THE SUPPLEMENTATION OF DAIRY COWS AT PASTURE IN QUEENSLAND

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SUMMARY

Traditionally dairy production in Queensland has been based on grazed pasture and crop, with minimal inputs of supplement and relatively low levels of milk production. Research into the role of supplementary feeding has demonstrated'0 number of areas where supplements are used efficiently. The low digestible energy intake by cows grazing tropical pastures is associated with a low digestible dry matter content of these 'species. Energy supplements can be effectively used to make up this deficiency. Protein supplements may be necessary when cows are given more than 4 kg grain/cow/day. Deficiencies of sodium and phosphorous are widespread.

Specific times when energy supplements are used with high efficiency for milk production include the eight weeks before calving, the first eight weeks of lactation and periods when yield of pasture on offer is very low.

An outline is given of some recent changes in the dairy industry. It is suggested these will contribute to an increase in the levels 'of supplementary feeding to dairy cows.

INTRODUCTION

The primary purpose of supplementary 'feeding on Queensland dairy farms has been to supply nutrients which ore deficient in the diet of cows due to either low quality or low quantity of grazed forage, There has been much less attention given to meeting the requirements of the dairy cow producing to her potential. The reasons for this emphasis are obvious when we look at the history of the State. Dairying was a pioneering industry. Natural grosses could be used to support a reasonable output of butter during the summer months. costs of production were very low as inputs' were kept to a minimum and production was concentrated around the four to six months of useful growth by natural pasture species.

Although the industry has now changed dramatically from the above picture the emphasis has remained on using grated roughage to produce milk. This is usually the least expensive source of nutrients, and by accepting a moderate level of milk production from his cows the farmer has been able to contain costs and obtain a net income from his operation. Under this system of dairying the pattern of milk production through the year is markedly affected by seosonal conditions.

The rapid adjustments now taking place in the industry may lead to a change in emphasis in the future. In this paper we suggest that the level of production by cows will become much more crucial to the economic viability of a dairy 'form. The research done on supplementary feeding is reviewed and then this information, together with observed trends in the industry, used to develop suggestions as to the likely use of supplements in the dairy industry.

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RESEARCH

Pasture Deficiencies

By far the majority of work has concentrated on demonstrating how tropical pastures are deficient in one or more nutrients when given to dairy cows. Energy has been the nutrient receiving most attention, though studies have included protein and minerals. In recent years considerable emphasis has also been given to the structure of tropical pastures.

(a) Digestible Energy Intake

Associated with the large pasture plant introduction to Queensland (Hutton 1970) was a stimulation of interest in evaluating pasture species for nutritional value. It was demonstrated that the intake of digestible energy by penned sheep given chaffed pasture was restricted by the relatively low organic matter digestibilities of these pastures (Milford 1960; Minson and Milford 1966). Positive correlations were demonstrated between organic matter digestibility, crude protein content and age of regrowth (Minson and Milford 1966). Those pastures native to the State, such as spear grass (*Heteropogon contortus*), were shown to decline rapidly in crude protein content (Shaw and Bisset 1955) and were lower in nutritional value than introduced grasses for much of the year. Other nutrients such as sulphur (Siebert and Kennedy 1972) were shown to be deficient in the natural pastures.

Dale and Holder (1968) and Hamilton *et al.* (1970) concluded that milk production by cows given abundant tropical'pastures was limited by a low intake of digestible nutrients, associated with a low digestibility of the pasture dry matter. When compared with a diet of lucerne and concentrates milk yields of cows given tropical pasture were relatively low, but much of this difference was removed when 50 percent of the energy requirements of the cow were supplied as hammermilled grain sorghum (Hamilton *et al.* 1970). The study of Hamilton *et al.* (1970) also demonstrated the higher digestible energy intake from legumes (*Lab lab purpureus*) than grasses.

A number of studies subsequently supported the suggestion that giving a supplement of high energy content would increase the milk production by cows. Cows grazing pure legume pasture (*Phaseolus atropurpureus*) increased daily milk production by 2 kg/cow when given 4 kg of concentrate daily (Stobbs 1971a). The response was similar for cows on kikuyu (*Pennisetum clandestinum*) postures (Royal ond Jeffery 1972; Jeffery *et al.* 1976) and on grass (*Panicum maximum* cv. trichoglume) and legume (*Neonotonia wightii* cv. Tinaroo) mixed pastures (Cowan 1975; Cowan and Davison 1978).

