SUPPLEMENTING DAIRY COWS IN THE TROPICS

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Milk production in any environment requires an ample and constant supply of feed throughout the year. Any given production system that has evolved in a particular location is dependent upon the interaction of climate, the dynamics of the soil-plant-animal complex and the socio-economic framework of the farmer (25).

There have been isolated reports from Australia (7) indicating that it is possible to obtain high lactation yields with Friesian cows grazing tropical grass/legume pastures. However, most observations are that milk yields are low when cows graze solely on tropical pastures (24). This is purely a reflection of the low nutritional quality of most tropical pastures. A relatively recent review compares research results from both temperate and tropical regions (24); summary is presented in Table 1.

ALTERNATIVES FOR INCREASING MILK PRODUCTION UNDER GRAZING CONDITIONS

If the data in Table 1 are translated to daily production per cow it becomes apparent that cows grazing unfertilized tropical grasses rarely

Table 1. A summary of research findings on temperate and tropical pastures showing differences in digestibility and milk production (24)

DIET	DM DIGESTIBILITY %	MAXIMUM MILK PRODUCTION[a/] KG/COW/LACTATION
Tropical pasture		
1. Immature	60-65	1800-2200
2. Semimature	50-55	1000-1400
Temperate pasture	70-80	3300-3800
Concentrate ration	80-85	4400-4900

[a/] Jersey cows

reach levels higher than 6-7 milk/cow/day. Attempts to improve this situation have included the use of grass legume associations and the application of N fertilizer to improved grasses. Comparison of the results of these alternatives to those obtained with tropical native grasses, reveals a modest increase in milk production (Table 2).

Table 2. Milk production under tropical grazing conditions and low stocking rates, l/cow/day (24)

SWARD	BREED JERSEY	HOLSTEIN	CROSSBREDS
Native	6.8	-	6.6
Grass/legume	10.9	13.3	8.0
Fertilized grasses	7.2	10.9	8.7

A third alternative takes advantage of the extraordinary rate of growth of tropical grasses which results in production of biomass up to 6-times as much as is possible in temperate climates (22). The alternative consists of stocking up the sward to nearly its full capacity even if this means that the individual cow's milk production potential is not reached. The aim, therefore, is to maximize milk production per unit of area. To illustrate these points, Table 3 contains milk production data as a function of the stocking rate.

Table 3. Milk production per cow and per hectare based on fertilized tropical grasses without supplements (24)

COUNTRY	SWARD	STOCKING RATE COWS/HA	MILK PRODUCTION	
			KG/COW/DAY	KG/HA/YEAR
Australia	Kikuyu (*Pennisetum clandestinum*)	2.5	7.8	5351
		3.3	7.1	6227
		4.7	6.9	9000
Peru	Jaragua (*Hyparrhenia rufa*) and Brachiaria (*Brachiaria decumbens*)	1.9	10.7	4266
		2.1	10.2	5002
		3.3	8.6	10430

In 1976, a system prototype for milk production in the humid tropics, was developed in Turrialba, Costa Rica (20). The system is based on high stocking rates (5.5 cows/ha), daily pasture rotation, minimum supplementation and genetic potential of the cow in balance with the environment and the quality of the pasture used (African Stargrass, *Cynodon nlemfuensis*). Milk production has varied between 15000 and 16000 kg/ha/year. The model has been used as the basis for technical assistance to farmers in Costa Rica and Honduras (20).

SUPPLEMENTATION: AN ALTERNATIVE FOR INCREASING MILK PRODUCTION

The previous paragraph introduces,in a way, the fourth alternative for increasing milk production under grazing conditions; that is the use of supplements. This alternative has been one of dubious value in the past because of the variable responses to supplementation. For example, under temperate conditions, grazing cows have shown small responses to supplementation, averaging 0.30 kg of milk/kg of concentrate. In tropical countries, European breeds of dairy cattle, introduced to improve animal production, have usually received large amounts of supplementary concentrates but have shown only small responses (12, 16, 18, 21). On the other hand, there have been reports of substantial increases (up to 24.5%) in milk production by feeding grain supplements (11, 19, 23) to grazing cows.

