THE DEVELOPMENT OF DAIRY FARMING IN THAILAND

by

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BACKGROUND

Although dairy farming in Thailand began around 80 years ago, the introduction of extensive dairy development took place in the early 1960s. It started with the establishment of the Thai Danish Farm and Training Centre (TDDF) at Muak Lek, as a joint venture between the Thai and Danish Governments. The approach was the clearing of land, purchase of cattle, construction of farm buildings, training of farmers, development of a dairy colony, provision of extension services and development of a small dairy plant, as well as a marketing system for pasteurized milk production. In 1971, the Thai Government took over responsibility and the project was organised under the management of the newly established government enterprise, under the name of “The Dairy Farming Promotion Organisation of Thailand (D.P.O.)”

The objectives of D.P.O. are to promote milk production, to process milk and to sell milk products. Several important activities have been employed by D.P.O. to promote dairy farming. These include offering crossbred heifers at cost price to newly established dairy farmers, training of people wanting to become dairy farmers, provision of extension services including artificial insemination, veterinary services, milk recording, farm management advice, a milk collection centre and the buying of milk at guaranteed prices.

Milk production in the Nong Pho area started almost at the same time as in Muak Lek, but in a different way. The farmers were already established there, with smaller pieces of land, but they were more progressive and had the assistance of the Department of Livestock Development (D.L.D.). Crossbreeding was successfully employed through the use of artificial insemination. In 1971, a cooperative dairy plant was built and the milk production, the organisation of milk processing and milk marketing have all been most impressive.

The Thai-German Dairy Training and Processing Plant in Chiang Mai was established in 1968 and operated as a joint venture until 1977, at which time it was taken over by the Department of Livestock Development (D.L.D.). Since 1979, D.P.O. has been responsible for the processing and marketing functions.

In 1982, D.P.O. started the dairy farming project in the South, which included construction of a dairy plant for UHT milk at Pranburi, Prachuab Kirikan. The purpose of the project was to reduce the area used for growing pineapples, because farmers were earning inadequate incomes due to over-supply of the product. In addition, waste from the pineapple canneries could be used as a cheap roughage for dairy cattle.

GOVERNMENT POLICIES FOR DAIRY FARMING

Current dairy policies approved by the Agricultural Policy and Planning Committee on 20th February, 1987 are as follows:

- to promote the expansion of raw milk production in order to reduce importation of dairy products,
- to increase the efficiency and quality of dairy farming, milk collection, milk processing and milk marketing,
- to strengthen dairy cooperatives as profit oriented organisations,
- to encourage the private sector to be involved in dairy development, and

- to organise an independent Milk Board with representation from all sectors of the dairy industry which would execute policy on an industry-wide basis.

The Government's plan for the development of dairying is aimed at a reduction of foreign exchange for the purchase of imported dairy products but also to provide the farmers with the opportunity to earn increased and more regular incomes and generate employment opportunities in farming, milk processing and manufacturing industries. The target is to produce 328,000 tons of raw milk by 1996, which can meet half the demand for dairy products. To achieve this, it will, for instance, be necessary to increase the number of dairy cows to 117,000, which will require a growth rate of 18% per annum (Table 1). The goal could be reached in two ways: by increasing the local supply of dairy cows through the insemination of local Brahman-cross cows and by purchasing from overseas.

THE GROWTH OF THE RAW MILK PRODUCTION FROM 1982 TO 1987

Over the past 25 years, the Government's support to dairy farming through D.P.O. and other key government departments has been successful. For instance, in the period from 1982 to 1987, the production of raw milk has increased annually by almost 24% to 79,000 tons by the end of the period. The number of dairy cattle has, over the same period, increased by approximately 20% annually to 75,500 head in 1987 (Table 2).

Ever since its establishment, the D.P.O. has, together with the Nonh Pho dairy cooperative, dominated the production and utilisation of raw milk. In 1985, D.P.O. had a share of 66% of the raw milk production, 66.8% of the dairy cattle population and 58.4% of the dairy farmers are suppliers.

Table 1. Plan target for raw milk production 1988–1996

Year	Number of cows	Raw milk Produced
1988	40,840	91,000
1989	46,680	109,000

1990	51,880	125,000
1991	59,850	147,000
1992	68,800	174,000
1993	78,660	204,000
1994	89,840	240,000
1995	102,900	281,000
1996	117,130	328,000
Average growth rate Per Annum (%)	14	18

Source: Office of Agricultural economics

Table 2. Dairy cattle numbers and raw milk production in 1982–1987

Year	**Total Female cattle (head)**	**Calves and heifers (head)**	**Dairy cows (head)**	**Milk Production**	
				tons/yr	**tons/day**
1982	30,046	16,280	13,766	27,027	74
1983	39,426	20,233	19,193	36,030	99
1984	48,489	24,639	23,850	46,197	127
1985	50,988	26,410	24,578	54,560	149
1986	69,907	36,479	33,428	69,175	190
1987	75,500	39,300	36,200	79,100	210
Average increase per year	19.87	19.82	22.22	23.87	23.87

Source : office of Agricultural Economics

DEMAND FOR RAW MILK PRODUCTION

The scope for development of the dairy industry is excellent, because the production of raw milk in 1989 is still only a fraction of the total demand. If all milk products consumed in 1986 had been made in Thailand, at least 500,000 tons of raw milk would have been required. The actual production of raw milk was 69,000 tons or 14 % of the demand.

The raw milk collected by D.P.O. and the cooperatives is processed into ready to drink (RTD) milk or sold in bulk to private dairy companies, and the latter also use the raw milk for RTD milk, which includes pasteurized milk, U.H.T. milk, canned sterilized milk, etc. In the first instance, the raw milk production could be used to meet the demand for RTD milk.

Table 3 shows how the position would be then: the production of raw milk in 1986 was 69,200 tons (14%) of the total demand, while RTD milk consumption was 81,600 tons or about 17% of the total demand. It is interesting to note, that the consumption of RTD milk went up to 126,300 tons in 1987. This increase is the result of the milk consumption promotion campaign supported by the Government and the private dairy companies.

Table 3. Raw Milk production and consumption of Ready-to-Drink Milk in 1982–1987.

Year	Raw Milk Production '000 tons	RTD milk Consumption '000 tons	Deficit of Raw milk '000 tons
1982	27.0	44.4	17.4
1983	36.0	58.4	22.4
1984	46.2	62.4	16.4
1985	54.6	66.0	11.4
1986	69.2	81.6	12.4

1987	79.1	126.3	47.4

CONSTRAINTS ON RAW MILK PRODUCTION

One constraint on the raw milk production is the high costs of some inputs required in the production, in particular concentrate feed. The percentage contribution to the total variable costs in the period January - June 1986 were: concentrates 60%, roughage 16%, disease 2%, labour 15% and others 7% (Source: office of Agricultural Economics).

Another constraint is shortage of dairy cattle: the growth in the number of local crossbreds is insufficient and imported cattle are rather expensive. The price (CIF) of imported New Zealand crossbred heifers (5–7 months pregnant), in 1987 and 1988, was 860 and 910 US dollars respectively. Early in 1989, the cost climbed further to 960 US dollars.

Ways to increase the productivity and reduce costs of production would be to:

- **improve feeding management. This would involve more use of improved grass/legume pastures, which could result in a reduction of the need for concentrates, as well as reduce the level of nitrogen fertiliser use. Furthermore, the pasture conservation could be improved and the use of by-products from crop production and/or agro-industries could be increased.**

- **improve management of the animals to improve the conception rate and reduce health problems, in particular mastitis.**

- **improve farm advisory services. The farm advisers should be familiar with progress in research and technology and should advise the farmers on the application of new**

techniques.

- **improved breeding programmes. For instance, a national progeny test scheme for locally selected bulls should be developed and thereby reduce the need for expensive overseas semen. Implementation of better breeding programmes would also result in higher milk yields.**
- **improve systems for handling excess stock (bull calves, excess female calves and cull cows). Bull calves could be raised for dairy beef production.**

COSTS OF RAW MILK PRODUCTION

Much greater emphasis must be placed on developing the required knowledge and skills to introduce and manage high quality improved pastures successfully. Farmers should understand and appreciate that there is a great deal of basic scientific evidence from many overseas countries showing that animal performance, and especially milk production, is much more dependent on the quantity and quality of feed eaten rather than on the genetic make-up of the animal. It is only when the level of feeding is high, in both quantity and quality, that the value and importance of good breeding generally becomes apparent. In other words, while dairy farmers should certainly give some attention to their breeding programme and the selection of semen, much more attention should be given to developing and improving their feed quantity and quality, particularly of their pastures which are the cheapest and most common source of feed for dairy cows in Thailand.

This view is supported by data obtained from a recent experiment at D.P.O. (Muak Lek). The cows involved were all 62.5 to 75% Holstein-Friesian or Red Dane crossbreeds in their lst, 2nd or 3rd lactation and fed different levels of concentrate according to milk production, ranging

from improved pasture only (no concentrate) to ad libitum concentrate feeding, with 10 cows on eachlevel of feeding. Detailed measurements of milk production, milk fat, animal health and pasture utilisation were made during both early and late lactation. Prior to the experiment a total of 50 cows were balanced across the five treatments, in order to ensure that there was no bias in production which might unfairly favour one treatment over another.

In this example, three comparisons were made: of cows fed improved pasture only ; of cows fed 1 kg of concentrate to 3 kg of milk (3:1) plus improved pasture; and of cows fed ad lib. concentrate plus improved pasture. It is assumed that the cows ate approximately 4 kg DM per 100 kg body weight daily, which meant that the average 350 kg liveweight cows each ate approximately 14 kg of pasture DM on the pasture only treatment, approximately 10–11 kg of pasture DM plus 3–4 kg of concentrate in the 3:1 treatment and approximately 13–15 kg of concentrate plus negligible pasture in the ad lib. concentrate treatment.

These data plus the more obvious economic parameters are presented in Table 4. It is clear that dairy farmers can achieve a highly economic return from cows fed pasture only, provided that the pasture is properly managed, leafy and hence of high quality. A production of 2,400 kg of milk can be obtained from just “average” cows and up to 3,150 kg from “good” cows, yielding an estimated “profit” of 14,400 Baht and 20,420 Baht respectively per lactation. When a relatively small input of concentrate was also fed along with improved pasture, milk production was increased and more importantly, profitability was also increased. When cows were fed to appetite on meal concentrate of 15.5% crude protein and an estimated TDN of 70%, milk production was further increased but profitability was decreased. Obviously with the present price of meal concentrate farmers will achieve greater profit by relying on improved pasture as their main source of feed for dairy cows plus a small input (3:1) of concentrate, rather than striving for higher milk production from only concentrate but at higher cost.

Table 4. Estimated returns and costs of production from "average" and "good" cows on different feeding regimes.

	"Average" Cows	"Good" Cows
Improved pasture only:		
Milk yield/cow/d kg.[1]	8.0	10.5
Total lactation kg.	2400	3150
Milk sales (Baht)[2]	16080	21105
Cost of grass (Baht)[3]	1440	1440
Profit per cow (Baht)	14400	19605
3:1 concentrate + improved pasture:		
Milk yield/cow/d kg.[1]	10	13
Total lactation kg.	3000	3900
Milk sales (Baht)[2]	20100	26130
Cost of concentrate (Baht)[4]	3300	4290
Cost of grass (Baht)[5]	1220	1220
Profit per cow (Baht)	15780	20620
Ad lib. concentrate:		
Milk yield/cow/d kg.[1]	13	17
Total lactation kg.	3900	5100
Milk sales (Baht)[6]	25740	33000
Cost of concentrate (Baht)[4]		

	12870	14850
Profit per cow (Baht)	12870	18150

[1] 300 day lactation

[2] 6.70 Bht/kg (6.50 + 0.2 for fat %)

[3] 14 kg DM/day, 0.4 Bht/kg

[4] 3.30 Bht/kg

[5] 10.5 kg DM/day, 0.4 Bht/kg

[6] 6.60 Bht/kg 6.5 + 0.1 for fat %)

CONCLUSIONS

The efforts of the Government in the development of dairy farming in Thailand have been successful. There has been a satisfactory increase in milk production and in the number of dairy cattle and dairy farmers, so that today Thai farmers produce 15% of the raw milk needs for all milk products. By 1996, they could be producing 50%. Such a rapid growth requires great investments in facilities for the farmers. For instance, it will be necessary to import dairy cattle to get enough animals and to get the right stock. Furthermore, training of farmers and good extension services are important factors, especially in making dairy farming into a good business. Serious efforts must be made to reduce the costs of milk production and, as concentrates are expensive, it would pay to look for better utilisation of pastures and fodder crops.

MILK PRODUCTION SYSTEMS BASED ON PASTURES IN THE TROPICS

by

Roberto Garcia Trujillo

THE LATIN AMERICAN REGION

The humid and semi-humid tropical areas of Latin America comprise approximately 70% of the total area of the region and are where 60% of the cattle are concentrated. Four different sub-areas exist, these are: a) native savannas, b) the “cerrados”, c)tropical humid and semi-humid forests with fertile soils and d) tropical humid and semi-humid forests with non-fertile soils.

80% of the soils in these zones are barren, especially those of the savannas and “cerrados” where improved pasture establishment requires high levels of fertilizers and soil improvement. Rainfall is a limiting factor for pasture development, due to the unequal distribution throughout the year and the fact that the dry season can last for almost seven months, except in the humid forest area. There are dairy cattle in the region (3–11 cows/100 inhabitants) but, because of the low productivity (750–1700 litres/cow/year), large amounts of milk and milk products are imported.

The present situation in the foreign market, the general economic crisis and different aspects of agricultural policy in the countries of the region are against the development of milk production and cattle production in general. These problems were exhaustively analyzed in the First Meeting of Cattle Development in Latin America and the Caribbean, sponsored by FAO in September 1988 in Montevideo. There are many different milk production systems in the region, but the non-intensive pasture systems with low milk producing cattle predominate, while the

most productive and the most intensive systems are mainly found in the high tropical areas or in production systems using mainly European breeds, where cattle remain housed or semi-housed and are fed forages, hay or silages and a high proportion of concentrates, supplemented with imported raw materials.

In Cuba, milk production is based on the utilization of pastures in the rainy season and green and preserved forages and sugar industry by-products in the dry season. Holstein dairy cows and their crossbreds with Zebu cattle are employed.

Although research on pasture production, feeds, production systems and other aspects is scarce, results are available which show that it is possible to considerably improve milk production in the tropics. The objective of this paper is to offer the results of some studies carried out in Cuba.

MILK PRODUCTION SYSTEMS BASED ON PASTURES

In the humid tropics, where rainfall is not limiting and declines to critical levels for only 2 to 4 months, milk production based on pastures is limited by the quality of pasture and the direct or indirect effects of the climate on the more productive animals. In the semi-humid tropics, the lack of rainfall during the dry period (lasting from 5 to 7 months), seriously limits pasture production and quality. Under these conditions, which prevail in the majority of the cattle breeding regions in the tropics, the development of a more productive milk production system should consider the equilibrium between the needs of the animals and feed production. The basic elements are pasture management, fertilizer use, stocking rate, forage production and supplementation, all being related to the animal potential.

Natural grasslands and their productivity

Natural or semi-natural, non-fertilized grasslands in areas with soils of low fertility allow a low stocking rate which, in general, does not exceed 1 cow/ha and is frequently about 0.5 to 0.8 cattle units per ha. Milk production recorded in the sub-humid area does not exceed 4 kg milk/cow/day and 300 kg of milk ha/year when Zebu cattle are used, as in the case of the western plains of Venezuela (Capriles, 1982), or from 5 to 7 kg milk cow/day and 1600 kg milk/ha/year when crossbreds are used and the animals are fed medium to low quality forage in the dry season, as reported by Blydestein et al. (1969) in Costa Rica or in certain dairy areas of the eastern provinces of Cuba (Table 1). In general, these herds are characterized by short lactations, poor calving rates and low percentages of cows in milk.

The low milk production of the animals in the grazing system with natural or semi-natural pastures is not only a consequence of this, but of the poor resources, operations and techniques with which these animals are managed and where supplementary feeds play an important role in their survival on account of the poor pasture quality or amount.

Under these conditions, legumes could be one of the most economic ways to improve the production level of these herds. In this sense, Monzote et al., (1985), with the introduction of Glycine into natural pasture in areas of low rainfall (800 mm/year), found an increase in milk production from 1041 to 1684 kg/lactation, compared to cows on natural pasture. In the rainy season, the association produced from 3 to 5 kg of milk/cow/day more than with natural pasture although, during the severe months of the dry season, this difference was only 0.3 to 1.2 kg of milk/cow/day.