The level of response was not affected by the type of grain given, with the exception of a slightly reduced response from oats when compared with other grains (Jeffery 1971). Molasses as fed hos consistently given a response in milk yield of 70% of that measured for grain supplements (Cowan and Davison 1978; Chopping *et al.* 1980).

The importance of the metabolizability of the diet to the level of milk production is demonstrated diagramatically in Fig. 1. Dairy cows grazing tropical pastures are restricted in their ME intakes by the ME concentration in the diet, and normal levels of milk production are from 8 to 12 kg/cow/day (Stobbs 1971b). This is less than half the potential of cows. By contrast the fattening steer is able to consume almost sufficient ME from these pastures to meet its genetic limit for growth (Stobbs 1975; pers. comm.).

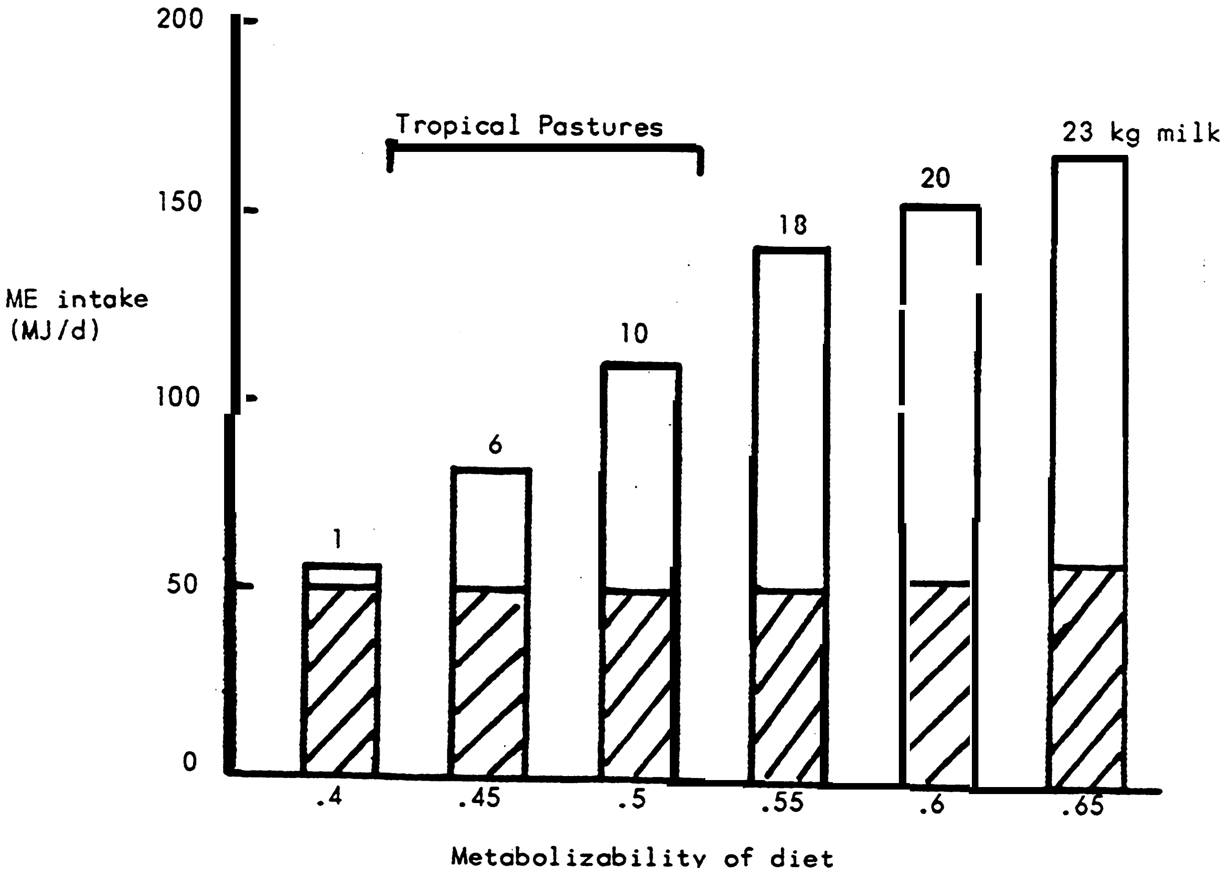

Fig. 1. Estimates of the effect of metabolizability of the diet on the levels of ME intake and milk production by a 500 kg cow (ARC 1980). Shaded area represents ME directed to maintenance and unshaded area ME for production.

The direct effects of giving concentrates of high energy content on the digestible energy intake have seldom been measured for cows grazing tropical pastures. Cowan *et al.* (1977) measured a substitution rate of 0.9 kg pasture dry matter for each kg of a hammermilled maize - soybean meal concentrate given to cows. Assuming pasture and concentrate have metabolizable energy (ME) contents of 9.5 and 12 MJ ME/kg DM respectively, this rate of substitution suggests a real increase in ME intake of 3.5 MJ for each kg concentrate. The measured milk response was 3.1 MJ, and at an efficiency of use of ME for milk production of 0.63 (ARC 1980) this would require an increase in ME intake of 5 MJ daily. Since body weight was also increased . the substitution rate appeared to be overestimated by the technique used in this study.

In many short term experiments (Stobbs 1971a; Royal and Jeffery 1972; Jeffery et aZ.1976; Cowan 1975; Cowan and Davison 1978) the response in milk yield is in the order of 0.5 kg/kg concentrate. This suggests an effective increase in ME intake in the order of 2.5 MJ for each 12 MJ given as concentrate. By contrast longer term studies (Rees *et al.* 1972; Colman and Kaiser 1974; Cowan, Oovison and O'Grady 1977) show a response in the order of 1 kg/kg concentrate, or an effective increase in ME intake of at least 5 MJ for each 12 MJ given as concentrate.