The reasons for such contradictory results have not been studied in detail. However, various factors conditioning animal response to supplementation have been identified. Firstly, as was noted in Table 1, tropical grasses are usually of relatively low digestibility, which explains the limited levels of milk production (17). Therefore, a large proportion of the ingested nutrients are used to meet the maintenance requirements and a very small proportion would be available for milk production. This is in contrast to the situation with beef cattle as their requirements for weight gain are much lower than the requirements for milk production; as a result, it is not uncommon to see high rates of weight gain in beef cattle grazing tropical pastures. Schematically, these concepts are illustrated in Figure 1.

Thus, the major limiting nutrient for milk production in tropical and sub-tropical environments is energy. It is granted that protein deficiencies will occur as the dry season settles and care must also be taken to ensure the supply of this nutrient at those times.

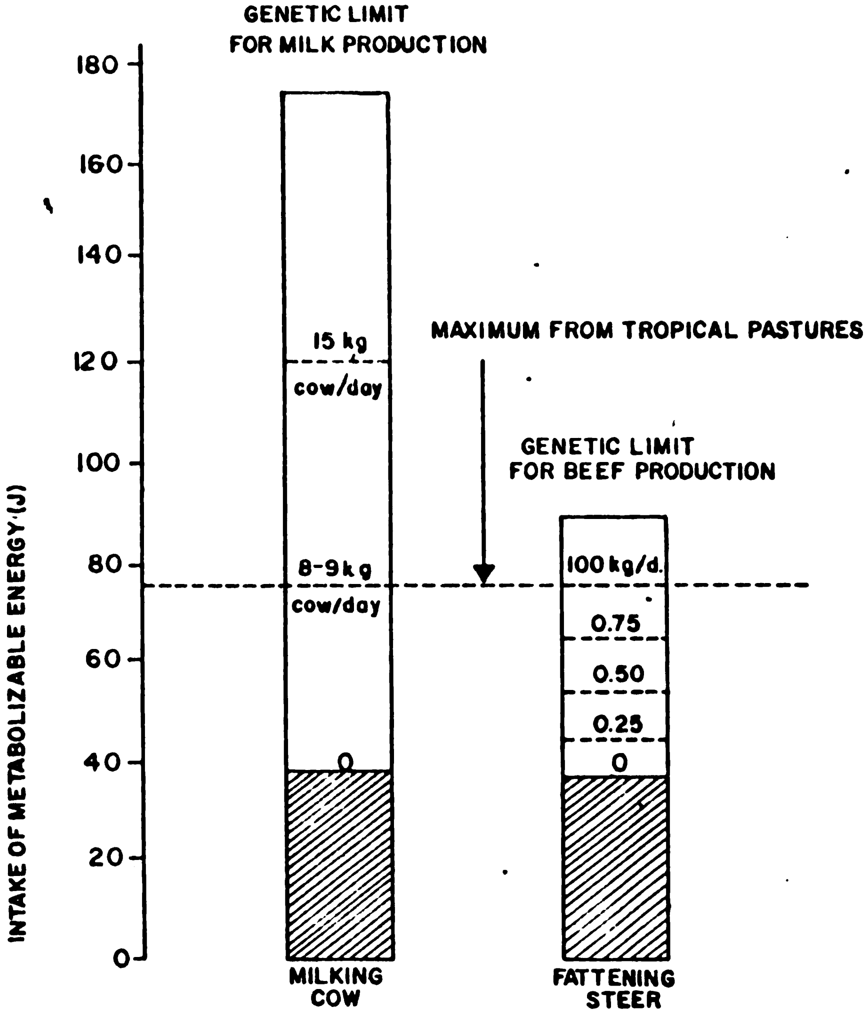

Fig. 1. A SIMPLE REPRESENTATION OF THE LEVELS OF MILK OR BEEF PRODUCTION OBTAINABLE FROM TROPICAL GRASSLANDS AT LOW STOCKING RATES. THE SHADED AREAS REPRESENT THE PROPORTION OF THE ENERGY CONSUMED DESTINED FOR MAINTENANCE; THE UNSHADED AREAS INDICATE THE ENERGY AVAILABLE FOR PRODUCTION (BASED ON ARC (1)).