Another alternative under these conditions could be the use of forage areas of sugar cane as a supplement during the dry season.

Table 1. Milk production results under different grazing systems in the tropics.

Pastures	Area	Irrigation	Fertilization kg/ha/year	Supplementation		Breed	Stocking rate	Milk production kg	
				Forage	Concentrate			Lactation	ha/yea
Bative	SH	none savannah	none	low	none	Zebu	0.5–0.8	240–350	120–300
NP+legume association	SH	none	P and K	low	none	xbred	1	1650	990
Native	SH	none	poor	moderate	low	xbred	1–1.8	1300	1600
Semi-natural	H	none	none	none	low	xbred	1	1800	1600
Improved	SH	none	moderate	high	low	xbred	2.5–3.3	1700–2500	5300–7300
Improved	SH	yes	high	none	none-low	xbred	2.7–4.5	2000–2400	6000–9000
Improved	SH	yes	high	low	none-mod-erate	Holstein	2.0–4.0	3000–4200	8500–14000
Improved	H	yes	high	low	low	xbred	4.0–6.5	2300–2700	7600–14000
Improved+legume	SH	none	low-medium	medium	none-low	xbred	1–1.5	2100–3200	2700–3800
Improved+legume	SH	yes	low-medium	none	none-low	European	1–1.5	3300–4200	4500–6000
Improved+tree legume	SH	none	medium	high	low	xbred	2.5–2.7	2500–3200	6000–9600
Improved+tree legume	SH	yes	high	low	medium	Holstein	2.5–3.0	3900–4300	7000–10500

Improved	SH	yes	high	medium	high	Holstein	4–5	4400–4600	17000

SH - Semi-humid H - humid Fertilization: low 50–80, medium 130–180, high 240–350

Concentrate kg/cow/day low: less than 2 medium: 2–3 high: more than 3

Improved pastures

The utilization of improved pastures and fertilizers markedly increases stocking rate capacity, milk production per ha and individual yield, especially when breeds and crossbreds of medium to high milk potential are used.

In general, stocking rate is increased to 2.2–4.5 cows/ha in the sub-humid regions according to the type of pasture and the level of fertilizer. Milk production/cow is increased to 6–8.5 kg/cow/day and up to 2500 kg/lactation with crossbred animals and from 10 to 14 kg of milk/cow/day (3000–4000 kg/lactation) with European breeds. Milk production/ha could reach or exceed 12000 kg/ha/year (see Table 1).

In the humid regions, the stocking rate of the grassland could reach 6.5 cows/ha with 14000 kg of milk/ha/year and 8.5 to 9 kg/cow/day, as demonstrated in some areas of the region (Cubillos et al. 1975, Muñoz et al. 1988b).

The effectiveness of the systems based on improved pastures depends on the equilibrium between pasture selection, the level of fertilizer use and stocking rate. An imbalance in this sense could ruin the system and the stocking rate is a decisive factor in the productivity of dairy herds. Different trials have demonstrated that, when medium potential animals are used,

the production per hectare can be employed as an indicator of productivity but when high potential cows are used and a higher production per hectare is obtained, the potential of the animals is only exploited to the extent of 50 to 60% (Figure 1), provoking a negative effect on reproduction and animal health.

The level of stocking rate and N fertilization are closely related. Our results show that from 50 to 100 kg N/ha/year, according to the stocking rate and system employed, are needed for soils of medium to low fertility per cow. A reduction in stocking rate, under Cuban conditions, has markedly improved individual milk production, without affecting milk production per ha, fertility, survival and health (Table 2).

The most productive pastures found are coastal bermuda grass with low stocking rates (2 to 2.5 cow/ha), common guinea grass and likoni for medium stocking rates and star grass with high stocking rates (4 to 5 cows/ha). Coastal bermuda grass requires a high level of fertilizer, irrigation in the dry season and careful management. Also,short grazing rotations in the rainy season (12 to 18 days), together with night grazing, allow ample selection, availability of pastures (50 kg DM/cow/day) and good milk production in European breeds. In the dry season, overgrazing should be avoided by restricting grazing time (3 to 4 hours/day) or housing some of the animals.

Figure 1. The effect of stocking rate and the type of pasture on milk production per cow and per hectare (from Pérez Infante, 1971 and others in Cuba).

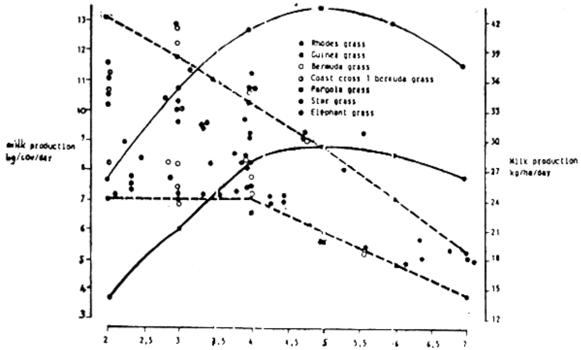


Table 2. Stocking rate (SR) reduction and performance of various dairy herds in Havana Province (Martinez, 1980; Salinas, 1988, unpublished).

	SR cows/ha	Improved pasture %	Milk/cow	Yield (kg)/hectare	Fodder supplement DM/cow/d	Animal losses %	Birth rate %
Case A: Three dairy units							
Unit A	2.84	33	1082	3078	4.2	3	58
Unit B[1]	2.26	38	1650	3741	3.8	6	67
Unit C	2.24	73	2102	4624	2.2	4	76
Case B: Dairy enterprise (15000 cows) then reduce stocking rate							
Previous	2.9	-	2428	7043	-	11	68
After	2.5	-	2662	7037	-	9	72
Case C: Dairy district (3800 cows) then reduce stocking rate							
Previous	3.3	-	2203	7279	6.4	13.8	-
After	2.2	-	2844	7580	4.4	10.0	-

[1] **Stocking rate reduced one year previously.**

FORAGE PRODUCTION

In the sub-humid tropics, large amounts of forage are used daily to make up for pasture deficiency in the dry season. In Cuba, various alternatives have been studied and used to this end. They can be classified as follows:

I. **Sowing areas of forage with irrigation so as to produce silage in the rainy season and green forage in the dry season.**
II. **Conserving pasture surplus in the rainy season to produce silage and hay supplies for the dry season.**
III. **Sowing forage areas with sugar cane which is harvested 12 months later during the dry season.**
IV. **Utilization of coarse by-products of the sugar industry (bagasse -molasses-urea, pre-digested bagasse).**

The main forage used in Cuba is king grass, which under production conditions, yields from 97 to 130 t/ha/year when fertilizer (300 to 350 N kg/ha) and irrigation in the dry period are used. The application of manure (25 to 30 t/ha/year) favours forage stability, decreases the need for N fertilizer (100 to 150 kg H/ha/year) and the use of P and K. Because this forage has a low DM content (18%) when it has a good nutritive value (from 10 to 11% CP), it is necessary to pre-wilt it so as to obtain a good quality silage.

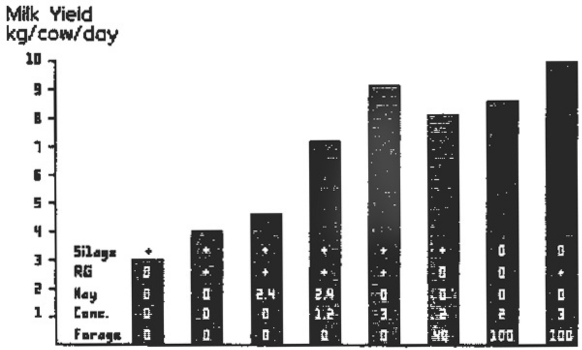
Star grass and guinea grass are also used as the main forage with good yields and supplementary forages such as sorghum and sunflower are used as pure crops or are

intercropped with pastures, new sowings or forage areas during the dry period.

In general, green forage is not used as the sole source of roughage in the dry season, except for some high producing herds or high producing groups of cows and when there is great availability, being employed as a supplement to silage diets and sugar cane (30% green forage: 70 % sugar cane or silage) (Esperance and Perdomo, 1978, Muñoz et al., 1988a).

Medium quality silages, which are more abundant in commercial units, when supplied together with grazing on non-irrigated pastures, produce from 3 to 5 kg of milk/cow/day, but the animals lose weight and have short lactations. In order to obtain an average of 8 kg of milk, supplementation of 1.2–2kg of concentrate is required with the addition of 3–40% of total roughage as green forage. Above this level of supplementation, a response of 1.5 kg of milk/kg of concentrate could be expected (Gutierrez et al., 1988) (Figure 2).

Figure 2. Milk production from tropical silage or forage of medium quality (adapted from Gutierrez et al., 1988).



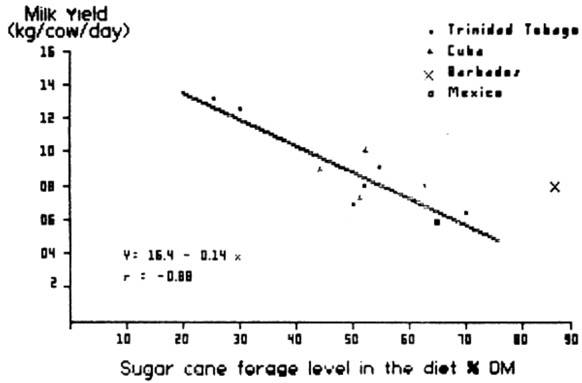
Milk production under non-irrigated conditions with animals fed silages is strongly related to the DM percentage of the silage and its consumption, an increase of 0.3 kg of milk and 0.37 kg of DM consumed per percentage unit increase in dry matter being reported.

Another difficulty with tropical silages is the loss of nutrients and materials produced during silage processing, when silages are not made with adequate techniques. Low capacity silos with long cut forage and high humidity could lose almost 60% of the material. However, when high DM and finely cut forages are used and the material is placed in adequate places or bunker silos, the losses could be diminished to 15% at the most.

Sugar cane is characterized by its high yields (up to 170 t fresh matter/ha with low N fertilization (100 to 150 kg N/ha/year) and is harvested during the dry period, thus there are no conservation expenses. Although used as forage, low consumptions are observed, particularly when it is not adequately mixed with other forage feeds and supplemented with NPN and minerals. When using sugar cane for animal diets, the material should be finely cut and 1% urea (Perez Infante and Garcia Vila, 1975), 0.12 to 0.15% sulphur (Ruiz, 1979) should be added and also it should be combined with 30% forages, pastures or both (Muñoz et al., 1988a), and the necessary concentrate supplementation to cover the animal requirements.

Experiments carried out in the Caribbean area (Garcia and Neckles, 1983; Perez Infante, 1975; Garcia Trujillo et al., 1981 unpublished; Senra et al., 1988 unpublished) show that as the percentage of sugar cane in the DM of the ration is increased, milk production decreases by approximately 1.46 kg milk for each 10% of sugar cane inclusion, yielding from 7 to 10 kg of milk/cow/day when 50% of sugar cane is added. This indicates that feeding factors and the animal potential could vary the response (Figure 3).

Figure 3. Sugar cane forage level in the diet and milk yield.



The sugar cane industry produces various fibrous by-products for animal feeding. The most widely used in Cuba is bagasse, pre-digested with 2–3% sodium hydroxide, to which 15% molasses and 10% urea are added, and which finally contains 8.37 MJ ME/kg DM and from 11 to 12% CP. This feed is used as forage in the dry season and consumed at a rate of 6–7 kg/cow/day.

At Indio Hatuey Branch Station, a comparison between the forage systems I, II and III (see above), crossbred (3/4 Holstein, 1/4 Zebu) cows on pasture without irrigation for 3 years showed higher milk production per lactation than on the sugar cane system (2565 vs 2427 kg), but the sugar cane system produced higher fertility (80 vs 67–72% cows pregnant per year), lower cullings (11 vs 22–25%) and thus the milk production/ha was higher (7704 vs 6640 kg) (Table 3).

In a later study where systems II and III included a protein supplement and stocking rate decreased to 2.5 cows/ha, milk yield per lactation was increased by 150 and 424 kg for the conservation and sugar cane systems, respectively. Protein supplementation resulted in calving intervals of 393 days on the sugar cane system and reduced both the use of concentrates and the cost of production in 10%.

The comparison of system I, III and IV with Holstein cows at ICA showed a higher milk production per cow on the silage system than on the sugar cane or bagasse pith systems (3553 vs 3100 kg/lactation and birth rate (87 vs 83%), but the production cost was slightly higher (0.22 vs 0.20 Cuban pesos/kg of milk).

SUPPLEMENTATION

Commercial concentrate supplementation is practised in dairy units using medium to high potential cows. The response to concentrates obtained, in terms of milk production, ranges from 0.2 to

Table 3. Comparison of three milk production systems (Garcia Trujillo, 1981, unpublished).

	With conservation areas	**King Grass forage areas**	**Sugar Cane forage areas**
Milk production			
kg/lactation	2537	2594	2427
kg/cow/year	2219	2209	2348
kg/hectare	6657	6727	7044
Fertility			
cows pregnant/year	67	72	80

%			
Culled cows %			
reproductive problems	14	22	11
total	22	25	11
Feeding cost			
(pesos/kg milk)	0.088	0.084	0.083

2.3 kg of milk/kg concentrate. This response mainly depends on the differential between the production potential of the basic diet and the cow's potential (Garcia Trujillo, 1988). Our experience recommends the use of limited amounts of the available concentrates 21 days before calving and in cows producing more than 12 kg of milk per day, although if basic diets of poor quality are used, economic responses to supplementation can be obtained but foreign currency will be wasted.

Legumes are the main crops available for total or partial substitution of concentrates in diets for dairy cows. Pereiro (1985) demonstrated, in a series of experiments, that with 30–38% of the total area in Glycine wightii with fertilized and irrigated coastal bermuda grass, irrigated in the dry season and grazed daily or on alternate days (3 hr daily), with 3.8 kg concentrate/cow/day, production of 13 kg milk with 2.8 cow/ha was achieved. Milk productions from 12 to 14 kg/cow/day were also obtained when Glycine was used as a protein supplement given to cows consuming diets of forage, silage and hay.

In the Institute of Animal Science in Cuba, Leucaena and Glycine have been used with 3.2 and 2.7 cows/ha respectively, with a 50% reduction in the concentrates needed to produce approximately 14 kg of milk/cow/day. Furthermore, good quality milk, a high calving rate (86%) and no health problems were observed in these cows.

Other alternative supplements have been developed using sugar cane by-products and sugar cane (Table 4). Muñoz (1982) worked with nitrogenous activator supplements (NAS) formed by filter cake mud (45%), molasses (40%), urea (11%) and minerals (4%), supplied to a dairy herd consuming fertilized pasture in the rainy season and non-irrigated pasture plus silage in the dry season, and produced 10.3 kg milk/cow/day with a calving rate of 83%. NAS increased the digestibility and consumption of low and medium quality basic diets.

Table 4. Some supplements produced from by-products of sugar cane industries or sugar cane.

Products	**Formulas %**					
	1	**2**	**3**	**4**	**5**(NAS)	**6**
Saccharina	90	70	-	-	-	-
Sun-dried sugar cane	-	-	50	-	-	-
Dried Filter Mud	-	-	-	30	40	-
Molasses	5–6	5–	15	15	35	69
Cereals	-	10	20	41	-	21
Proteins	-	10	10	10	0–10	4
Urea	0–1	0–1	1	1	10	3
Minerals	4	3	4	3	5	3

NAS: Nitrogen activated supplement Supply: 350 g/kg milk Except NAS (1.5–2.5 kg cow)

Sugar cane dehydrated in the sun (50%) or dry filter cake mud (30%) have been used at ICA to produce supplements where the remaining components were molasses, cereals and minerals. These supplements are supplied at a rate of 300 g per kg of milk and allowed the production of 9 to 10 kg of milk during the dry season. More recently, a new product obtained from clean

sugar cane, without leaves, enriched with protein, has been obtained by an aerobic fermentation process. This new product was developed by Dr. Arabel Elias at our Institute of Animal Science and has been named “Saccharina”. Saccharina can have between 9 to 11% of CP and approximately 10.4 MJ ME/kg DM for ruminants. It is used to supplement all animal species and from 10 to 12 kg of milk per cow per day have been obtained in dairy cows supplemented with this product.

CONCLUSIONS

In the system based on pastures, stocking rate adjustment is of vital importance so as to have a stable and productive system. 90% of the animal potential should be obtained from pastures and supplements. Stocking rates should also be adjusted to avoid surplus forage supply during the rainy period and the surplus conserved for the other months. Pasture availability of 50 kg DM/cow/day should allow the exploitation of the most productive pastures.