(b) Protein Supplements

Less emphasis has been given to protein supplementation of tropical pasture as experimental results have generally shown energy to be more limiting to production. Providing energy as hammermilled grain sorghum was more effective in increasing milk production than was providing protein as cotton seed meal (Hamilton *et al.* 1970). A linear response in milk yield was obtained when cows grazing nitrogen fertilized kikuyu grass were supplemented with up to 3.8 kg/day of a concentrate mix, and the effect was attributed to the change in energy rather than protein intake (Royal and Jeffery 1972).

More recent work has shown areas where protein supplementation con be important. When casein, which had been treated with formaldehyde to prevent its degradation in the rumen, wos given to cows grazing nitrogen fertilized pangola grass a milk response was observed (Stobbs, Minson and McLeod 1977). Giving leaf material 'of the legume *Leucaena leucocephala*, in which the protein is noturally protected from rumen degradation, caused an increase in milk production (Flores *et al.* 1979). These studies have suggested that even where tropical pastures have a high content of crude protein, this protein may not be absorbed as amino acids due to its excessive degradation in the rumen. It should be noted that this effect was measured for cows with moderate levels of milk production and consuming low levels of concentrate.

When the level of concentrate intake was substantially increased there was evidence of a response in milk output to the inclusion of protein meal in the diet. Fig. 2 compares the response obtained in two experiments using similar cows and pastures, but with different levels of protein in the concentrate. Where a 15% crude protein concentrate was given the response was linear to 6 kg/cow/day (Cowan *et a2.*1977). 'However when grain only, with a protein content of 9%, was given the response reached a maximum at 3.5 kg grain/cow/day and above this level there was some reduction in yield (Davison, unpublished). There may have been an induced protein deficiency in these cows due to the substitution of grain for pasture.