LEVEL OF SUPPLEMENTATION: The amount of supplement given to milking cows is highly variable. In Latin America, in general, there is a tendency to use high levels of supplements for cows of European blood and small amounts or none for the native or crossbred cows. Very few trials have been conducted to define the proper level of supplementation in tropical conditions.

In Table 4, a summary of various studies is presented indicating the stage of lactation at which the treatments were applied. An examination of the data in Table 4 leads to the conclusion that under grazing conditions and low stocking rate, supplementing dairy cows may cause an increase in milk production. However, if there is a response, this will be modest and the level of supplement necessary to elicit such a response is low. It would appear that levels of supplement higher than 3 kg/cow/day (or 0.7 kg/100 kg LW/day) will not cause further increases in milk output. As the responses are low, it would be very difficult to justify from an economic point of view the practice of supplementation of dairy cows. However, attention is called to the three reports which show significant effects (see Table 4). These experiments were conducted at the initial stages of lactation while the others used cows in the middle of their lactation. This observation seems to hold the key for the appropriate supplementation of dairy cows.

THE INFLUENCE OF THE LACTATION STAGE ON THE DEGREE OF RESPONSE TO SUPPLEMENTATION: Perhaps the singlemost reason for the rather poor response to supplementation of grazing cows is the stage of lactation at which comparisons were made. Because of statistical convenience most researchers have applied the supplementation treatments to cows after they have passed the lactation peak which is usually attained 35 to 50 days after parturition. In fact, switch back designs require the use of cows that are already in their downward phase of milk production. However, as the cow nears the end of its lactation curve, it will be more prone to utilize feed nutrients for body reserve replenishment. (i.e. weight gain) than for milk production.

Table 4. Milk production based on tropical pastures and supplementation

TREATMENT	SWARD	PRODUCTION KG MILK/COW	NOTES AND REF.
From day-30 to day-120 of lactation			
A. Concentrate, 1 kg/4 kg milk B. A + 0.5 kg molasses C. A + 1.0 kg molasses	Pangola, Guinea and Molasses grass	8.5/day 9.2/day 9.1/day	A < B and A < C, ($P \leq 0.01$) (9)
From day-84 to day-168 of lactation			
A. Grazing only B. A + 1.9 kg conc./cow/day C. A + 3.8 kg conc./cow/day	Pangola grass	9952/lact. 10648/lact. 11557/lact.	A < B < C ($P \leq 0.05$) (2)
Stage of lactation unknown			
A. Concentrate, 1 kg/cow/day B. Concentrate, 3 kg/cow/day C. Concentrate, 0.5 kg/liter, above 4 liters	Native grasses	7.0/day 6.0/day 5.7/day	N.S. Diff. (8)
From day-90 to day-174 of lactation			
Five levels of cassava root meal (0-2 kg/cow/day)	African Stargrass	Maximum increase (14%) obtained at 0.7 kg cassava/cow/day	N.S. Diff. (13)
From day-130 to day-230 of lactation			
Constant level of molasses (1.5 kg/cow) plus variable levels of green bananas (0-1.2 kg DM/100 kg LW/day)	African Stargrass	Maximum increase (12%) was obtained with 0.2 kg DM	N.S. diff. (26)
For 90-days at various stages of lactation			
Constant level of molasses,urea (0.5 kg/cow) plus variable levels of green bananas (0-1.2 kg DM/100 kg LW/day)	African Stargrass	Maximum increase (20%) was obtained with 0.3 kg DM	Sign. diff. ($P < 0.01$) (5)

In a recent paper (6) the results of twelve supplementation experiments with cows in mid-lactation, were tabulated (and reproduced in Table 5). As the overall average shows, response to supplementation is only 0.34 kg milk per kg supplement. This closely agrees with other results both under tropical conditions (6) as well as temperate conditions (14).

On the other hand, as was mentioned before, a few experiments have shown a significant improvement of milk production. Work in Great Britain (4) and the U.S.A. (15) have led to the concept that the key for significant increases in milk production consists of ensuring proper nutrition during the first two months of lactation, when the cow has the greatest need for nutrients. Broster and Clough (4) state a rule of thumb by which for every kg of milk that the cow fails to produce at her lactation peak, 150 kg of milk will be lost in the whole lactation. Also, McCullough (15) states that if a cow is well-fed in the beginning, any decrease of milk production (due to poor feed) at later stages can be quickly remedied by proper supplementation. This would not be true for a cow poorly fed at the initial stage of lactation.