In the semi-humid areas of the tropics, the production of forages to cover pasture deficiency in the dry season is necessary. There are various options and one of them is to use sugar cane for crossbred cattle in small units. In large units or with cattle with a higher potential, silages and green forages should give better results, if these are of good quality.

Legumes are essential components of any system of dairying. The grass-legume pastures are better with low stocking rates, while with medium and highly stocking rates, forage legumes are preferred. Legumes save concentrates and fertilizers and improve the productive performance and health of the herd.

Commercial concentrates are very expensive thus these must only be used in those animals with the required physiological status (European breeds, end of the pregnancy, beginning of

lactation).

Low producing crossbred cattle (10 kg milk/cow/day) can be fed with by-products obtained from sugar cane.

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DAIRY PRODUCTION IN THE SEMI-ARID RANGELANDS OF WEST AFRICA

by

Modibo Traoré

INTRODUCTION

The semi-arid zone of West Africa covers nearly 1.5 million km^2 between the arid Sahara desert in the north and the Sudanese savannah in the south. It includes a small fringe of the Sahel and a larger Sahelo-Sudanese area in the south. There are two main seasons a year: a short (3–5 mo.) rainy season starting in June and a longer (7–9 mo.) dry season. Annual rainfall varies from 500 mm in the north to 900– 1000 mm in the Sahelo-Sudanese south.

THE ENVIRONMENT

The soils are generally sandy and of windblown origin in the north. Their organic matter content is low. On the rocky outcrops and on the laterite crusts, one finds shallow skeleton soils, rich in major minerals. The dunes, the rocky outcrops and the laterite crusts constitute the higher areas, whereas the valleys with clay-loam soils form the lower parts. Slopes of varying degrees, with intermediate soils, make the transition between the two types. The rainwater runs in streams down from the heights to the valleys where it sometimes forms temporary lakes. The intensity of run-off varies with the topography and the texture of the soil, but in general only 75% of precipitation penetrates the soil (Penning de Vries and Djiteye, 1982).

VEGETATION

Two principal types of vegetation are found in the region. The northern part (Sahel) is the area of steppe and shrubland, made up essentially of annual grasses and woody plants of the genera Acacia, Balanites, Zizipus, etc. In the south, savannah replaces the steppe; the grass canopy improves with the appearance of tall perennial grasses. The woody vegetation become more and more divers and dense as one goes south.

The steppe is an open formation. The rate of recovery of the herbaceous stratum is poor; the xerophytic character of the grasses is very pronounced: short growing season grasses with narrow leaves in circles or basal rosettes. Depending on the density of the different elements, the steppe takes the form of trees, shrubland or grassland. The spatial distribution of these different forms is a function of the nature of the soil and of the topography. The sand dunes, with poor water holding capacity, and the slopes rarely have woody plants but the herbaceous stratum, made up of annual grasses, is well developed.

The most common species are Cenchrus biflorus, Schoenefeldia gracilis, Elionorus elegans, Borreria spp., etc. The importance of the herbaceous stratum is a function of the development of the trees and shrubs. The perennial grasses with longer growing seasons which appear include Andropogon gayanus and Diheteropogon hagerupii. The transition zone between a dune area and an adjacent valley is generally formed by a compacted soil, impermeable and unsuitable for the establishment of vegetation. The last type is found locally between the dunes and valleys, separated by bare strips where only a few species with very short cycles (Zornia, Dactyloctanium) are still able to survive. The poor nature of the soil and the irregular rainfall impose an important restriction on production.

Penning de Vries and Djiteye (1982) estimate the total herbaceous biomass production of this region as 1000–2000 kg dry matter per hectare. Although the energy value of this biomass is satisfactorily maintained up to the middle of the dry season, it must be emphasized that the nitrogen content becomes insufficient from the end of the rainy season, with the flowering of the grasses. The contribution of edible material from the forage trees in this period (leaves, flowers and pods) partially compensates for the poor quality of the herbaceous biomass. Nevertheless, many areas remain unexploitable because of the lack of water.

Like the steppe, the savannah can take various forms: grassy savannah, shrubby, woody and

forested. The dominant species in the southern part of the semi-arid zone are the annual grasses with long cycles: (Pennisetum pedicellatum, Andropogon pseudapricus, Diheteropogon hagerupii) and the perennial grass Andropogon gayanus. The biomass production of the grass canopy reaches an average of 3.5 tonnes per hectare. The extent of this production explains why this zone can burn each year during the dry season. The bush fires destroy the reserves of dry grass, reduce the seeds and modify the form of the trees. As a general rule, the areas in the north part are of better quality than those of the south, where in addition, the tsetse fly appears in the region of the 14th parallel.

The semi-arid zone of West Africa is crossed by two of the major rivers of the continent: the Niger and the Senegal. Along the route, these rivers overflow their banks and flood entire regions in which important aquatic grasslands develop. In the Echinochloa stagnina flood plains of the central delta of the Niger, biomass production can reach 6–17 tonnes per hectare (Boudet, 1975).

The stocking capacity of the pastures of the semi-arid zone is strongly related to the rainfall (northern part) and the pattern of fires (southern part). Boudet (1975) calculated it at 50–60 kg/ha/year in the steppe and 80 kg on average in the savannas.

Furthermore, the state of the areas of the semi-arid zone is subject to major variations. If during the rainy period (3–5 months/year) the animals have at their disposal relatively abundant and good quality forage, the situation rapidly reverses in the dry season; in the north, pastures which are still of acceptable quality have to be abandoned through lack of water, just as in the south, a great part of the biomass is wiped out by the fires.

THE SYSTEMS OF PRODUCTION AND THEIR CONSTRAINTS

The semi-arid zone of Africa supports 60 to 70% of the national cattle populations of the countries concerned. Except for some establishments of an experimental nature (state ranches, pilot farms, etc.), livestock management is conducted according to traditional systems. Two main systems of production can be identified:

The pastoral system

This system is found in the northern part of the zone where the irregularity of the rains prevents the establishment of crops. The principal product is milk and the main function of the cattle is to more or less provide for human subsistence. The pastoral system is characterized by temporal and spatial mobility. The periodic migrations here take the form of nomadism between water holes in the dry season. The livestock involved are relatively few (less than 10% in Mali).

The herds are composed of cattle, small ruminants (notably goats) and camels, all contributing to milk production. In addition, the small ruminants provide meat to the herders and the camels are used for transport. Crops (mainly milo) provide important complementary foods; the herders obtain this in exchange for cattle or milk from the settled population. The level of commercialisation of the cattle is minimal, but occasionally two or three old bullocks or infertile cows can be sold in order to meet tax obligations or for the purchase of consumable goods. As well as their economic functions, the livestock dominate all aspects of social life.

Jahnke (1984) identified three fundamental principles of herd management in the pastoral system:

- **adaptation to the natural environment: the availability of water and the quality of pastures determines the migration of the total or part of the herd over distances and times in** different years. The overall size of the herds and the distribution of species have the objective of guaranteeing regular provision of milk by the best utilization of available vegetation;

- the prevention of risks: the animals are divided up into different groups in order to divide the risks of disease and to adapt to the requirements for distant pastures in case of prolonged drought. The tendency for the herders to increase numbers and keep old females is also part of this same strategy.

- adaptation to the institutional environment, characterized by a method of collective responsibility for pastures; increasing production by increasing numbers results from collective exploitation of pastures.

The productivity of livestock in the pastoral system is low (see Table 1), varying from one region to the other and between years. Camels and small ruminants are 1.5–2 times more productive than the cattle; but, on average, the annual productivity of the area varies from 26.2–31.4 kg/ha for milk and 2.6–3.1 kg/ha for meat (Jahnke, 1984).

Since the drought which started in the 1970s, there has been a major disturbance of the pastoral system. Faced with environmental degradation, an effort to adapt has resulted in certain cases in the settlement of some of the herders around permanent waterholes. At the same time, the distances involved in transhumance have been extended for the others. The proportion of cattle has been reduced in favour of small ruminants and camels, but overall, the equilibrium between present numbers and available forage resources remains precarious.

Table 1. The productivity of livestock in the pastoral production systems of tropical Africa.

Production	Cattle	Camels	Sheep & goats	Mixed herds

Milk				
kg/head	66	248	22	-
kg/livestock unit	95	248	220	161
Meat				
kg/head	9.6	7.4	3.5	-
kg/livestock unit	13.7	7.4	34.5	16.3

The agropastoral systems

These are the systems in which livestock production is practised in association with agriculture. This association may be close and complex, or livestock and crop production may, on the contrary, be parallel activities in their own right and can even belong to different management units. In this case, the association comes down to geographical proximity. Two principal sub-systems of management can be distinguished according to the nature of cultivation practised: rain-fed farming (mainly milo) and irrigated farming (rice).

In the rain-fed mixed farming system, a minimum of agricultural activity is carried out near to the dwellings, to provide crops for family consumption. The milk also contributes to the food supply but may also obtain some (variable) income for the farmer. Within the same production unit, the livestock can provide the means of production as animal power and manure. They generally benefit from the crop residues and, more rarely, from agro-industrial by-products whose distribution is limited to draught animals.

Competition exists, however, between the two activities in the use of land; it is accepted that it is the crops and not the livestock which provide the principal basis for subsistence. The latter do not usually benefit from the right to graze during the cropping period. The migration of zebu

herds towards the north occurs regularly and is sometimes seen as inevitable. At the southern limit of the region where the trypano-tolerant animals are found, this transhumance is not generally practised.

The irrigated mixed farming system applies to the central delta of the Niger and of the Senegal. The income derived from livestock rearing is relatively limited. Transhumance takes place, as a rule, in the rainy season towards the Sahel, but a milking herd of females remains permanently near the dwellings to provide milk. It is in the dry period, after the wetland grazing and crop residues have been used up, that the greater part of the herd descends towards the semi-humid zone to the south in search of pasture.

The existence of belts of traditional dairies around the big towns of the semi-arid zone is well known. With the growth in demand for milk and the progressive transfer of animals from the hands of the traditional herders to the new breeders (businessmen, civil servants, etc.), a rapid evolution is taking place among these establishments. Production of milk for the market and the high demand for rentable land are profoundly modifying the feeding techniques. There is an increased tendency to keep exotic breeds with higher potential and massive utilization of agro-industrial by-products takes place.

The productivity of livestock in the agro-pastoral systems varies greatly from one region to the other. As a general rule, however, it remains low, but output is still higher than that of the pastoral system. In all situations, it appears that the genetic potential of the animals is not achieved in the traditional system. The production of milk and meat is clearly inferior to that obtained from the same animals placed in controlled management conditions with improved nutrition and health.

With the drought of the last two decades, the evolution of agro-pastoral systems has not

favoured livestock production; the wetlands have been transformed into rice paddies and entire regions that were traditionally devoted to pasture have been put into crops. The weakening of the traditional policies for utilizing the resources and the absence of pastoral codes in the different countries has led to poorer and poorer management of pastures, notably around the towns and in the flood areas.

STRATEGIES FOR IMPROVING PRODUCTION

The improvement of feeding systems aimed at increasing dairy production in the zone should be based on:

1. **In the pastoral system of the northern area:**

    - **a proper balance between the stocking rate and the carrying capacity of the pastures;**
    - **a rangeland water development policy that respects requirements for rational rangeland management;**
    - **improving impoverished rangelands by restoring vegetation where it has died out and by enriching cover with, for instance, legume crops;**
    - **controlling major epidemic diseases to overcome the herders' obsession with disaster and pave the way for new attitudes in favour of smaller, more productive herds.**

2. **In agropastoral systems and peri-urban dairying:**

    - **the preparation of pastoral codes that describe grazing rights in order to curtail agricultural encroachment and allow for better resource management;**

- **closer integration of agriculture and livestock production through the introduction of fodder crops, such as cowpea, or the application of more fertilizer (including manure) to increase crop yields and, consequently, crop residues that can be fed to animals;**

- **better use of locally available agro-industrial by-products (bran, polishings, molasses as urea-molasses blocks, etc.) through the preparation of supplements formulated to meet the needs of the animals and adapted to rangeland conditions;**

- **gradual intensification in peri-urban livestock development projects to meet market needs. More importance should be given to experiments and the development of fodder crops as such, wherever conditions allow.**

Any improvement aimed at increasing dairy production should consider the sociological aspect, which is closely related to livestock in this region. Some solutions have been proposed here to increase the milk production in the different production systems.

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FEEDING SYSTEMS AND PROBLEMS IN THE INDO-GANGES PLAIN: CASE STUDY

by

V.C. Badve

India has the largest bovine population in the world, with 191 million cattle and 69 million buffaloes, of which 80–85% of animals are nondescript. The numbers of milch animals are 50.7 million cattle and 28.3 millions buffaloes (Livestock Census, 1982). The National Commission on Agriculture, in its report in 1976, mentioned an annual milk yield of 157 kg and 504 kg from cows and buffaloes respectively. The low productivity of Indian animals is attributed to inadequate availability of feeds and fodders. The annual requirement of feeds and fodder are estimated to be 25.4 million tonnes concentrates, 353.0 million tonnes dry fodder and 308.1 million tonnes green fodder. However, only 16.5 million tonnes concentrates, 300.5 million tonnes straw and 261.0 million tonnes green fodder are available. The gap between availability and requirement of feedstuffs is wide, resulting in a large scale shortage. The occurrence of drought and flood has become a constant feature in most parts of the country. This creates serious problems with respect to livestock feeds.

In spite of all these problems, milk production in the country is showing an increasing trend.

Currently, milk is the second most important agricultural commodity after rice. A decade ago milk production was hardly 30 million tonnes, while it reached 43.9 million tonnes in 1986–87. It is expected to exceed 50 million tonnes by 1990. The target set for 2000 AD is 65 million tonnes (Tables 1 and 2) (Chatterjee and Acharya, 1987). The increase in production is due to a massive cross-breeding programme, especially in cattle, and the use of improved quality feed and fodder. The population of crossbred cattle is estimated to be 12–13 millions, of which more than half would be breeding females with 1800–2400 kg milk production per lactation.

CURRENT PATTERN OF UTILIZATION OF FEED RESOURCES

Crop residues

Crop residues and other cellulosic materials are staple feeds for dairy animals in India. The most abundant residues are cereal straws, sugarcane tops, sugarcane bagasse, pulse straws, millet straws, etc. According to Singh and Rangnekar (1986), the availability of dry fodder/straw from grain and groundnut crops is estimated to be 302.39 million tonnes (Table 3). These feeds are unable to meet the maintenance requirement of animals because of the low digestibility, influenced by high fibre, lignin and silica content.

Table 1. Trends in milk production, per capita availability, processing and milch animal population since 1951 and projected to 2000 AD.

YEAR	HUMAN POPULATION (IN MILLIONS)	MILCH ANIMALS PRODUCTION (IN MILLIONS)		MILK PRODUCTION (MILLION TONNES)	PER CAPITA AVAILABILITY (GRAM /DAY)
		COW	BUFFALOES		
1951	361	46.37	21.01	17.4	132
1961	439	51.01	24.24	20.4	127

1971–72	546	53.41	28.61	22.5	112
1981–82	685	54.37	28.65	34.5	136
1983–84	720	-	-	37.1	141
1985–86	751	55.45	33.07	42.3	154
1986–87	766	-	-	43.9	157
1989–90 (Projected)	812	-	-	51.0	172
2000 AD (Projected)	986	51.25	30.59	65.0	180

Source: Dairy India (1987).

Table 2. Trends in milk production by region in Sixth and Seventh plans (production in million tonnes)

Region		1984–85		1986–87 Anticipated achievement	1987–88	1989–90	
		Target	**Achieved**		**Target**	**Target (%)**	
1.	Northern Region	18.17	17.77	19.53	20.56	22.96	(44.8)
2.	Central and Eastern Region	7.69	8.43	9.42	9.79	11.27	(22.0)
3.	Western Region	4.73	5.48	5.73	5.94	6.23	(12.16)
4.	Southern Region	7.61	8.49	9.22	9.64	10.79	(21.04)
Total		38.20	40.17	43.90	45.93	51.25	(100)

Source: Dairy India (1987).

Regions referred to in Table 2.

Northern Region:	Harayana, Himachal Pradesh, Jammu and Kashmir, Punjab, Rajastan and Uttar Pradesh.
Central and Eastern Region:	Arunachal Pradesh, Meghalaya, Sikkim, Mizoram, Nagaland, Madhya Pradesh, Bihar, Orissa, West Bengal, Assam, Manipur, Tripura.
Western Region:	Goa, Gujarath and Maharashtra.
Southern Region:	Andhra Pradesh, Karnataka, Kerala, Pondicherry, Tamilnadu, Andaman and Nicobar.