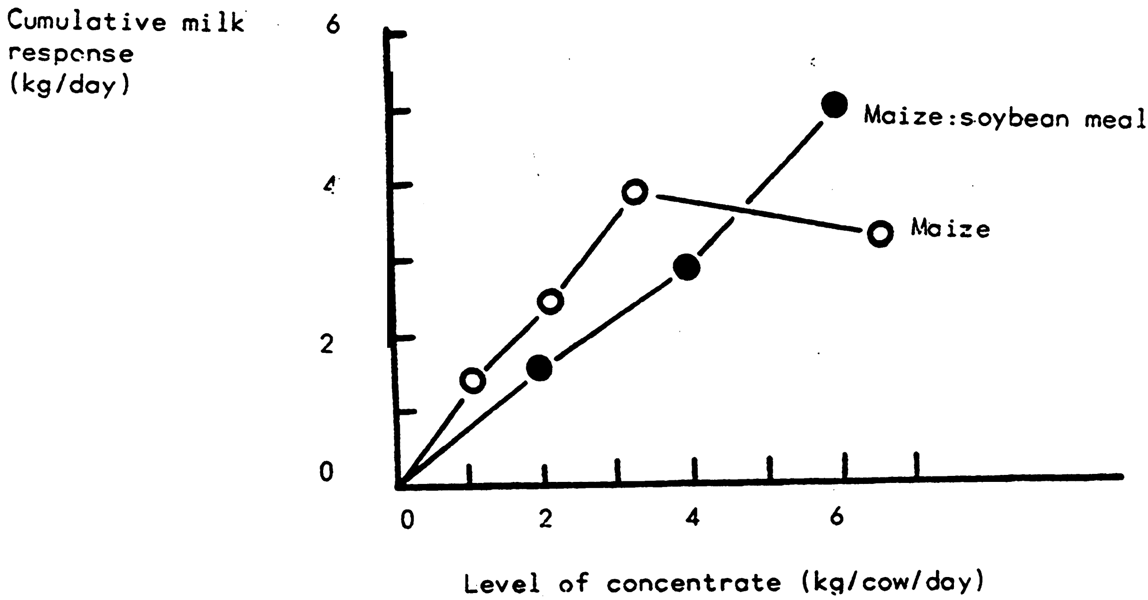

Fig. 2. Response in milk yield to level of concentrate feeding to cows during the first three months of lactation.

At these high levels of feeding the concentrate becomes a substantial part of the total diet and nutritional imbalances in the concentrate are less likely to be made up from pasture intake. As the level of production expected is also high more attention needs to be given to the relative amounts of both protein and energy in the concentrate (Cowan 1982a). A second effect of a high level of concentrate intake appears to be a reduction in the effect of protein degradability in the rumen on milk production. The rate of microbial protein synthesis will be increased with the increase in grain intake (McMeniman *et al.* 1976) and there will be some natural reduction in protein degradation due to a faster rate of passage of food through the rumen (Tamminga *et al.* 1979). There will also be a reduction in the rate of loss of body energy, thus reducing the requirement for dietary amino acids to supplement this energy (Cowan *et al.* 1982). Orskov *et al.* (1981) showed that differences between proteins in rate of degradation in the rumen were reflected in differences in milk yield when cows were given a total dietary intake of 135 MJ ME daily, but this effect was removed when energy intake was increased to 160 MJ ME daily.

(c) Minerals

The mineral content of tropical pasture species is often low when compared with that in temperate pastures. Norton (1982) demonstrated thot tropical pastures have relatively low contents of phosphorous, calcium and sodium. Cowan and Stobbs (1976) and Davison (1982) observed a further decrease in the phosphorous content of grass following the application of nitrogen fertilizer.

When either sodium chloride (Davison *et al.* 1980) or phosphorous supplements (Davison *et al.* 1982) were given to Friesian cows grazing tropical grass-legume pastures milk production was increased by about 10%. There i's indirect evidence, based on the observotions of farmers and advisers, that giving o phosphorous supplement may improve reproductive status in the herd.

(d) Pasture Structure

Stobbs (1970; 1971a) suggested that the structure of tropical. pastures was such that cows had difficulty harvesting their requirements . The pastures are generally tall, with o low density and with leaves occurring at intervals along an elongated stem (Stobbs 1974). The animal has a marked preference for leaf (Davison *et al.* 1981). Consequently supplements of energy and protein are needed to maintain the level of food intake. In rotationally' grazed pastures the leof content of the diet voried from above 80% on day one to below 30% on day 7 of grazing, suggesting cows had increasing difficulty in harvesting their food requirements from pasture (Cowan and Dovison, unpublished).