Raising the nutritional level at the beginning of the lactation implies that the animal will consume whatever supplement she is given. However, food intake at this stage is not good enough to allow for adequate intake of nutrients (3) and there may be a need for supplementation starting before parturition in order to build up body reserves, especially if the cows are not in good body condition (10). These considerations led to the conduction of an experiment in Costa Rica (5) whose objectives were to elucidate whether or not the stage of lactation had any influence on the response to

Table 5. Results of experiments on tropical pastures showing the milk yield response to supplementation in mid-lactation (6)

COUNTRY	MEAN SUPPLEMENTATION LEVEL (KG/DAY) HIGH	LOW	PERIOD OF LACTATION (WEEKS)	MILK YIELD OF LOW LEVEL OF SUPPLEMENTATION (KG/DAY)	RESPONSE (KG MILK PER KG SUPPLEMENT)
Trinidad	2.4	0	27	6.9	0.33
	2.5	0.5	27	6.7	0.20
Brazil	3.8	0	11-23	10.0	0.42
	1.9	0	11-23	10.0	0.37
Cuba	3.6	0	10-30	9.5	0.21
	2.7	0	10-30	9.5	0.28
	11.8	0	10-30	9.5	0.31
Australia	3.8	0	17-30	8.8	0.48
	2.7	0	17-30	8.8	0.41
	1.1	0	17-30	8.8	0.64
Brazil	4.1	0	10-22	10.8	0.35
	2.2	0	10-22	10.8	0.34
Cuba	6.0	0	8-23	7.9	0.07
	3.0	0	8-35	7.9	0.27
Venezuela	2.0	1.0	>6	8.7	0.29
	3.0	1.0	>6	8.7	0.34
Brazil	3.3	0	-	8.6	0.33
Cuba	3.7	0	9-24	14.1	-0.16
Uganda	2.7	0.7	9-26	8.6	0.25
Cuba	6.9	0	14-28	7.6	0.40
	3.7	0	14-28	7.6	0.40
	3.1	0	14-28	7.6	0.66
Australia	3.0	0	-	13.6	0.37
	3.0	0	-	11.4	0.50
Average					0.34 ± 0.17

variable levels of an energy-rich supplement.

Sixty cows were grouped by the stage of lactation they were at: two-months prior calving, calving, one-month after calving, three months and five months after calving. Within each group, four levels of supplements were tested: 0, 0.3, 0.7 and 1.2 kg of bananas (dry matter basis)/100 kg LW/day. Supplementation was carried out for three months. For simplicity's sake, the results are presented in two tables (Tables 6 and 7). The first one shows that the lowest level of supplement was sufficient to cause the greatest response (across lactation stages).

Looking at the response at the various stages of lactation, when 0.3 kg bananas (DM)/100 kg LW/day is used, the following results were obtained (Table 7).

Clearly, for supplementation to be effective, it is necessary to start it one month before parturition (especially if the cow is in need of improvement of her body condition), at calving or one month after calving. As the cow enters her fifth or sixth month of lactation, the supplementation must come to a stop as it would be inneficient. Obviously, since bananas or any other tropical source of starch) is poor in protein, it is important to add a protein supplement. For Costa Rica, the recommendation is 40 g meat and bone meal and 2 g urea per 100 kg LW per day, mixed with a small amount of molasses to prevent rejections.