Table 3. Estimated availability of dry fodders/straw from grain and groundnut crops in India in the year 1983–84.

Crops	Area million ha.	Production million tonnes	Ratio Grain/straw	Estimated dry fodder, million tonnes
Paddy	40.99	89.57	1:1.5	134.35
Wheat	24.39	45.14	1:1.5	67.71
Sorghum	16.26	11.93	1:3	35.79
Pearl millet	11.81	7.62	1:3	22.86
Finger millet	2.60	2.99	1:3	8.97
Small millet	3.61	1.71	1:3	5.13
Maize	5.88	7.92	1:2	15.84
Barley	1.37	1.78	1:1	1.78
Pulses	23.41	12.65	1:0.5	6.32
Groundnut	7.64	7.28	1:0.5	3.64

Total	302.39

Source:- Singh & Rangnekar (1986).

As feed supplies to the animals are closely tied to the local cropping pattern, variation in feeding regimes are observed from region to region. In the Northern part of the country, wheat straw (bhusa) is more intensively utilised, while feeding paddy straw is common in Eastern and Southern regions and part of the Western region, particularly in coastal areas. Sorghum stovers are fed in the Central and Western regions and in parts of the Southern region. Feeding millet and pulse straw is also observed in certain localities.

In sugarcane growing areas of the country (part of Uttar Pradesh, Maharashtra and Gujarat), sugarcane tops are extensively fed to dairy animals during the harvesting season from October to May. During the summer months, they constitute the bulk of green materiaL available to animals in these regions. A survey was conducted with farmers of different size categories and in three different seasons in three villages from Western Maharashtra which showed seasonal variation in the feeding of cane tops (Table 4). Maximum use of cane tops (up to 52% of total dry matter) was observed with small farmers in the summer season (Thole et al., 1988).

Table 4. Seasonal changes in forage availability (%) in different farmer categories (dry basis)

Farm size	**Large**			**Average**			**Small**		
Season	**Summer**	**Rainy**	**Winter**	**Summer**	**Rainy**	**Winter**	**Summer**	**Rainy**	**Winter**
MAIZE	4	7	1	19	19	6	14	1	0
SORGHUM	7	21	9	15	41	23	7	36	6
CANE TOPS	21	9	17	31	9	33	52	11	34
LUCERNE	17	15	11	21	15	10	4	4	2
GRASS	7	13	11	2	3	2	2	16	11

GRASS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DRY	13	15	8	8	8	8	19	30	44

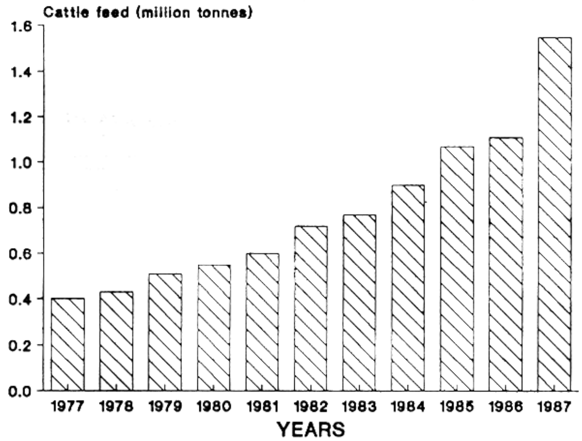
Source: Thole et al., (1988).

Feeding concentrates

The use of agro-Industrial by-products, either as individual concentrates or as a part of balanced concentrate mixture, is a widely observed practice all over the country. In places, farmers mix by-products with conventional feed ingredients like brans and oilcakes, sprinkle some water on the mixture and feed animals at the time of milking. Salt or mineral mixture are often added to such feeds. It has been generally observed that concentrates are fed only to lactating animals.

With the increasing popularity of dairying, compound feeds are being adopted. Because of organised milk collection through dairy cooperatives, the supply of inputs to farmers has been made possible. In 1977, total compound feed production was 400,000 tonnes and this had increased to 1.56 million tonnes in 1987 (Figure 1). Today, there are 71 feed mills in the private sector and 44 under dairy cooperatives, with a total capacity of 2.7 million tonnes/annum. In Operation Flood III, Programme 10, additional cattle feed plants with 100 tonnes/day capacity will be installed. To keep the cost of compounded feed down, the technique of least cost formulation needs to be adopted widely.

Figure 1. Trends in cattle feed production in India.



Feeding green forage

Although forage based feeding systems help lower feed costs, the scope for such systems is limited in India because of the need to give priority to food crops. The average cultivated area under fodder crops is estimated as 4.4%. In areas with better irrigation facilities, intensive fodder production is practised and in the Northern Region, particularly Punjab and Haryana, 10% of the irrigated land is allocated to fodder cultivation. The major part of the ration of dairy animals in this region consists of lucerne, berseem, maize, oat, sorghum, etc. In other parts of the country, although the area under fodder crops has not increased, the technique of a mixed cropping system of forages with other cash crops like vegetables and sugarcane is widely adopted by farmers. Growing maize with sugarcane, brinjal, cabbage, etc., is a common practice in irrigated tracts of Maharashtra. Table 5 shows the crop rotation in different agro-climatic zones of India.

Table 5. Intensive fodder crop rotations for different agro- climatic zones of India.

ZONES	CROP ROTATION	GREEN FODDER YIELD T/ha/annum
NORTHERN	**Hybrid napier intercropped with berseem**	211.7
	Hybrid napier + lucerne	176.0
	Berseem + Japan rape - Jowar + cowpea	170.5
	Maize + Cowpea-Maize + Cowpea - Turnip-Oat	190.0
CENTRAL & WESTERN	**Hybrid napier + cowpea-berseem + mustard**	286.3
	Maize + cowpea-M.P. Chari-berseem + mustard	197.2
	M.P.Chari-turnip-oat	192.3
	M.P.Chari + cowpea-berseem + mustard-Jowar + cowpea	168.6
	Maize + cowpea- maize + cowpea-oat-maize + cowpea	168.5
EASTERN	**Maize + cowpea-oat-bajra + cowpea**	102.6
	Jowar + cowpea-berseem + mustard-maize + cowpea	96.0
	Maize + ricebean-berseem + mustard	111.5
	Hybrid napier alone	144.2
SOUTHERN	**Sorghum + cowpea-maize + cowpea-maize + cowpea**	110.7
	Maize + cowpea-maize + cowpea-maize +	106.0

	cowpea Guineagrass round the year	93.5

Soruce: Lal M. and Tripathi S.N. (1987)

Growing short duration forages in the gap period of the prevalent crop sequence is a standard practice in irrigated areas. For example in the wheat-sorghum-maize-bajra sequence, a gap period exists between April and June which is utilized for growing forage crop mixtures like maize + cowpea, sorghum + cowpea or bajra + cowpea with a yield of 35–40 tonnes/ha, without affecting main crop.

TECHNOLOGY OPTIONS AVAILABLE TO THE FARMERS

Supplementation

Supplementation of crop residues with fresh grasses and legumes or concentrate feeds significantly improves feed intake and the performance of animals. Feeding wheat straw with berseem or lucerne is common practice in the Northern region of the country. In dryland farming systems where forages are scarce, crop residues are supplemented with concentrate feeds. Supplementation of the basal diet with good quality forage or concentrates helps to overcome the problem of low palatability. The role of agro-forestry systems in augmenting the supply of green forage needs to be emphasized to farmers.

Urea treatment

Treating crop residues with 4 percent urea and 45–50 percent moisture improves the nutritive value by increasing digestibility, palatability and crude protein content. The process is simple and can easily be practised by the farmers. Feeding treated wheat straw supplemented with

berseem (90:10 mixture on a dry matter basis) ad lib. was shown to support a milk production level of 6 kg/head/day without concentrates (Agarwal et al., 1988). However urea treatment is not yet used on a wide scale by farmers because of inadequate extension efforts to popularise the technology and the limited availability of liquid cash for farmers to purchase urea.

Steam treatment

According to Rangnekar et al. (1982, 1986), steaming under high pressure has been found to be effective for improving palatability as well as digestibility of sugarcane bagasse. It has been demonstrated that it is possible to utilise this process in sugar factories, since steam can be made available at a very low cost. Field trials with steam treated material have shown good results and acceptance by the farmers. In some areas, this material has been used as an alternative roughage source during feed scarcity to maintain animals while, in other areas, it has been used in complete feeds for lactating cattle.

Urea-molasses blocks

Urea-molasses blocks provide nitrogen to the micro-organisms in the rumen and thus improve the digestion of straw. They can also supply amino acids which can by-pass rumen fermentation and be absorbed in the lower gut of the animal. Cattle and buffaloes fed these supplements showed improved body condition, increased conception rates and increased milk yield. The National Dairy Development Board (NDDB) has launched a programme to popularise the feeding of urea-molasses blocks.

FUTURE DEVELOPMENT

In India, nutrition research should emphasize the development of feeding systems based on

existing feed resources, under farm conditions.

A feed security system for animals needs to be developed to meet the requirements of livestock in famine and flood prone areas.

Evolving new varieties of cultivated fodders which have high yields, respond to inputs and are disease resistant is also a priority.

The identification of non-conventional feeds for livestock and developing processes for improving their nutritive values needs to be undertaken on large scale.

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FEEDING DAIRY CATTLE IN TROPICAL REGIONS OF CHINA

by

Cheng Nanging

INTRODUCTION

Guangdong Province is in the tropical zone of China with an annual average temperature of 19–26°C. The lowest monthly average temperature is 7–12°C and the warmest monthly temperature

is 27–29°C. The amount of sunshine is 1600 to 2600 hours and accumulated temperature is 6000–9500°C. Average rainfall is 1000 to 2300 mm and non-frost days in 1986 where 346.

There are about 23,000 black and white cattle in the province, with about 12,000 (52%) on the state operated farms, about 5,000 on the collective farms (21%) and about 6,000 (26.2%) in the farmers' hands. There are about 2,000 water buffalo in milk, most of them belonging to farmers. Local water buffalo can produce about 800–1200 kg milk per year. The crossbred of local and Murrah or local and Nili-Ravi can produce about 1500–1800 kg milk and the highest can produce about 1800–2000 kg per year.

Besides selling fresh milk in the province, there are some milk processing plants. They produce yoghurt, vita milk, citrus fruit milk, condensed milk, etc.

In order to meet the people's milk demand, between 1980–1985, this province imported 3,318 black and white dairy cattle from New Zealand, Denmark, the USA, Canada and Australia. The milk productivity and management of these cattle and the original local black and white are as follows.

PRODUCTIVITY OF LOCAL AND IMPORTED DAIRY CATTLE

Adaptation to local conditions

Cattle from New Zealand are better adapted to the Guangdong Province conditions than cattle from other countries. In the first year of their importation, those cattle suffered serious heat stress. In the Chu-Cuen dairy cattle farm, among 675 cattle imported in 1985, 18.7% of them had to be slaughtered in the first year because of foot-rot, septicaemia, mastitis, pneumonia, dystocia, uterine prolapse, ruptured uterus and other diseases. In the second and third years,

they had to cull only 5.8% and 1.9% of the total cows, respectively.

Milk production

From Table 1, it can be seen that the milk production of cattle from New Zealand is nearly equal to that found in their home country. The milk production of the cows from other countries, although it is increasing each year, is still lower than the production in their home countries (although higher than the New Zealand cows). The milk production has increased rapidly every year. Some of the cows produced 6000 kg of milk in a 305 day lactation and the highest one achieved 9327 kg of milk in 305 days.

Table 1. Milk production.

Country of origin	Lactation	No. of cattle	Average milk production kg	Average butter fat %
New Zealand	1	541	2948	4.3
	2	594	3580	4.3
	3	532	4003	4.3
	4	159	4257	4.3
	5	222	4187	4.3
USA	1	482	3013	3.2–3.7
	2	357	4280	-
	3	252	5405	4.4
Denmark	1	119	4434	3.9
	2	64	5123	4.0
Australia	1	6	4472	-

	2	3	4058	-
Guangdong black and white	1	984	4238	
	2	710	4797	
	3	656	5110	
	4	422	5146	

Reproductive performance

Table 2 shows that the reproductive performance of imported and local cattle are not very different.

Body weight of the cattle

The birth weight is smallest in New Zealand calves and their is not much difference between the others (Table 3). The body weights of heifers are highest in the American Holsteins.

Table 2. Reproductive performance.

Origin	**Number of cattle**	**Conception rate at one heat %**	**Conception rate per year %**
New Zealand	1132	57.2	91.7
Denmark	499	56.4	89.8
USA	1816	41.5	81.1
Guangdong black and white	1639	56.9	86.7

Table 3. Body weight (kg).

Origin	Birth weight	3 months of age	6 months of age	12 months of age	18 months of age
New Zealand	31.1	107.8	154.2	251.5	316.7
Denmark	35.6	-	138.9	267.9	340.9
USA	35.8	92.2	185.9	281.6	415.5
Guangdong black and white	34.5	-	-	-	345.7

GUANGDONG DAIRY CATTLE MANAGEMENT

Most of the dairy cattle are fed in-doors. In order to let the cattle adapt to the tropical climate and also to give high milk production, people have paid much attention to site selection, housing construction, dairy cattle management and disease prevention and cure.

Dairy cattle farm site selection

In the selection of farm sites, they have not only to consider those items such as prevention of sickness, transportation and communications, water supply, excrement and urine management and so on, but they specially select and construct a farm on the top of a hill, where the air flow is good and the manure, after fermentation in a manure pit, can be used to irrigate grassland around the farm automatically by gravitation through irrigation canals.

Housing design

In the past, most of the cattle houses had walls with doors and windows. Now, most of the cattle houses are open and they have only a big roof made of alloy, which is good for heat

radiation. In windy areas, the roof may be made of cement.

Feed and feeding

Elephant grass is most important for cattle in Guangdong province because it can produce 8,000–15,000 kg of grass per Mu (1/15 of a hectare). Some of the farms plant a small area of stylo for calves. In the winter and spring season, they supply corn and elephant grass silage, and sometimes they also supply Chinese cabbage and sweet potatoes. Some of the farms supply grass hay the whole year round. In the concentrate, corn makes up about 40–50% and by-product feed ingredients such as wheat meal and soyabean meal make up about 30–50%. They also supply sufficient amounts of minerals, salt and some necessary trace elements. Most of the dairy cattle farms feed their cattle according to the feeding standards provided by the government. Sin-Tun dairy cattle farm uses a complete diet self-feeding system and gets very good results.

Dairy cattle management

The farmers do their best to avoid heat stress and foot rot in the cattle. Some of the farms lay bricks on the ground in the yard and some of them put sand down. Most of the cows' bedding is made of cement. Some of the farms have fixed bedding, with about 20 cm depth of sand in it, and some have a carpet on the bed to make the cattle comfortable. They put a water supply in the house, as well as outside, so that water is available all the time. Most of the farms have electric fans in the milking parlour as well as in the cows bedding area. Most of the farms let the cows have a shower once or twice a day and, in hot seasons, they use the shower two or three times a day.

Many dairy cattle farms are using milking machines to milk their cows. Chu-Cuen, Kwan-Ming

and Sin-Tun dairy cattle farms are using herring bone milking parlours with fully automatic milking machines and the milking time per cow is only 8 minutes. They can machine-milk 12 to 20 cows at one time and have therefore raised their labour efficiency and produce very hygienic milk.

Management of bull calves

In many countries, young calves are sold for veal during the first few days of life but in our province, because the price of milk is very high and because most of the people cannot afford very expensive veal meat, most of the bull calves are slaughtered at birth.

DAIRY CATTLE PROJECT DEVELOPMENT AND INCREASED MILK PRODUCTION

Tentative ideas

In the past 10 years, thanks to the open door policy, the income of urban and rural people has increased remarkably and personal purchasing power has been raised in our country. The demand for more and more milk supply is a great problem for us to solve.