Level of Nutrition

(a) Early Lactation

The restrictions on digestible energy intake by cows grazing tropical pastures would be expected to hove most effect in reducing milk production during eorly lactation. During this time the physiological demond for energy is at a maximum, and intake by the cow is only gradually increasing (ARC 1980). When Friesian cows, grazing at 1.3, 1.6, 1.9 and 2.5 cows/ha on a tropical gross-legume posture, were given 3.6 kg hammermilled maize daily for 50 days from calving the immediate response in milk yield was consistent with those noted above for cows in mid-lactation (Cowan *et al.* 1975). However after groin feeding ceased these cows continuoed to produce more milk than cows not given supplement, and'the response over the full lactation was 2.3 kg milk/kg groin (Table 1).

The ME contained in one kg of grain is insufficient to support a direct response of this size, and some guide as to the mechanism of response can be obtained by comparing the responses at the four stocking rates (Table 1). The residual-response was much greater at the low than the high stocking rate, and this difference is associated with a similar difference in the yields of pasture on offer to cows (Cowan *et al.* 1975). At the high stocking rate cows were severely restricted in their posture intake, milk yield declined rapidly ofter the initiol 50 day period and lactation length was 250 days. By contrast cows at the low stocking rate milked for 290 days. It appears probable that the effect of giving groin during early lactation was to raise peak yield of the cow ond so stimulate appetite throughout loctotion (Broster 1974). At the low stocking rate cows were able to at least partly satisfy this oppetite from posture.

TABLE 1 Effect of feeding maize during the first 50 days of lactation on the milk yields (kg) of cows grazing tropical grass-legume posture .

Stage of lactation	Level of grain (kg/day)	Stocking rate (cows/ha) 1.3	1.6	1.9	2.5	Mean
First 50 days	0	925	900	885	890	900
	3.6	1025	1005	1040	980	1015
	difference	100	105	155	90	115
Total lactation	0	3811	3345	3388	3289	3458
	3.6	4375	3873	3868	3359	3869
	difference	564	528	480	70	411

(b) Pasture on Offer

The response in milk yield to a grain supplement increases as the yield of posture on offer to cows is decreased. When cows in mid-lactation were given 3 kg hammermilled maize daily the milk response was 0.8 kg/day for animals grazing obundont grass-legume posture, but 2.5 kg/day for animals severely restricted in the amount of pasture available (Cowan ond Dovison 1978b). Cowan and O'Grady (1976) observed that the milk yields of Friesian cows were relatively constant ot posture yields above 2 t green DM/ho, but below this yield there was a steady decrease in the level of milk yield by cows. Thus the immediate response to giving energy supplements to cows would be expected to increase at yields of green pasture DM below 2 t/ha, and this suggestion was supported by the data of Cowan *et al.* (1977).

Following a period of low pasture on offer to cows there appears to be some increase in the level of intake by cows relative to animals maintained on high quality pastures (Cowan and Davison 1978b). For cows in mid lactation there wos no evidence of a residual response in milk yield three to four weeks after returning to high quality, unsupplemented postures.

The response to groin feeding will also be influenced by the length of the feeding period. Dovison *et al.* (1982) demonstrated thot in the longer term the response was consistently 1 kg milk/kg grain, but it took two weeks for cows on pastures of very low yield to achieve this level of response, and up to 16 weeks for cows on postures of high yield.

(c) Body Weight

Body weights of heifers before calving (Cowan *et al.* 1974) ond of commercial herds of Friesian cows (Brown *et al* 1982) were correlated with the level of milk production. For each additional kg of body weight milk output increased by 7 to 10 kg/cow/year. A review of the responses obtained to increases in feeding level during late pregnancy suggested most cows in Queensland would increase milk output in the order of 10 to 17% if an additional 2,500 MJ ME were given over the last eight weeks of pregnancy (Cowan 1982b). If groin was used to provide this energy the return in milk soles would be approximately three times the cost of the. groin. Moss (1983) measured increases in weight gain of dairy heifers of 1 kg for each 5 kg groin given, and suggested that increasing the weight of heifers by giving grain would lead to a favourable financial return in subsequent milk soles (Cowan *et al.* 1974).