Coincident with the conclusions given above, Broster and Clough (4)

Table 6. Milk production of cows grazing African Stargrass, supplemented with a constant level of molasses (1 kg/head/day) and variable levels of green banana fruits (5)

LEVEL OF BANANAS KG DM/100 KG LW/DAY	AVERAGE MILK PRODUCTION KG/COW/DAY
0.0	7.7
0.3	9.2
0.7	7.9
1.2	8.0

Table 7. Milk production of cows grazing African Stargrass and receiving 1 kg molasses/head/day and 0.3 kg bananas (DM)[a]/100 kg LW/day (5)

POINT AT WHICH THE 3-MONTH SUPPLEMENTATION IS INITIATED	MILK PRODUCTION, KG/DAY	
	NO SUPPLEMENT	WITH SUPPLEMENT
1 month prior to calving	7.9	10.6
at calving	8.9	10.3
1 month after calving	8.4	10.8
3 months after calving	6.4	8.0
5 months after calving	6.8	6.2
Averages	7.7	9.2

[a] Equivalent to 1.5 kg green bananas (as-fed basis)/100 kg LW/day

recommend that supplementation should start before parturition, increasing the level as the cow reaches her lactation peak and reducing it, afterwards, until it is eliminated from the feeding program, this of course depending upon the quality of the sward (Figure 2).

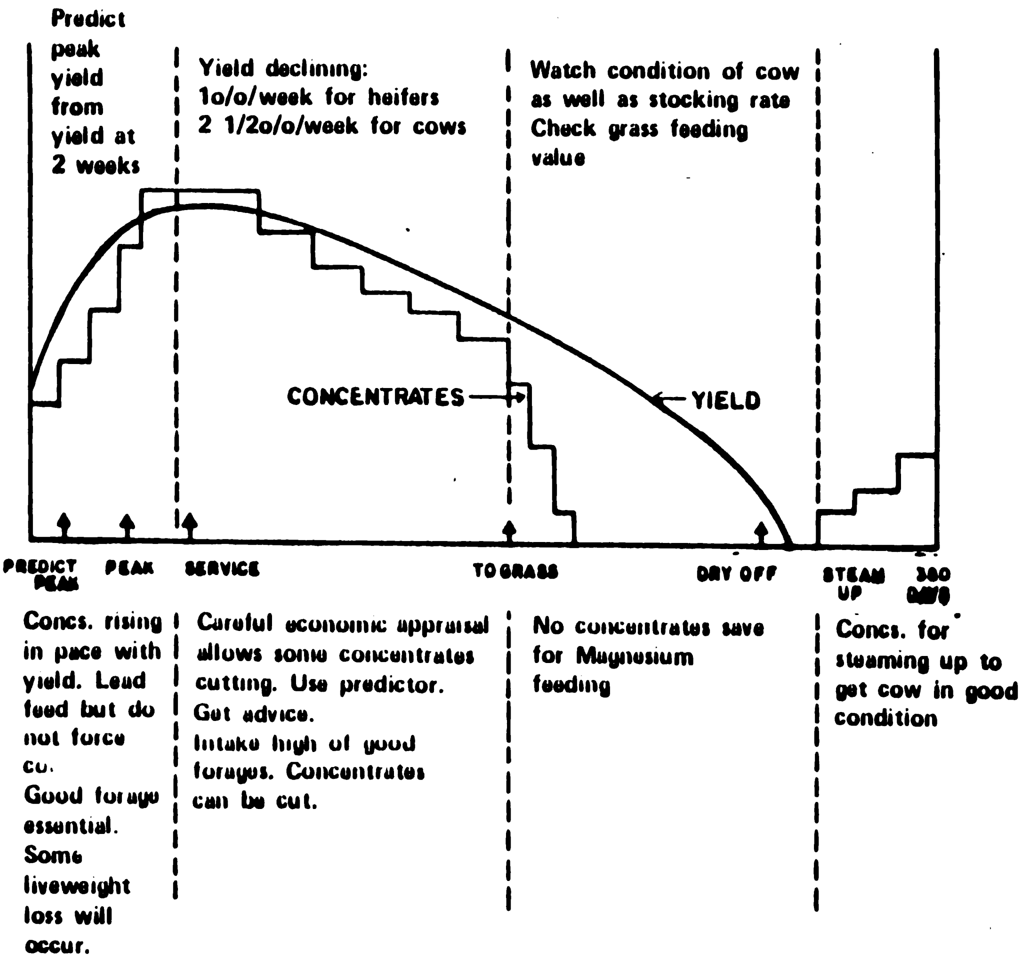

Fig. 2 Main features of a feeding program for lactating cows under grazing conditions (4).

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