First of all, a better plan for dairy cattle distribution needs to be made and to increase the number of milking cattle. At present, most of the big dairy cattle farms are inside Guangzhou City or very close to Guangzhou. It is easier to transport milk to the consumers but there are many problems such as feed, especially forage and roughage supply, and pollution problems. So many people think that the distribution of dairy cattle should be changed.

a. **Those farms in the city or very close to the city should raise a limited amount of good quality, high production cows, because they have a long dairy cattle-raising history, their technicians are good and so they could make good use of high quality cows.**

b. **Those farms in rural areas should raise cows that are better adapted to the conditions. In this area, it is easier to manage forage and roughage supply and the cost of labour is lower. With the improvement in transportation, it is not a problem to send milk to the city from 100 miles away in the rural areas. This is the area to develop more dairy cattle farms in the future.**

c. **There is a need to get more milk from water buffalo. In Nanhai and Jiashe Country, there are about 2000 milking buffaloes. They produce about 2392 tons of milk per one year. Farmer who raise one buffalo for milk can earn 1200 – 1500 yen of per year. Our province has more than three million water buffaloes. If 5% to 10% are milked, it will not only provide more milk to the people but will also increase the economic income of the farmers.**

From a genetic point of view, in order to raise more good quality, high production dairy cattle and have good quality bulls from those high production cows, we are trying to make use of embryo transfer techniques. In the past few years, we used Chinese-produced FSH to super-ovulate donor cows and obtained 5–6 viable embryos on average per cow. The transfer success rate of fresh or frozen embryos was about 40–50%. We are also planning to do some experiments using injection of recombinant DNA growth hormone products and try to make use to bio-technology methods to increase milk production.

MILK PRODUCTION SYSTEMS IN TROPICAL LATIN AMERICA[1]

by

J I Restrepo, E Murgueitio and T R Preston

INTRODUCTION

In many developing societies, cattle are more important as a source of manure - for fuel and/or fertiliser - and power, than of milk and meat. For the rural poor, they are more secure than the bank, as a means of safeguarding savings from inflation and devaluation.

In this paper, it is argued that it is more economical, in terms of national resource utilization, to satisfy the demand for milk and beef by combining both activities in the same animal. The justification for this approach is that: (i) the target levels of production - 2,000 litres of milk and 300 kg of beef per cow per year - are closely related to national demand rations which vary from 4 to 5 litres milk per 1 kg of beef; (ii), as a result of (i), larger national cattle herds can be supported which increases employment opportunities and enables more efficient use to be made of presently under-utilised locally available feed resources, which are usually low in protein and high in cell wall material; (iii) advantage can be taken of important physiological traits, previously disregarded in intensive specialised systems - for example, the effect of suckling in stimulating milk yield, reducing stress in both cows and calves and permitting the calf to use supplementary feed of low protein content, more efficiently.

Of special importance to developing countries is that breeding programmes for dual purpose milk-beef systems permit a much greater degree of self-reliance (i.e. reduced dependence on expensive (imported) inputs), the technology is simpler and therefore more easily applied and

with greater chance of acceptance than for specialised systems, especially milk production.

DUAL PURPOSE CATTLE PRODUCTION SYSTEMS

Dual purpose cattle production systems are those in which income is divided approximately equally between milk and beef. They are predominant in many parts of Latin America (see Table 1).

[1] Parts of this article were taken from "Dual Purpose Cattle Production Systems" by T.R. Preston and Lucia Vaccaro, published in "New Techniques in Cattle Production" (Editor, C.J.C. Phillips). Butterworths, London. Chapter 2: 20–32.

Table 1. Cattle production systems in the coffee-growing region of Colombia

	Altitude (m above sea level)			
	>2,000	1,250–2,000	>1,250	
Total Type of farms	%	%	%	%
Specialised beef	8	2	10	20
Specialised milk	9	9	2	20
Dual purpose	25	22	13	60

Source: Suárez and Jaramillo 1988

Their salient characteristics are that, almost invariably, the calves are raised on the cow by some form of restricted suckling. Usually milking is only once daily and the major feed resources are pasture or fibre-rich crop residues and by-products with minimum use of supplements.

The genetic resources vary enormously but the most popular animals for this system are crossbreds, derived from European Bos taurus types (Brown Swiss and Holstein predominantly) and Bos indicus (zebu). Typical performance data from a number of countries are summarised in Table 2.

Table 2. Typical performance data for cattle managed according to the dual purpose system on demonstration or experimental farms in a number of tropical countries

	Milk/year		Weaning weight (kg)	Calving interval (days)
	Saleable (kg)	Calf (kg)		
Dominican				
Republic (1)	1,750	470	165	380
M�xico (2)	1,400	450	150	401*
Costa Rica (3)	1,300	400	155	400*
Malaysia (4)	1,860	?	?	438*

*** Exclusively with AI (1) Fernandex et al 1978; (2) Alvarez et al 1980; (3) M E Ruiz, personal communication; (4) Cheah and Kumar (1984)**

The dual purpose system arose through the need to increase the income from typically extensive beef production systems. Often the first stage is the milking of a proportion of the cows, those with appropriate genetic potential and temperament being chosen for this purpose. The next step is usually to introduce a sire from a recognised dairy breed, in order to increase dairy traits. Further innovations may follow, such as pasture improvement, supplementation of cows and calves, twice daily milking and occasionally machine milking.

More recently (Preston, 1977), dual purpose systems have been advocated as an appropriate way to integrate cattle into intensive mixed farms, especially in the wet tropics. The arguments used are that such systems enable better use to be made of available resources, that they are well understood by farmers (who developed them in the first place) and that they satisfy the demand ratio for milk and beef.

Aside from these economic considerations, there are distinct biological advantages intrinsic to dual purpose systems. These features are not well known and even less well understood. It is important to describe them, and what is known about them, so that those scientists that are in research centres in industrialised countries, who have the necessary laboratory resources and expertise, may feel stimulated to direct some of their attention to these areas with a view to establishing the underlying mechanisms.

RESTRICTED SUCKLING

Effects on the cow

Use of the calf to stimulate milk let-down is the traditional technique employed to coax beef animals to surrender a part of their milk output for human consumption. In crossbred cattle derived from Zebu (Bos indicus), typically used in dual purpose systems, there appears to be a negative linear relationship between the proportion of genes derived from the Bos taurus parent and the incidence of short lactations (Table 3).

Table 3. Effect of genetic makeup on incidence of short lactations in Holstein:Zebu crosses in M�xico

Percentage of Holstein genes	Incidence of short lactations (<70 days) (%)
25	76
50	40

75	10
100	None

Source: Alvarez et al (1980)

In an unselected F1 herd (derived by crossing Zebu females with Holstein and Brown Swiss sires), milked by machine (Table 4), half the animals had lactations lasting less than 70 days when the calf was not present at milking. In their second lactation, those cows which had short lactations previously, milked normally when the calf was used to stimulate let-down. By contrast, the cows which milked normally in their first lactation (without calf stimulation), regressed to the mean in their second lactation, half of them becoming dry before 70 days.

Table 4. Milk production from F1 European (Holstein or Brown Swiss)/Zebu crosses milked with and without calf stimulation

	33 first-calvers	
First lactation	Without calf-stimulation	
	16 milked	17 became
	adequately	dry <100d
Second lactation:	Without calf	With calf
	stimulation	stimulation
Prematurely dry <100d	8	0
Lactation length* (days)	216	270
Total milk* (kg)	590	1680
Saleable milk* (kg)	590	1000

***For the cows which milked more than 100 days**

Source: Alvarez et al., 1980.

As well as ensuring normal length lactations in crossbred cattle, restricted calf suckling brings other benefits. In a recognised dairy breed (e.g. Holstein), cows that suckled their calves after milking gave more milk during the period that suckling was practised and subsequently after the calf had been weaned (Table 5). There is less mastitis in cows that are milked and also suckle their own calves or calves from other cows (Table 6), compared with cows that are milked by hand or machine but do not suckle.

If cows which suckle their calves give more milk than those which do not suckle, it would be expected that either they must eat more food or mobilise more body tissue. However, in an experiment designed to test this hypothesis (Table 7), Holstein cows that suckled their calves after machine milking, gave more milk and lost less weight immediately after calving than cows which had their calves removed permanently 3–5 days after birth. The differences in body weight continued to be manifested at least through the first 3 months of lactation. Feed intake was maintained constant in both groups. The implication is that the stress on the dam caused by taking away its offspring leds to adrenalin-stimulated demand for glucose and resulting increased mobilization of body reserves.

Table 5. Effect of two systems of restricted suckling on milk yield of Holstein cows and milk intake by their calves.

	Control (did not suckle)	Suckled	
		2xdaily for 70days	2xdaily for 28days then 1xdaily for 42days

Saleable milk (kg/d)			
5–28 days	12.5	9.7	9.5
29–70 days	11.5	9.5	13.5
71–112 days	10.0	11.8	12.9
Consumed by calf (kg/d)			
5–28 days	-	5.8	5.4
29–70 days	-	6.3	2.5
Total milk yield (kg/d)			
5–28 days	12.5	15.5	14.9
29–70 days	11.5	15.8	16.0
71–112 days	10.0	11.8	12.9

Source: J. Ugarte and T.R. Preston, unpublished data.

Table 6. Effect of suckling on incidence of sub-clinical mastitis (expressed as % of all quarters examined) in F1 (European x Zebu) and Holstein cows in the tropics.

Authors:	Breed	Calf suckling	
		No	Yes
Alvarez et al., 1980	F1 (EXZ)	21	6
Ugarte and Preston, 1972	Holstein	6	2
Ugarte and Preston, 1975	Holstein	8	2

Table 7. Effect of suckling on milk production and bodyweight change in Holstein cows in Venezuela

Table 7. Effect of suckling on milk production and bodyweight change in Holstein cows in Venezuela
(The control cows had their calves removed permanently after the first 4 days; the experimental group suckled their own calves for 20 minute periods twice daily immediately after the cows had been machine-milked)

	Control (no suckling)	Restricted suckling	SEx
Milk production (kg/d)			
Saleable	7.9	9.0	±0.8
Consumed by calf	4.0	6.1	
Total	11.9	15.1	
Liveweight change (kg)			
Pre- to 7 days post-partum	-72	-46	±15
From 7 to 84 days post-partum	+15	+3	±5

Source: Velazco et al., 1982.

Table 8. Calves use milk more efficiently by suckling rather than by bucket feeding (calves were crossbred European x Zebu raised from birth to 84 days of age either by bucket feeding of whole milk or by restricted suckling for 20 minutes following milking.

	Bucket	Suckling	SEx
Condition Score*	1.61	1.35	±0.04
Milk intake (kg/d)	3.08	2.73	±0.12
Milk conversion (kg milk/kg LW gain)	9.7	4.9	±1.0

***Belly girth (cm)/liveweight(kg): low value = more tissueand less gut fill**

Source: Fatullah Khan and T.R. Preston, unpublished data.

Effects on the calf

Efficiency of milk utilization is higher in calves that are suckled than when they take the same amount of milk from a bucket (Table 8). This is understandable in the light of Ørskov's work (centrskov, 1983) which demonstrated that psychological stimuli, rather than physical factors, were the mechanisms which controlled the closing of the oesophageal groove which directs milk to the abomasum. Bucket feeding, by contrast, results in much milk spilling over into the rumen where the fermentative mode of digestion leads to losses in both the quality and quantity of nutrients available to the animal.

Other benefits are a reduced incidence of diarrhoea and elimination of navel sucking, as a result of which suckled calves can be housed in groups, permitting lower investment in housing, simpler feeding and management and less stress on the calves.

DISADVANTAGES OF RESTRICTED SUCKLING

Poorer fertility is generally ascribed to calf suckling, due to extension of the interval between calving and conception. It is generally believed that this is due to delay in initiation of ovarian activity. However, there is some evidence that the impaired fertility is due not to delay in ovarian activity but to poor manifestation of oestrus (silent heats) due to a reduced amplitude of the progesterone peaks which regulate ovarian cycles (Velazco et al., 1982).

Use of natural mating rather than artificial insemination is therefore advocated in dual purpose systems. This is substantiated by observations in a dairy enterprise in Mauritius where calves were raised by restricted suckling. When there was exclusive use of AI, calving intervals were long and variable; running bulls with the herd reduced both the average calving interval and variability (Naidoo et al., 1981).

RESTRICTED SUCKLING IN BOS TAURUS HERDS

Modifications to the management of cows and calves may be needed when calf suckling is introduced into herds in which the cows are mainly of Bos taurus origin and therefore do not need the physical presence of their calves to stimulate milk let-down. In such cases the calves are suckled when milking is completed, either in the shed where the cows are milked or in a pen designated for that purpose. It has been observed that, in this system, up to 20% of cows may withhold most of their milk during milking, retaining it for their calves. This problem can be overcome by cross-suckling, in a way which does not allow cows to suckle their own offspring (E. Murgueitio, unpublished data). For example, the cows in early lactation suckle the calves from cows in late lactation, and vice versa.

BREEDING PROGRAMMES FOR DUAL PURPOSE SYSTEMS

There is now broad agreement that in the humid tropics, the most appropriate animals for dual purpose systems are those derived by crossing native cattle (usually Bos indicus) with any of the recognised dairy breeds and that the optimum proportion of European genes will vary according to the harshness of the environment (McDowell, 1985). The results from the on-farm evaluations in Brazil, made by Madalena et al. (1982), show that there are few advantages and many disadvantages when the proportion of genes from a specialised European dairy breed exceeds 50%.

The most popular crossing sires are Holstein, Brown Swiss, Normandy and Simmental. Few breed comparisons have been made but the more reliable data indicate a significant advantage to the use of Holstein sires compared with Brown Swiss (Vaccaro, 1984). While there are many who advocate the merits of the native Criollo breeds in Latin America, their numbers are small and there are almost no data which permit valid comparisons to be made with other breeds and

crosses (Vaccaro, 1987).

It is frequently argued that it is difficult to stabilise a cattle population in order to maintain approximately equal proportions of Bos taurus and Bos indicus genes. However, in practice this is not a major problem, once it is accepted that the appropriate way is by using F1 bulls. The recommended system is to “manufacture” such bulls by crossing native “adapted” females with imported semen from progeny tested sires of the selected European breed (Vaccaro L., personal communication). Hardiness and fertility are ensured by selecting the female parent for these characteristics. A sustainable level of milk production (1,000 to 1,500 kg per lactation) is guaranteed by choosing semen from a bull with a proven capability to maintain yields (in purebred dairy females) of about 5,000 kg per lactation (the potential yield of the F1 offspring is then at least 2,500 kg, ignoring both the dam's contribution and the effects of heterosis). Almost all dairy bulls presently standing at approved insemination centres in the industrialised countries have this capacity. F1 bulls can be run with the herd which facilitates natural mating. This is recommended in view of the difficulties of heat detection in cattle that raise their calves by restricted suckling systems.

CONCLUSIONS

The basic justification for the dual purpose concept is that the target levels of production - 2,000 litres of milk and 300 kg of beef per cow per year - are closely related to national demand ratios which vary from 4 to 5 litres milk per 1 kg of beef. The total cattle population required to support these yield levels is no higher than if the milk and beef were produced in separate herds, but with the additional benefits (for most developing countries) of supporting more employment opportunities and enabling greater and more efficient use to be made of presently under-utilised local feed resources.

Another important issue is that advantage can be taken of important physiological traits, which have been disregarded in intensive specialised systems - for example, the effect of suckling in stimulating milk yield, reducing stress in both cows and calves and permitting the calf to use more efficiently supplementary feed of low protein content.

Breeding programmes for dual purpose milk-beef systems are simple and low cost because they take advantage of F1 sires produced by combining imported "proven" (for milk!) semen with the adaptability and fertility of native females. This avoids the need to set up national progeny testing schemes which besides being expensive are also unreliable due to the difficulty of obtaining the necessary herd records.

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RESTRICTED SUCKLING IN DUAL PURPOSE SYSTEMS

by

J. Ugarte

INTRODUCTION

In the majority of the countries with a high level of agricultural development, the feeding of dairy calves is based on artificial rearing. The availability of milk substitutes based on by-products from the dairy industry has stimulated artificial rearing. This is not so in developing countries where there is a lack of fresh milk. In this case, artificial rearing must be based on fresh milk. Thus it is not logical to milk by hand or machine and later give part of the milk to the calf. It is better to make use of the calf's ability to extract milk from the cow.

Traditional rearing of dairy calves is characterized by the presence of the calf with the cow during milking to stimulate milk let-down and it stays with her after milking to consume the milk remaining in the udder. The time the cow is with the calf varies between 1 and 12 hours and is inversely related to the age of the calf. Age at weaning is rarely less than 6 months.

However, in dual purpose herds, natural (traditional) rearing does not efficient use of the cows' potential for the production of milk for the market. Hence, a variant of natural rearing was developed, called restricted suckling, characterized by the reduction in the time the calf remains with the cow each day, which is that strictly necessary for suckling, and in the age at weaning onto other feeds. This allows a greater economic effectiveness since:

1. **it uses the maximum milk potential of the cows through the consumption by the calf of the residual milk.**
2. **it achieves high milk yields at milking and good calf growth.**
3. **it attains satisfactory reproductive performance and a low incidence of mastitis**
4. **it maintains a low calf mortality rate.**

RESULTS OF RESTRICTED SUCKLING

Residual milk

15% of the milk in the udder at the start of milking remains at the end as residual milk, containing 3 times more fat content than normal milk (Lane et al., 1970).

