat and bone meal. Milk yields over an eight week period in mid lactation were 14.3 and 15.0 kg/day for cows given the low level of silage without and with a protein supplement ($P < 0.05$) and 15.3 and 16.6 kg/day for cows given the high level of silage without and with a protein supplement ($P < 0.05$) respectively (Davison et al. 1982).

MINERAL SUPPLEMENTS

Milk yield responses to both sodium supplementation (Davison et al. 1979) and phosphorus supplementation (Davison, unpublished data) have been recorded for cows grazing tropical grass-legume pasture on the Atherton Tableland. A 10% increase in milk yield was recorded to sodium supplementation and reflected the low sodium levels in both grasses (0.06 - 0.15 % DM) and legume (0.01 - 0.02 % DM). Phosphorus levels in pasture are marginal for lactating cows (N.R.C. 1978) with a range of 0.23 - 0.51 % DM in grasses and 0.15 - 0.23 % DM in legumes. Cows given molasses with or without a phosphorus supplement averaged 15.9 and 14.8 kg milk/day respectively ($P < 0.01$) over the first 180 days of lactation.

THE ECONOMICS OF PASTURE BASED FEEDING SYSTEMS

G. BUSBY* and P.G.H. VAN BEEK**

The economics of dairying in Queensland have been described by Oliver and Busby (1980), Busby (1981) and Van Beek (unpublished data). These studies show that at present dairyfarmers with a single labour unit need to produce about 240,000 l of milk annually to remain viable. This level of production at the current average price of 20 cents/l will result in a gross milk income of $48,000. Efficient farms have variable costs which are 30 to 50% of the gross milk return.

The major variable cost on dairyfarms is feed supply. It has been shown that feeding systems based on feeds grown on the farm produce milk for 2 cents/l less than systems based on purchased feeds (Busby 1981). For this reason considerable attention has been given to defining efficient pasture based feeding systems for cows. This paper gives a brief economic analysis of four of these systems as described above. In these analyses the definition of optimum stocking rate is based on performance data from animals and pasture, rather than using rates which maximize returns per unit area. The data therefore refer to stable pasture systems as defined.

DRYLAND PASTURES

Two options available for increasing the productivity of dryland pastures are either incorporating a legume in the sward or applying nitrogen fertilizer. For the grass-legume system the optimum stocking rate is defined as 1.6 cows/ha. At this rate cows maintained body weight, gave milk of acceptable chemical composition and milked for 270 days. The legume content of the pasture was also maintained at about 30% of the dry matter.

For nitrogen fertilized grass pastures 2.5 cows/ha was defined as the optimum stocking rate for pastures receiving 400 kg nitrogen/ha/year. Apart from

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the legume content the criteria were as described for grass-legume pastures. The economic margins produced by these pastures are shown in Table 1.

The establishment costs of perennial pastures when discounted over its life are very low. For example grass-legume pastures stocked at up to 1.6 have persisted as vigorous, weed free swards for over 20 years. These costs have therefore been omitted in Table 1.

TABLE 1 Returns from grass-legume pastures stocked at 1.6 cows/ha and grass pastures stocked at 2.5 cows/ha and receiving 400 kg N/ha/year

Unit	Grass-legume pasture		Grass pasture	
	(cow)	(ha)	(cow)	(ha)
Grass on offer (kg DM)	1229	1967	2484	6210
Legume on offer (kg DM)	490	783	-	-
Milk yield (l)	3345	5352	3000	7500
Gross return @ 20 ¢/l ($)	669	1070	600	1500
Superphosphate ($)	17	28	11	28
Muriate of potash ($)	15	25	10	25
Nitrogen ($)	-	-	118	291
Additional cost for increased cow numbers ($)	-	-	-	17*
Margin over feed cost ($)	637	1017	451	1111

* Includes an estimate of variable and capital costs for 0.9 additional cows, less returns from sales of calves and cull cows.