(d) Level of Concentrate Intake

The general response to groin feeding of 1 kg milk/kg grain is consistent in bath experimental trials (Cowan *et al.* 1977; Colman and Kaiser 1974; Davison *et al* 1982) and surveys of form practice (Rees *et al.* 1972). In oddition to this increase in milk yield there are increases in the body weight of cows and the yield of pasture on offer (Cowan *et al.* 1977). This pasture sparing effect reduces the frequent fluctuations in pasture yield ossocioted with irregular rainfall patterns in many of the dairying areas. Giving 4 kg groin/cow/day throughout lactation to cows stocked at 4/ha allowed on increase in pasture on offer of 800 kg green DM/ha (Cowan *et al.* 1977). This would represent a substantial change in the amount of pasture ovoiloble to cows for much of the year.

RECENT CHANGES IN THE INDUSTRY

There are a number of recent changes in the dairy industry which suggest a steady trend to increased levels of concentrate feeding. These can be summarized as,

(a) relative improvements in payments to farmers for milk (Thurbon and Morton 1982)

(b) the need for continuity of supply associated with the greater emphasis on the fresh milk market

(c) roughage, both grazed and conserved is becoming relatively more expensive (Fig. 3)

(d) a reluctance to continue expanding herd size beyond 150 cows, with the consequent need to employ labour

(e) an apparent linear relationship between gross margin/cow and the level of production of cows. Fig.4 shows this relationship for 26 herds co-operating with the Department of Primary Industries in farm accounting schemes.

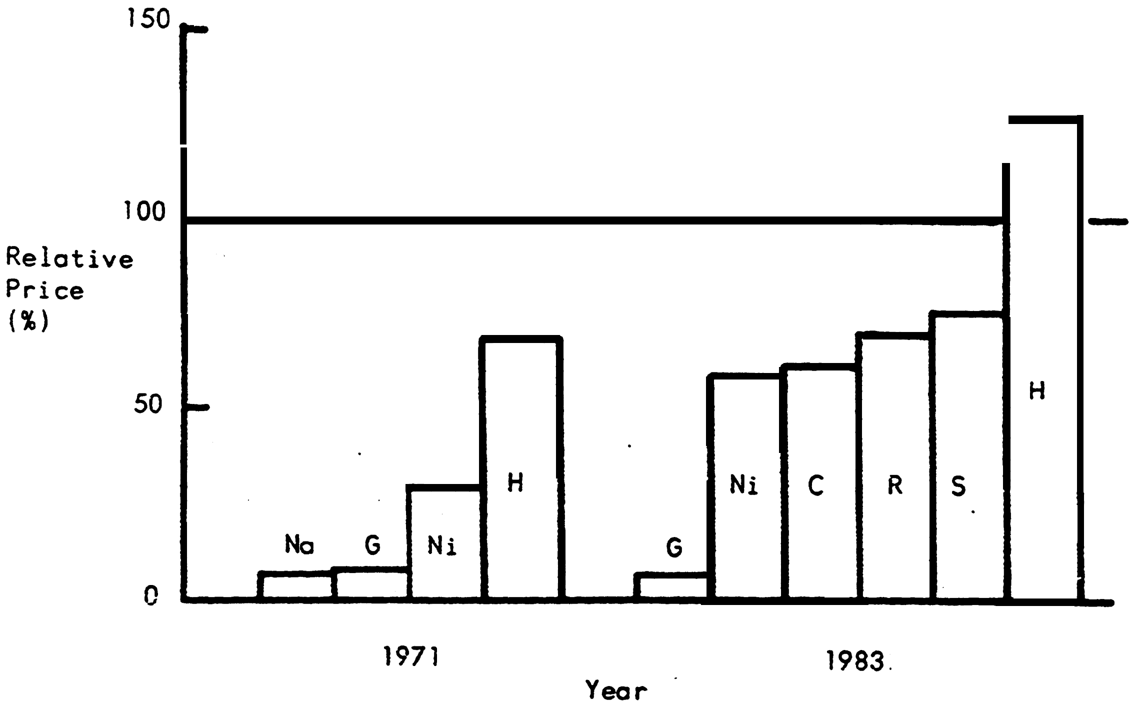

Fig. 3. The prices of one kg DM for roughages commonly recommended to dairy farmers in relation to the price of sorghum grain in 1971 and 1983 (Na, native pasture; G, grass-legume pasture; Ni, nitrogen fertilized summer grasses; H, hay; C, irrigated clovers; R, irrigated ryegrass; S, maize silage).