The amount of residual milk has been correlated to total milk and with the interval between milkings. It varies throughout the lactation from 9.1 and 23.5% of total production in the first and tenth months of lactation respectively (Marx, 1971). Only small amounts of residual milk

have been found in the udder of cows after the calves have suckled (1.2 – 3.4%), always less than in hand or machine milked cows (Kreilis et al., 1971).

Considering that the rate of milk secretion is more intense immediately after milking and that the amount of residual milk remains relatively constant, it is expected that, by delaying the suckling time, this recently secreted milk would also be consumed by the calf, with a possible reduction in the amount of milk to be obtained in the following milking. Milk consumption rose from 3.8 to 5.2 litres on increasing this interval from 20 min to 2 hours while production obtained at milking was reduced from 13.9 to 12.4 litres for a total production of 17.6 litres. By this method, the producer may obtain a certain amount of milk for the calf without affecting the total production of the cow.

The frequency of sucklings also affects the destination of milk produced. Thus, comparing suckling once or twice a day, Ugarte and Preston (1972) found that milk consumption did not differ between maternal breeds but was 50% greater for twice a day, while total production (milking and calf consumption) remained equal (Table 1). In the experimental cows, the decrease in milk production during the milking of Holstein cows suckling calves twice and once a day was 3.5 and 0.4 litres respectively, while in the F1 (Holstein x Zebu) it was of 3.6 and 1.2 litres. Suckling once or twice are equally effective methods of taking the maximum advantage of milk production in cows of this potential.

Table 1. Effect of suckling once or twice daily on milk production and calf growth (Ugarte and Preston, 1972).

	Litres of milk daily			
	At milking	**Consumed by calf**	**Total**	**Daily gain kg.**
Once daily x 60 m.	7.2	5.4	12.6	0.72

Twice daily x 30 m.	4.5	8.1	12.6	0.94
Control	8.0	-	8.0	0.54

A satisfactory variant was the combination of different numbers of sucklings (Ugarte and Preston, 1973) (Table 2). On reducing it from two to one from the fourth week of age to weaning (10 weeks), milk consumption was reduced by 54% (3 litres per day), as was the daily gain of the calf, although this was acceptable (478 g/day) and resulted in an average of 535 grams over the whole period 7 – 70 days. The production obtained at milking increased by 4.2 litres (31%), while the cumulative total to weaning was similar to the control (without calves) and total production was 28% higher.

Table 2. Effect of reducing suckling to once daily after the 4th week on milk yield and calf growth.

Milk yield (litres) 1–70 days									
SUCKLING TREATMENT	**1–28 days**			**29–70 days**			**1–70 days**		
	Milking	**To calf**	**TOTAL**	**Milking**	**To calf**	**TOTAL**	**Milking**	**To calf**	**TOTAL**
2x daily to 70 days	9.8	5.8	15.6	9.0	6.8	15.8	9.3	6.4	15.7
2x daily to 28 days and lx from 29–70 days	9.4	5.6	15.0	13.4	2.6	16.0	11.8	3.8	15.6
CONTROL	12.6	-	12.6	11.5	-	11.5	11.9	-	11.9

Milk yield (litres) 71–112 days by milking	
2x daily to 70	11.8
days	
2x daily to 28	
days and 1x from	12.9

29–70 days	
CONTROL	10.0

Daily gain of calves (kg)				
	1–28	**29–70**	**1–70**	**70–154**
2 x daily to 70	0.735	0.954	0.865	0.705
days				
2 x daily to 28				
days and lx daily from	0.624	0.478	0.535	0.718
29–70 days				

It should be noted that the intervals between milkings were 15 and 9 hours and that restricted suckling took place after the milking with the shortest interval (afternoon), when the cows produced less milk. To increase consumption by the calf, suckling should take place in the morning, since differences of 0.8 and 1.0 litres were found on suckling the calves in the morning, compared to the afternoon, with intervals between milkings of 15:9 and 16:8 hours (Table 3).

Table 3. Effect of suckling after morning or afternoon milking on milk production and consumption by the calf (litres).

	At milking			**Calf**	**Total**
	Morning	**Afternoon**	**Total**	**Consumption**	
Experiment 1					
Morning	7.71	2.40	10.11	4.40	14.54
Afternoon	5.94	6.75	12.69	3.59	16.21
Experiment 2					

Morning	12.87	4.28	17.15	2.98	20.18
Afternoon	11.06	7.15	18.21	1.99	20.23

Age at weaning

This has usually ranged between 4 and 8 weeks. However, in systems of natural rearing, weaning ages have generally been high since it is not common practice to use sufficient amounts of concentrates. The calf must receive milk in the early stages to avoid seriously reducing performance.

When calves suckling once a day were weaned at 35, 56 and 70 days, no significant differences were observed in weight at weaning and at 154 days (Ugarte, 1977) (Table 4). On the other hand, total milk consumption increased with age at weaning. Total production (milking + consumption) over the period 7–70 days was apparently not affected by age at weaning. As particularly careful management is needed when calves are weaned at 35 days, 56 day weaning is recommended.

Table 4. Effect of weaning age on milk production and calf growth.

Period	**Weaning age, days**		
	35	**56**	**70**
Milk consumed (litres)	48	135	241
Net milk (litres)	1,210	1,242	1,088
Total milk (litres)	1,258	1,377	1,329
Liveweight gain of calves (kg)			
7 – 70 days	0.23	0.18	0.31
71 – 154 days	0.80	0.85	0.67

7 – 154 days	0.56	0.57	0.52

Milk production throughout lactation

A study carried out by Ugarte and Preston (1975) with 60 cows and calves suckling twice a day and an equal number without calves showed that from weaning (70 days) until cows were dried off, milk production did not differ significantly between treatments (6.1 and 5.7 litres per day, respectively). Lactation length did not differ either and total daily production throughout the lactation of cows suckling calves (milking + consumption) was 8.28 litres, while in cows without calves it was 7.35 litres (Table 5).

Table 5. Saleable milk, calf consumption and total production throughout the lactation (1/day).

	No. of animals	First 10 weeks			From 10 weeks to drying off	Total	Lactation length days
		Milk-ing	To calf	Total			
Restricted suckling	57	6.2	6.9	13.1	6.1	8.3	262
Control	58	10.7	-	10.7	5.7	7.4	258
SE±		0.4	-	0.3	0.2	0.2	8

These results agree with those obtained at a commercial level (with 97,678 cows milked twice a day for one year (Ugarte, 1977)). Daily milk production during milking was higher without the calf but, since about 332 litres were consumed by the calf, the F1 and F2 cows in restricted suckling produced 1.3% and 9% more milk in total (Table 6).

Table 6. Daily milk production (during one year) of F1 and F2 (Holstein-Zebu) rearing calves by restricted suckling or artificially (litres).

BREED	COWS			
	Without Calf		With calf (restricted suckling)	
	no.	litres/d	no.	litres/d
F1 (50% H × 50% Z)	26902	5.91	54165	4.74
F2 (75% H × 25% Z)	9194	6.49	7417	5.73
Total	39096	6.05	61582	4.85

Mastitis

A study of 61 herds in tropical areas revealed that the incidence of mastitis represents 12.6% of milking cows (Fustes et al., 1985). A lower incidence of clinical and subclinical mastitis was found during the suckling period. After weaning, no significant differences were found between rearing systems (Ugarte and Preston, 1975) (Table 7). This is due to several factors, such as the mechanical effect of suckling, the cleaning effect of the saliva and a more complete emptying of the udder.

Table 7. Mastitis incidence in suckling cows.

HERD 1 Quarters affected by clinical and subclinical mastitis during the first 10 weeks of lactation (number).			
	Cows	Clinical	Subclinical
Restricted suckling	36	5	14
Control	36	18	52

Table 7 (continued).

HERD 2 Quarters affected by clinical mastitis throughout the lactation %

	Cows	Weeks after calving			
		1–10	11–20	21–30	31—drying
Restricted suckling	56	0.5	11	11	4
Control	58	2.0	14	11	4

Reproduction

It is accepted that natural rearing produces long calving intervals and this has been more evident on increasing the age at weaning. However, when the animals are early weaned (70 days) these considerations are not valid.

This was confirmed in a population of F1 and F2 (Holstein x Zebu) cows, without calves or suckling calves until 90 days (Table 8). Intervals between calving and conception were slightly longer with restricted suckling compared to artificial rearing, but considerably less than with traditional rearing. In another study, Rodriguez (1987), on analyzing more than 120,000 cows, reported intervals of 109, 151 and 218 days to first insemination and 128, 166 and 240 days to conception for artificial rearing restricted suckling and traditional rearing systems respectively.

Table 8. Interval between calving and conception of cows under different management systems.

BREED	Number of cows	Artificial rearing	Restricted suckling[a]	TraditionaL[b]rearing
F1 (50% H × 50% Z)	27628	126	166	237
		(8524)	(16461)	(2643)
F2 (75% H × 25% Z)	5680	136	163	178
		(3179)	(2334)	(667)
Others[1]	54141	129	175	254

		(17257)	(29245)	(7639)

[1] Mainly zebu x Brown Swiss in different proportions

( ) Number of cows on each system

[a] Weaning at 3 – 4 months of age

[b] Weaning at 6–8 months of age

<u>Mortality</u>

On analyzing deaths occurring in 195,000 births during a one year period, values found were of 9.9%, 6.5% and 7.2% mortality for calves reared artificially, by restricted suckling and by natural rearing (Table 9).

Table 9. Calf mortality in different rearing systems.

Rearing system	No. of calves	Mortality %
Artificial	3820	9.87
Restricted suckling	75937	6.54
Other systems	116153	7.21

<u>Cost of rearing</u>

The cost of a calf reared artificially was 115.59 Cuban pesos, while, with restricted suckling, it was of 82.89 Cuban pesos, giving a difference of 32.70 Cuban pesos (Ugarte, 1977). Rodriguez

(1987) also found a favourable difference for calves reared by suckling of 55.24 Cuban pesos (142.15 and 86.94 Cuban pesos in artificial rearing and suckling respectively).

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HEIFER REARING IN THE TROPICS

by

J. Ugarte

INTRODUCTION

It is generally recognized that dairy heifers have lower growth rates throughout their life in tropical areas than in temperate ones (Figure 1). The pattern of growth is the traditional curved shape with a high growth rate and body development in the early stages of life, followed by a continuous slow increase as the animal gets older (Vaccaro and Rivero, 1985) (Figure 2). Liveweight differences between heifers reared in tropical and temperate areas are greater in animals over 18 months of age. These results suggest that more attention must be paid to this

aspect, because of the positive relationship between mature weight and milk production.

These problems are not related to the genetic potential of the breed but are due to the environmental conditions, particularly feeding level (Menéndez, 1984).

PUBERTY

Age at first calving is basically determined by age at puberty. Average age at puberty is one of the most important components of the herd net reproduction because of its relation to the number of calves obtained each year and to the feed intake up to calving.

It is generally accepted that live weight is the most important factor affecting puberty. Heifers of large breeds usually reach puberty at 270 kg and smaller ones at 240 kg. In normally fed heifers, live weight is less variable and age at puberty tends to be relatively uniform, according to the breed.

LIVE WEIGHT GAIN AND AGE AT MATING

There is general agreement that it is economically advantageous to mate the heifers at early ages, no older than 15 months. This means daily liveweight gains from birth of 650 to 800 g. Higher gains of over 900 g/day, from 3 to 12 months of age, are undesirable because they decrease the growth of secretive tissue and increase fat deposition in the developing mammary gland. More difficulties at calving in over-fed heifers have also been reported (James and Tomlinson, 1988).

Unfortunately these liveweight gains and mating ages are not feasible in tropical areas because they depend on feeding cereals. Hence, it is necessary to look for alternatives that may not achieve the performance obtained in developed countries but are adjusted to the prevailing

conditions and naturally available resources of tropical countries.

Figure 1. Liveweight of female Holstein calves.

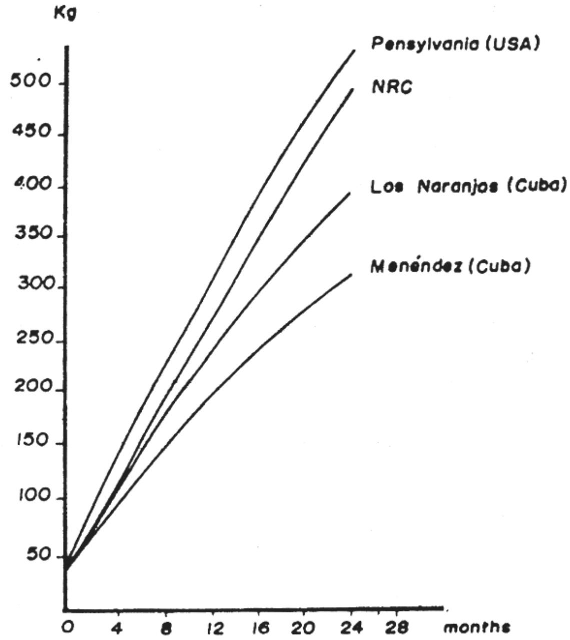
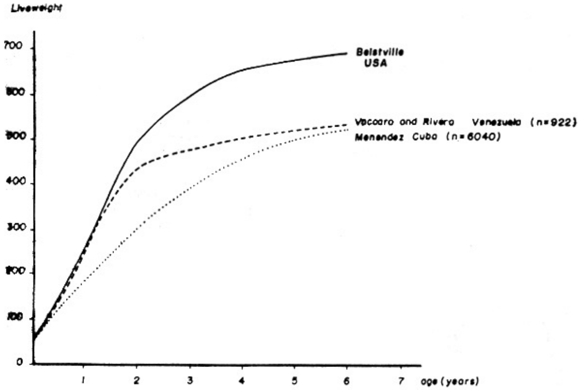


Figure 2. Liveweight of female Holsteins in the Venezuelan and Cuban tropics compared to Beltsville standards.



It is well known that heifers in these areas are commonly underfed and receive poor management. Usually they graze on poor quality soils and receive small amounts of supplements or none at all. This could explain the low productivity and efficiency of cattle in such regions and the great number of unproductive animals in the herds (0.6 to 1.0 heifer/cow). Older ages at calving are mainly responsible for the latter results.

In the long term, insufficient feeding or seasonal scarcity of nutrients, affects reproductive performance in such a way that, even supplying high value diets afterwards, it is impossible to re-establish normal performance, even if the heifer weight is apparently high enough for normal reproductive activity (Perón 1984) (Table 1).

Table 1. Effect of nutritional level on reproductive behaviour (Perón, 1984).

	Nutritional level	
	Medium	**Low[1] - Medium[2]**
Puberty		

Age (days)	595	764
Weight (kg)	290	278
Average daily gain (g)	443	295
Progesterone level (ng/ml)		
Before puberty (35 d.)	1.06	0.77
During oestrus cycle	7.42	5.04
Feeding cost/heifer ($)	68.08	193.76

[1] **406 days at a live weight gain of 173 g/day**

[2] **118 days at a live weight gain of 525 g/day**

This latter author used low nutritional levels in 3/4 Holstein, 1/2 Holstein and 1/4 Holstein x Zebu heifers for 406 days and then a medium-high level for 118 days. He noticed that heifers reached puberty at higher ages and weights and the feeding cost was three times more than for those normally fed.

The effect of growth rate on age at first service and calving age was determined by Rosete and Zamora (1985) (Figure 3). They fixed 320 kg as service weight and daily gains varied from 350 to 600 g. For the highest gain, calving occurred at 27 months of age and, for the lowest, at 39 months.

The former age (27 months) is higher than previously reported for intensively managed herds in temperate areas but is more feasible to achieve in tropical conditions. 27 months is the age considered most adequate at calving for normally reared heifers (Ponce de León 1988).

The effect of age at first calving on total number of calvings is shown in Figure 4.

WEIGHT AT CALVING

It is not possible to analyze age and weight at first calving separately. Roy (1978) suggested different weights for Holstein heifers with different ages, according to the daily liveweight gain. He pointed out that liveweight before calving must be over 500 kg for 2 to 3 years old heifers.

Heifers must have good body condition at calving, with a high liveweight. This is reasonable, considering the relationship between weight at calving, milk production and weight changes in the first stage of lactation.