Nitrogen fertilized grass pasture is capable of supporting higher stocking rates and thus allows the stocking pressure on grass-legume pastures to be maintained at 1.6 cows/ha as cow numbers increase. Less dependence is placed on nitrogen fertilized pastures on large farms. In these situations stocking rate is low but returns from grass-legume pastures are relatively high.

IRRIGATED PASTURES

Much greater intensification is achieved by irrigating tropical grasses. Irrigated pangola grass which received 675 kg N/ha/year supported 5.9 cows/ha without supplementary feeding. Total milk output was 16,000 l/ha/year, giving a gross return of $3200/ha/year and a margin over costs for feed and extra cows of $2220/ha/year. The margin for each cow was $377. Despite the reduction in margin for each cow, development of these pastures allowed large increases in both stocking rate and margin per unit area.

Two important reasons for the reduced margin per cow in very intensive systems of utilizing tropical pastures were the slow growth of these grasses during winter and early spring, and the inherent low digestibility of tropical grass species. To overcome these limitations temperate pastures were used to provide feed for approximately five months of the year. The returns are shown in Table 2.

At the end of the fifth grazing ryegrass could no longer support the full stocking rate. However with increased amounts of irrigation clovers were capable of maintaining this stocking rate throughout summer.

TABLE 2 Returns from temperate pastures stocked at 6.5 cows/ha

	Ryegrass	Clovers
Annual establishment costs ($/ha)		
Machinery	34	34
Seed	48	96
Irrigation	20	20
Nitrogen	70	70
Superphosphate	41	41
Muriate of potash	25	25
Total	238	286
Capital cost for irrigation ($/ha)		
Annuity	90	90
Nett annual costs for extra cows	56	56
Total	146	146
Costs over 5 grazing cycles ($/ha)		
Irrigation	115	115
Nitrogen	175	
Machinery	10	10
Bloat control	-	80
Supplementary feeding	115	115
Total	405	320
Returns from milk sales ($/ha)	1899	1996
Margin over feed costs ($/ha)	1100	1247
($/cow)	169	191

SUPPLEMENTARY FEEDING

The economics of supplementary feeding depends on the relative prices of feed and milk and on the conversion ratio. When supplements are given for a complete lactation or longer the ratio is consistently in the order of 1:1 for maize and 1:0.7 for molasses. The margins are 4 and 7.5 cents/kg supplement respectively.

In the short term the response to supplementary feeding is usually less than in the longer term. An exception is where the yield of pasture on offer is very low. The margin for short term feeding of grain has varied from a loss of 10 cents/kg when it was given for four weeks to cows in mid lactation and grazing abundant high quality pasture, to a gain of 4 cents/kg when it was given to similar cows grazing very sparse pastures. The margins from giving cows a supplement for a short period during early lactation were much higher, and averaged 34 cents/kg over the full lactation.

CONCLUSION

This series of papers demonstrates the high milk producing potential of leniently grazed tropical grass legume pastures but highlights the vulnerability of the twining legumes to increased stocking rate. The absolute milk levels achieved on these pastures of 3,500 - 4,000 lt unsupplemented is comparable with production in the temperate regions. The integration of the grass + nitrogen milk producing system and the grass legume system allows for restoration of degraded pastures by reduced stocking on the legume areas.

Irrigation is assuming greater importance in the Queensland industry on grass + nitrogen systems. Irrigated annual ryegrass and clover pasture systems are capable of producing high milk yields in the late autumn to spring period, traditionally the problem time for milk production. Research is now showing that dairy farms in tropical areas with irrigation are ideally situated to produce high milk yields per cow and per unit area. The influence of energy supplements during the problem period of pasture supply has also been highlighted in these papers with a four fold increase in the response to grain when pasture on offer was very limiting relative to adequate pasture. From an economic view point the various pasture production options discussed in these papers were sound. This session was introduced by an outline of the Qld industry demonstrating a fall in milk output. With the technology discussed in these papers and the favourable prices received there is every reason to expect a reversal of this situation.

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