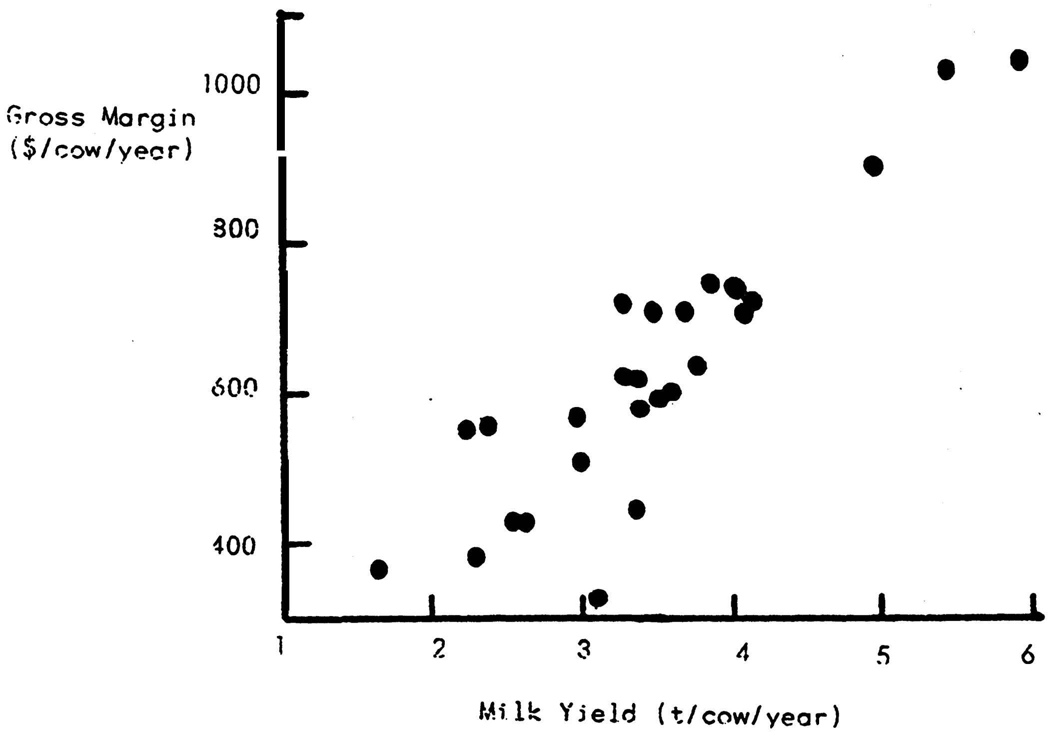

Fig. 4. The relationship between gross margin/cow and level of milk production/cow in 26 dairy herds. Data include herds from most dairying areas in Queensland.

FUTURE RESEARCH NEEDS

It is our assessment that the intensification of dairying will continue, and the problems involved in maintaining both high inputs of supplementary feeds and high efficiency of pasture utilization deserve further study. There will be increased emphasis on the substitution of supplement for pasture. In practice it may be most useful to accept this effect and concentrate on ways of using pasture spared efficiently.

The nutritional balance of concentrates appears important once feeding level exceeds about 4 kg grain/cow/day. However the levels of protein and minerals required will be influenced by pasture conditions and there is still a need for rapid methods of evaluating pastures for nutritional adequacy.

In a more general sense we need a more complete understanding of the relationships between body size of cows, food intake and level of milk production. We have seen a number of situations where the productivity of a farm practice appeared to increase over the first two to three years of its implementation, and was associated with increases in body weight of cows. Most of our research trials use animals for one year of less, and the potential of a farm practice may not be being fully evaluated.

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