Low weights at calving are closely related to calving difficulties and subsequent reproductive disorders. This is the main reason for the high percentage of heifers which never reach the second lactation in tropical areas (48 to 63%).

UTILIZATION OF NATURAL RESOURCES

It is a fact that farmers in tropical areas must base their animal production on the utilization of natural resources, basically grasses and sugar cane, and on the agricultural and industrial by-products (Preston and Leng, 1987).

The possibilities of achieving an adequate weight (300–320 kg) and age (16–18 months) of heifers at mating on pasture were discussed by Zamora (1983). However, limited availability of irrigation and the high cost of fertilizers make it impossible to allow an adequate quantity of good quality pasture throughout the year. Hence, it is necessary to use other sources of nutrients in order to supplement the basic diet seasonally or throughout the year. There are large amounts of by-products and other materials that can be used for this purpose. By-

products of the sugar cane industry are of major importance in most of countries, together with animal wastes such as poultry manure. Mixtures of these products, as supplements to pasture, have increased the heifers' daily gains to over 500 g (Perón 1984 and Rosete 1989).

Figure 3. Effect of growth rate on breeding age (Rosete and Zamora, 1985).

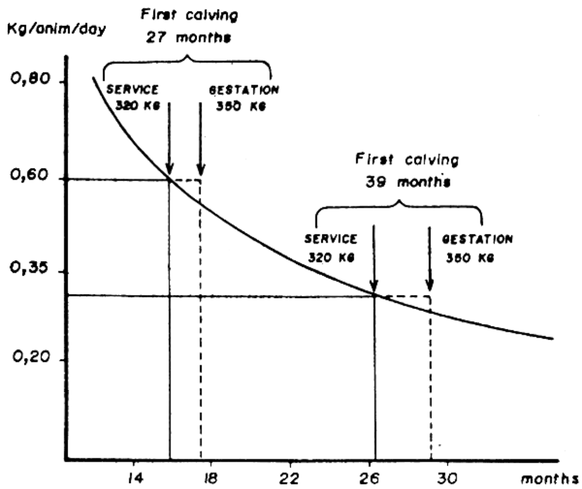
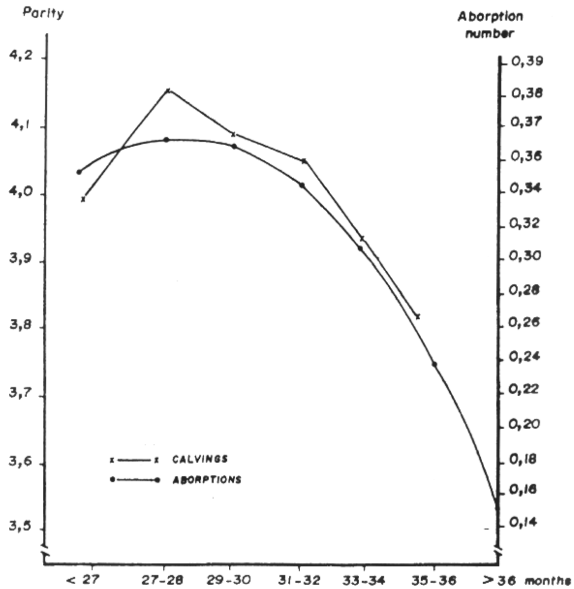


Figure 4. Effect of age at first calving on total number of calvings and abortions (Ponce de León, 1988).



On the other hand, sugar cane (whole plant) is successfully fed in the Caribbean area and South America but hitherto mainly with male calves, bulls and cows. In the future, heifer rearing could also depend on sugar cane during part of the year.

The use of legumes, fed as supplementary forage with pasture or sugar cane diets, has increased rapidly in the last 5 years. Relatively high weight gains (600 g/day or even more) have been obtained (Marrero, 1989).

It is not usually considered necessary to manage heifers separately from older cows in small

dairy units. In medium and large dairy herds, poor body condition in heifers is frequently found, due to feeding competition. Increases of 10% of total milk yield (0.86 litres/ day), 6% less abortions, 7% less total animal losses and 1.4 months less in calving interval were reported when heifers were managed separately from older cows during their first lactation (Ribas et al., 1989).

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FEEDING COWS FOR MILK PRODUCTION IN THE ARUSHA/KILIMANJAROO COFFEE/BANANA BELT OF TANZANIA. FAO PROJECT: ASSISTANCE TO SMALLHOLDERS IN DAIRY DEVELOPMENT. CASE STUDY.

by

L.S. Morungu

INTRODUCTION

The feeding of dairy cows for milk production is a major problem in many tropical countries. The problem is even greater where limited areas of land are available for intensive pasture or fodder production, as is the case in the Arushu/Kilimanjaro coffee/banana belt of Tanzania. This paper seeks to describe the farming systems of the area in question and the initiation and implementation of a project to try to help dairy farmers in that area.

ARUSHU/KILIMANJARO REGIONS

Background

Arusha and Kilimanjaro regions, with a total area of 96,000 km^2, are located in the north-eastern part of Tanzania and are bordered by Kenya on the northern and north-eastern sides. The population of these two regions is estimated to be 2.6 million people, 80% of which live in the rural areas while 20% are found in the urban centres of Arusha and Moshi. There are three main agro-ecological zones:

1. **The lowlands zone is characterised by unreliable rainfall and low population density. Drought is not uncommon and average annual temperatures are more than 30°C. The annual crops include maize, sorghum, cassava and, in the irrigated areas, one finds paddy and sugarcane. Extensive livestock keeping is practised in this zone the cattle grazed are predominantly, the Tanzania Shorthorn Zebu (TSZ).**

2. **The middle belt zone is characterised by a high populationdensity and a high rainfall, with temperatures ranging between 25 and 30°C. In this zone, one finds intensive farming of coffee, grown under bananas. While coffee is the main cash crop, bananas form the staple**

food. The lowest extreme of this zone is climatically similar to the lowlands and here one finds beef cattle production and the growing of annual crops, mainly maize and beans. In the coffee/banana belt, improved dairy cattle and also the (TSZ) traditional cattle are kept under zero grazing. This system is necessitated by the fact that farm holdings are very small (average 1 hectare) so that there is no spare land forgrazing. This belt is found on the slopes of Mounts Meru, Kilimanjaro and the Pare Mountain Ranges.

3. **The upper belt has very high rainfall, very high altitude and temperatures below 20°C. In this zone, there are national forests at the lower extremes and scant vegetation at higher altitudes. This zone is neither suitable for arable agriculture nor livestock keeping. This zone is mainly on the higher slopes of Mounts Meru and Kilimanjaro and to a lesser extent on the Pare Mountain ranges.**

The project area covers a total area of 11, 294 km^2, has a total population of 1,178,000 and a cattle population of 500, 327 (of which 399,933 are indigenous and 87,197 are dairy cattle).

<u>PRODUCTION SYSTEMS IN THE COFFEE/BANANA BELT</u>

Categorisation of the farming systems has equipped the project to understand the farmers and their problems and in planning a strategic implementation programme. The main production systems are:

<u>Category I</u>. The farmer in this category has a small plot surrounding the homestead, mainly growing bananas. Sales of coffee are very low. In most cases, the farmer has no plot in the lowlands and, if any, it is difficult to cultivate. Capital availability is non-existent, due primarily to low coffee sales from his plot in the coffee/banana belt. The other characteristic is the absence of cattle, often coupled with the absence of small ruminants.

Category II. In this category, one sees a comparatively larger plot surrounding the homestead under bananas and coffee but the absence of a plot in the lowlands for annual crops and, if any, difficult to cultivate. Incomes in this category are mainly from the coffee sales while family labour only is available. The cattle found in this case are the local zebu (Tanzania Shorthorn Zebu - TSZ).

Category III. This is characterised by a piece of land around the homestead under bananas/coffee, as well as a piece of land in the lowlands, but difficult to cultivate due to lack of labour, distance and lack of or cost of transport to the lowlands. The source of labour is family labour, which in most cases consists of old people. Cattle are either the local cattle or up-graded dairy animals.

Category IV. This is characterised by a plot surrounding the homestead, also under bananas and coffee, as well as a plot of land in the lowlands. The source of incomes is mainly from the sales of coffee, milk and surplus bananas. The source of labour is the family, coupled with hired labour at certain times. The type of cattle are mainly dairy grade animals. There is no real accumulation of capital in this category.

Category V. This category is more or the less the same as Category IV above in terms of land ownership, source of income and labour, with the differences that there is sometimes accumulation of capital (purchase of land). Family labour is used part-time, including use of hired labour. The cattle are improved dairy cows.

Category VI. This category consists of farmers around or close to urban centres with very small plots. The source of income is from sales of specialised products like milk, chicken, pigs, etc. The source of labour is mainly hired labour, supervised by the family. Cattle, if any, consists of improved dairy cows.

INTEGRATED ASSISTANCE TO DAIRY DEVELOPMENT IN THE ARUSHA/ KILIMANJARO AREA

Since the inception of the FAO International Scheme for the Coordination of Dairy Development (ISCDD), missions were sent to a number of member countries who had expressed interest in developing or strengthening their dairy industry. Such a mission visited the Arusha/Kilimanjiro area in 1985 and recommended a dairy development programme based on an integrated approach, paying special attention to smallholders.

The problems of development are both of a technical nature and also constraints on inputs, facilities and services. The latter include feeding, breeding and AI; animal health and veterinary services; the dairy activities of the rural cooperatives - milk collection, processing and marketing; and also the training of both dairy farmers and technical personnel.

The programme was divided into nine sub-projects:

1. **Assistance to small holders in dairy development.**
2. **Development of dairy activities in rural cooperatives.**
3. **Fodder production on large scale farms.**
4. **Expansion of the heifer breeding programme in Arushu/Kilimanjaro area.**
5. **Strengthening of the veterinary services.**
6. **Assistance to the vaccine production at ADRI in Dar-es-Salaam.**
7. **Expansion of the AI services.**
8. **Renovation of TDL operated collection/cooling centres and equipment of new centres at cooperative societies.**
9. **Support to the rehabilitation of the TDL plant in Arusha.**

ASSISTANCE TO SMALLHOLDERS IN DAIRY DEVELOPMENT - FAO PROJECT URT/86/013

This is the first of nine sub-projects and is currently being implemented and largely financed by FAO/UNDP; other donors include France, HPT, WFP, EEC, etc. It is a "transition project", due to the nature of its objectives (general and specific) and also because it lays the ground for the implementation of the other sub-projects. The general objectives of this project include strengthening of extension services, development of dairy activities in the rural cooperatives and thirdly the coordination of dairy development.

The specific objectives, which seek to deal with certain technical roles, include:

1. **to strengthen the extensive services of the regional and district livestock authorities in the project area, including farmers' training,**
2. **to investigate and popularise the treatment of roughages with urea to improve its feeding value for smallholder farmers,**
3. **to increase the quality and quantity of fodder grown by smallholder farmers,**
4. **to increase the quality and range of inputs and services required by the smallholder dairy farmers, which are provided through the rural cooperative societies,**
5. **to improve the nutrition of the animals by increasing the quality of molasses/urea mixtures fed,**
6. **to procure suitable breeding bulls for use by smallholder farmers in areas where AI services are not readily available,**
7. **to investigate the economics of baling roughages (especially maize stover) to reduce transport costs, and**
8. **to assist in the coordination of various components of the integrated plan through support to the Dairy Development Coordination Committee.**

PROJECT IMPLEMENTATION

Strengthening of the extension services

The extension services in Tanzania are centralized under the Ministry of Agriculture and Livestock Development. The scale of the project area, with 80,000 dairy farmers having a mixture of improved cows and milking zebu cows, makes it almost impossible to have an effective extension programme, considering the limited number of extension workers, especially when one thinks of individual visits as the sole extension method.

It was therefore advised that group activities, including meetings, seminars, demonstrations, study tours, farm visits and field days, be carried out with farmers. An intensive training programme was initiated for training local extension workers in two specific fields: specific technical messages and communication skills.

Involvement of women

The project has recognised the importance of women in dairy development. They are the ones that are attending the animals while the men are elsewhere. However, attendance by women at seminars has been minimal and this prompted the introduction of specific programmes (seminars) for womens' groups. Even though there has been some positive steps in this direction, more effort to involve women in extension seminars is being encouraged. To date, about 4 % of those attending field days and seminars are women; contact is also made with women's groups in rural areas and also with other groups working with programmes which are in contact with the women in the villages.

Development of dairy activities in the cooperative societies

The rural cooperative societies are multi-purpose, with the main activity being marketing of

cash crops, mainly coffee, and provisions of agricultural inputs to farmers. Since the farmers are also the cattle owners, the cooperatives have been encouraged to stock the inputs required by the dairy farmers, which include the concentrate feeds (wheat feed, maize bran, cotton seed cake and other cakes, etc.), molasses/urea mixture (MUM), dairy equipment, veterinary first aid kits and drugs.

The cooperatives have also been advised to form livestock committees to oversee this work, but this has not been effected to any substantial extent. Efforts have also been extended to advise the cooperatives to train their own personnel and, up to 1988, fifty-seven out of seventy MUM centres of the cooperative societies had sent their employees for training at the Livestock Training Institute, Tengeru. The cooperatives paid 50% of the course fees. Efforts are also under way to involve the cooperatives in AI field services for their farmers.

Dairy development coordination

The need for coordination arose from the fact that the project involves a lot of donors, including France, Britain, EEC, WFP, HPT, FAO/UNDP, etc. To coordinate all these donors and the different activities, the project has helped to form a Dairy Development Coordinating Committee which is mainly charged with coordination and monitoring of the implementation of the integrated dairy development plan.

The work of the committee is carried out by a series of technical sub-committees which in turn monitor the activities within their fields of competence. The sub-committees which have been formed under the coordinating committee include:

1. **Extension, Research and Training Sub-Committee**
2. **Heifer Production and Distribution Sub-Committee**

3. **Fodder Production and Distribution Sub-Committee**
4. **Veterinary Services and Breeding Sub-Committee**
5. **Women's Activities Sub-Committee**
6. **Milk Collection, Processing and Marketing Sub-Committee**

Feeding

Feeding is the main problem in the coffee/banana belt and this has been mainly due to scarcity of land. What the smallholder has tried to do to maintain his dairy animals has included the feeding of banana pseudostems, banana leaves, banana peelings, weeds and roadside grasses.

Except for the green feed which is grown on the edges of the coffee/banana plots, one will note that the rest of the feed resources are limited in terms of nutritive values which, in turn, affects DM intakes.

Efforts by the project have been directed towards increasing the quantity and quality of roughages produced by the smallholder farmers and also the introduction of legumes into the pastures and forage trees like Leucaena spp. Eight legume multiplication plots have been established and vegetative materials have been distributed to farmers.

Efforts to improve the feeding value of maize stover have been directed towards treatment with urea solution. Trials over the last three years have indicated that the method works and the extensionists have advised farmers to apply it by the pit method. Trials are underway to try large-scale treatment of maize stover at cooperative level. This will be undertaken, together with a study of ways of reducing transport costs of maize stover by baling, since maize stover and other roughages are transported from the lowland zone to the coffee/banana belt in loose form.

J.M. Centres has studied the impact of roughage treatment using the pit and basket methods (Table 1). Increasing the quality of maize stover at farm level has not been without problems (see below), despite the fact that practical guidelines were established for roughage treatment in terms of quantity of urea, maize stover, etc. Some positive aspects of roughage treatment have included increased intakes and particularly milk yields, and reduced wastage of the maize stover; 110kg of treated maize stover was enough to feed one cow for two weeks (with other feeds).

Table 1. Comparison of methods of treating maize stover with urea (J.M. Centres, 1989, unpublished data).

	PIT METHOD		BASKET METHOD	
	BEFORE	AFTER	BEFORE	AFTER
DM%	93.2	56.2	91.0	59.2
% DIGESTIBILITY	40.1	54.0	37.5	51.9
CP (%AM)	4.1	7.0	2.9	7.4

Feed Evaluation

This has been concerned with collection and evaluation of the feed resources currently used by the farmers. The feeds collected include banana leaves and pseudostems, elephant grass, guatemala grass, roadside hay, weeds from coffee plantations, bean straw, maize stover and even bean trash.

Description of the nutritive value of feeds used in the project area will provide information for adequate feed formulation. Determination of changes in nutritive value as a result urea treatment will provide information on the economics of treatment. Determination of differences

in nutritive values of different varieties of maize stover and bean straw will help to advise farmers (and even plant breeders). Determination of optimum length of time for treatment of stover/straw with urea and optimum quantity of urea is being carried out under farm conditions. Lastly, measuring the changes in production of milk following introduction of new technologies would help to evaluate their impact.

The feed evaluation aspect has been done and will continue to be done jointly by the project, the Sokoine University of Agriculture and INRA-France.

PROBLEMS AND ACHIEVEMENTS

J.M. Centres (1988) has analyzed the data on extension. The number of seminars has increased 460% between 1986 and 1988, while the increase between 1987 and 1988 was 170%; 40,354 farmers have been contacted since 1986 through seminars/demonstrations. In 1988, only 18,773 farmers were contacted through 638 seminars/demonstrations. Assuming farmers attend more than one seminar or demonstration, the reports say that only around 15,000 farmers will have been contacted in three years.

This figure is low considering the total number of around 80,000 farmers in the project area. The frequency of the seminars/ demonstrations needs to be increased in the villages and adjusted in relation to the dairy cattle population. Efforts to get more farmers attending these sessions need to be promoted. Emphasis should be put on women involvement. Field staff involvement needs to be reviewed, together with more follow-up of the farmers after demonstrations. Timing of seminars/demonstrations should coincide with topics.

Extension Materials

To aid in the extension programme, a number of extension materials have been prepared, distributed and used both by farmers and extension workers.

Handouts. These have been prepared on 16 different topics including: Desmodium, Siratro, Leucaena, establishment of Desmodium cuttings, 'Grass equals Milk', feeding of dairy cattle, feeding of pregnant cows, molasses/urea mixture feeding, roughage treatment, dairy cattle breeding, milk production from zebu cattle, calf rearing, calf housing, housing of dairy cattle, milking hygiene, etc.

Booklets. These have been prepared and distributed. These include calf-rearing (6040 copies), dairy cattle breeding (4670), milking hygiene (1430), diseases of dairy cattle (3920), roughage treatment (1020), feeding of dairy cattle and women in dairy development.

Slides and films have also been prepared on the topics mentioned above.

Between July 1988 and March 1989, a total of 59 seminars and 115 demonstrations were carried out, including 31 with audio-visual support. Around 3800 farmers attended these seminars and demonstrations.

Pasture establishment

The main problem here has been seed availability. The project has been trying to combat this problem by using the limited seed available to establish pasture seed multiplication plots in different locations. It is hoped that, when this is achieved, there will be seed available to farmers. Another problem related to this is the problem of seed-setting with Desmodium. It is not known as yet why this legume is not producing seed. The project has therefore been distributing cuttings to farmers and the results are encouraging.

Roughage treatement

The project has conducted roughage treatment (mainly maize stover) campaigns at farmers' level (small scale), advocating the pit method mainly and the basket method since 1986. Technically, the pit method is a good one in terms of practicability, reduced wastage and increased yields. Problems encountered in 1986/87 have included moulding during treatment, storage of the treated product, lack or limited amount of maize stover, insufficient labour during treatment and transport of the maize stover in sufficient quantities. These problems have been compounded in 1987 by the interference of the Rinderpest Campaign, abnormal rain distribution and drought, and a shortage of the roughage treatment booklets.

J.M. Centres has also looked at the percentage of farmers who have repeated the roughage treatments after the one they did during the demonstration and also through attendance at the opening of the pits. The numbers of farmers using the treatments were 28 and 76 in 1986 and 1987 respectively, and the numbers repeating the treatment in 1987 and 1988 were 12 and 17.

Large scale treatment

This started this year, 1989, but on a very limited scale due to the rains. Baling was done on only 4 farms in the Rombo District due to distances between farms and the bad roads. It is expected that large scale baling and treatment will begin August/September, 1989.

Molasses/urea mixture feeding (MUM)

The idea of using molasses from the Tanganyika Planting Company (TPC), which is a sugar factory in the project area, goes back to 1976. The plans for the scheme, as it is currently being developed, were drawn up in 1980 but implemented only in 1982. At that time it was estimated

that initial demand would be in the region of 3,000 tonnes per year with a long term potential of 10,000 tonnes. At that time molasses was plentiful and the project was assured of its short term requirements.

The mixing plant was completed in 1984 and the first sales of MUM were in 1985. Initially there were village tanks served by a tanker lorry. In 1986, plans were drawn up to increase the number of villages tanks from 20 to 70 and commissioning of the new tanks started at the end of 1986, and by 1986/7, 40 were in operation. New tanker lorries were also made available.

The initial price was 700 Tanzanian shillings (Tz) per ton. This was calculated on the basis of Tz 450/- for raw molasses and a further Tz 250/- for the urea and mixing charges. However when the tendering system was introduced at the start of the 1986/87 season, the price of MUM to the project was kept at Tz 750/- to help establish the use of this feed by dairy farmers. In mid-1987, the project was informed that it would have to pay Tz 3,500/- per ton and that the quantity allocated to the project was 3000 tonnes for the 1987/88 season. While the price to farmers had been 2.00 Tz per litre in the past it had to be 8.00 Tz for the same quantity. This had a very serious effect on the sales and use of MUM by the farmers in the project.

Experience to date shows that farmers cannot compete in terms of price with other users of MUM, even if demand was increased. Sales of MUM have therefore decreased due to prices.

The tendering system has therefore priced the MUM out of reach of many of the small scale farmers. Scarcity of other feeds makes MUM an extremely important component of the programme to raise milk yield. The project is still fighting for a price policy to be based on either the price of milk, the price of other livestock feeds (e.g. cottonseed cake, maize bran, etc.), TPC's costs of production or national inflation.

MILK MARKETING IN THE PROJECT AREA

Commercial milk marketing

In the project area is a milk processing plant situated in Arushu town, the Tanzania Dairies Ltd (TDL), which is one of seven in Tanzania. This plant collects milk from both large scale farms and smallholder farmers. It operates over 9 collection and cooling centres in the project area; the distance between TDL and the cooling centres varies from 30 to 100 kilometres.

The plant is faced with a problem that not all the cooling centres are in working order and therefore the plant does not work to capacity, as it cannot collect all the milk available and hence depends a lot on reconstituting and marketing reconstituted milk. The constraints that the plant is experiencing renders it ineffective in organising collection, processing and marketing of milk. The result has been vending of milk by middlemen and the establishment of dairy cooperatives in rural areas.

There are in the project are 3 dairy cooperatives in Kilimanjaro area where 2 are transporting and selling milk to Moshi town, while one is processing milk into cheese and markets it in Arusha and Moshi townships. These dairy cooperatives and other smallholders have found it a good business to sell the milk on their own, rather than to sell to TDL, because the price paid by the latter is lower than that which could be obtained by selling direct to consumers in town or their neighbours.

Commercialisation of milk has been growing over the years due to an increasing consumption pattern. This has resulted in smallholders investing in concentrate feeds, minerals, vitamins and drugs. This is due to high prices paid for milk and dairy animals, and the fact that farmers have realised for a long time that milk is nutritious and also an economic use of scarce land.

CONCLUSION

The feeding of dairy cattle for milk production in the Arushu/ Kilimanjaro area is the biggest problem, due to scarcity of land which necessitates zero-grazing and the use of diverse feeds from various sources. This requires, among other things, an efficient system to increase the quantity and quality of agricultural by-products and, most of all, an efficient extension programme. Involving the rural cooperatives in dairy activities will help farmers in obtaining the necessary dairy inputs locally. There is considerable potential for increasing milk production from the dairy and local cattle population, as the demand for milk is still far from being satisfied.

MILK PRODUCTION FROM TROPICAL FODDER AND SUGAR CANE RESIDUES CASE STUDY: ON FARM RESEARCH IN MAURITIUS

by

A.A. Boodoo

INTRODUCTION

The cattle population in Mauritius amounts to about 35,000 head, made up of various breeds. Of this, approximately 7,000 are females of producing age. The cattle industry in general can be

described as being a low input system. The local cattle are called Creole; they are Bos taurus type and of medium size, 300–450 kg adult weight, polled and humpless. They are predominantly white or white-brown with dun, black or brown characteristic spots (Bennie, 1956). Cross-breeding programmes, using AI and bulls, have resulted in various levels of Friesian-Creole crosses. Other exotic breeds and their crosses exist in smaller numbers.

The small farms in the villages consist of 1–4 cows per household. These cows have a milk yield of 1200–1500 litres per lactation, short lactations (225–250 days), long calving intervals (15–18 months) and they first calve at 3–3 1/2 years of age. The cows are hand-milked twice a day, generally before sunrise and at sunset. All cattle are kept indoors and fodder is brought to them. The stables vary from very simple ones built of poles with a thatched roof to improved ones with concrete walls and a roof of iron sheets.

Feed resources

The traditional practice of cowkeepers (small cattle owners in the villages) is to feed their cows mainly on sugar cane tops, which are abundant during the sugar cane harvest season (June to November), together with some selected grasses and crop residues. During the rest of the year, they feed a mixture of various grasses, creepers, shrubs, twigs and crop residues; these forages are available in varying amounts all the year round. Most of them are highly fibrous and contain 4–12% crude protein in dry matter. All forages are collected free from the neighbourhood and none are cultivated, at the cowkeeper level, for use as cattle feed.

Socio-economic importance of cowkeepers

The cowkeepers form an important socio-economic group as they supply about 95% of the fresh milk produced in the country. This is equivalent to about 12% of the total consumption of

milk which amounts to about 90 million litres per year (fresh milk and imported milk powder). Cattle rearing in the village smallholdings is a family business and generally a part-time activity. This makes the business a flexible one in the sense that, depending on circumstances, the smallholder can add or sell one or two head of cattle quite easily. This is perhaps one important factor contributing to the fact that, despite the recent wave of industrialisation with its accompanying migration of labour from agriculture to the factories, the cowkeeper community has continued to be in business, although their number has decreased compared to a couple of decades ago. The cowkeeping tradition is still present in the rural areas and people still like to invest in this family business. There is a continuing demand for fresh milk both in the urban and rural areas.

BACKGROUND

In 1971, the Milk and Meat Project (FAO) diagnosed that lack of supplementation limited milk production. However, it was not specified whether it was energy or protein in the supplement that was important, and the basal diet of cane tops and grasses was not evaluated. This FAO study also proved technically that milk yield could be increased considerably by better feeding and management.

Recent research findings (Ma Poon et al., 1977 Gaya et al., 1982), obtained by the Ministry of Agriculture on Government farms, pointed out that one important limiting factor regarding milk production was the role of appropriate supplements which can stimulate consumption and utilization of roughages rather than depress roughage intake.

On the basis of these findings, the need was felt to further investigate the milk production potential of cows in the country. As the cows in the village smallholdings make a major contribution to the national production of fresh milk, it was decided, within the context of a

project funded by the UNDP, to carry out the on-farm research described here in these smallholdings. This was decided because it was possible to have access to a large number of pregnant cows (experimental units) in a relatively short time and at almost no cost in the villages, whereas it would have been very difficult to obtain similar facilities on state farms.

OBJECTIVES

The objectives of this study were to:

a. **investigate the effect on milk yield of supplementing the village cows with two types of concentrate, the traditional dairy concentrate (cowfeed), consisting of about 45% locally produced ingredients, and imported cottonseed cake;**
b. **describe the forage feed base'at the cowkeeper level;**
c. **evaluate the performance of the local Creole breed, Friesians and their crosses.**

ORGANIZATION OF ON-FARM TRIAL

Multi-disciplinary approach

The Animal Nutritionist was the team leader. The Extension Officer organized the evening meetings with the cowkeepers. Extension Assistants residing in the villages made daily visits to the farms and helped in data collection. They travelled on bicycles. Notebooks were kept at the cowkeepers' homes for recording animal weights, milk production, fodder offered, etc. The Veterinary Officer looked after the health of the cows and assessed pregnancy.

Equipment used

This consisted of a van for transporting staff, concentrates and an electronic cattle scale; a

bathroom scale to measure birth weight of calves; a spring balance to measure the quantity of forage; and a kitchen scale for concentrates and minerals.

Specialized facilities

A chemistry laboratory was available for chemical analysis of feedstuffs and cannulated animals for nylon bag study of forages.

PROCEDURE

Concentrates

The cowfeed had 17% crude protein and was made up of 30% cane molasses, 30% cottonseed cake (or groundnut cake), 5% wheat bran, 11.5% rice bran, 20% maize, 1% common salt and 2.5% calcium carbonate. Cottonseed cake had 44% crude protein and was fed together with a mineral supplement of 15 g common salt and 50 g calcium carbonate per day. It was chosen for comparison with cowfeed because the Ministry proposed to use it later as a straight protein supplement, thus sparing mixing and transport costs.

Forages

The cowkeepers fed their cows forages ad libitum according to normal practice. Regular visits, 3 times per week, were made to the cowkeepers' farms and observations were made of management practices and animal behaviour associated with the supply and consumption of fodder. Measurements were made of total feed intake on 30% of the total number (88) of cows participating in the project.

The cane tops were first separated into two fractions, sheath bundle and leaf blade, with a large

knife before analysis. For nylon bag work, two mature Friesian × Creole steers fitted with permanent rumen cannulae were used. They were fed a mixture of 20 – 25 kg Setaria sphacelata and Ischmaemum aristatum and 1 kg cottonseed cake plus minerals.

Choice of cows

Cowkeepers who were willing to participate in the project voluntarily registered their names at their local Extension Office. When their cows were seven months pregnant, they started to receive the concentrates. Each cow was alloted in turn to either the cowfeed or cottonseed cake treatment.

Table 1 summarises the pattern of feeding the supplements which were given in two feeds daily.

Table 1. Daily levels of supplementation during the last 3 months of pregnancy and during lactation (Boodoo et al., 1988a)

	Cowfeed	Cottonseed cake
7th month (kg/d)	2	1
8th and 9th month (kg/d)	3	1
Lactation (kg/l milk)	0.5	0.25

The amount of cowfeed fed was twice that of cottonseed cake, because it had less than half the amount of protein as compared to cottonseed cake. Supplementation started at the end of pregnancy to make sure all the cows participating in the trial had adequate nutrition for fetal growth and lactation.

Management of calf

Only one aspect of the traditional management of the cowkeeper was interfered with during this study; anyone who used to allow his calf to suckle its dam was required to feed it from a bucket from the 7th day after calving until weaning at three months. This was necessary to measure total milk yield accurately.

RESULTS

The trial was conducted in 2 different climatic areas, with 3000 and 1450 mm rain per year respectively. The mean milk production of the cows (all breeds together) on the two types of supplement is summarized in Table 2. Milk composition was determined from monthly morning milk samples.

Table 2. Mean milk production and milk composition data, 22 cows per concentrate in each area (Boodoo et al., 1988a).

	Wet uplands		Dry Northern Area		Significance	
	Cowfeed	**CSC**	**Cowfeed**	**CSC**	**Area**	**Feed**
Milk production (kg)						
301 day lactation	3023	2871	2538	2649	P<.05	NS
SE	146	104	139	129		
Milk composition						
Mean fat (%)	4.08	4.57	4.31	4.61	NS	NS
SE	0.222	0.164	0.183	0.192		
Mean protein (%)	3.41	3.58	3.47	3.40	NS	NS
SE	0.149	0.118	0.061	0.089		

There was no significant difference between cowfeed and cottonseed cake in terms of milk

yield. However, supplementation increased milk production by about 1400 kg per lactation, compared to the traditional yield of about 1200 – 1500 kg. Supplementation also prolonged lactation from the national mean of 225–250 days to 301 days. The lactation curves (Boodoo et al., 1988a) were of the classical shape with peak lactation (14.7 and 11.3 litres/day, for the wetter and drier areas respectively) occurring in the second month. The upland cows produced significantly more milk but there were no significant differences in milk fat and in milk protein due to the different areas and concentrates.

The effect of breed on milk production

The cows were classified on the basis of their phenotypic appearance into (1) the local breed, Creole (23 cows), (2) Creole × Friesian (47 cows) and (3) Friesian (18 cows). Table 3 summarises their milk production data. There were no significant differences in total milk production between breeds. These yields compare with national yields of up to 1500 kg for cows receiving little or no supplement and imply a response to supplementation.

Effect of harvest season on milk production

The average milk production of cows calving during the sugar cane crop season (June to November) was 2950 ±92 kg and was significantly (p<0.001) higher than the average for cows calving outside the cropping season (December to May) which was 2705 ±76 kg. There was not a statistically significant interaction between area and time of calving on the total milk production per lactation.

Table 3. Milk production data (kg) by breed (Boodoo et al., 1989). (SE in brackets)

		Creole	Crossbred	Friesian
Uplands	301 days	2788 (232)	2958 (115)	2899 (176)

Uplands	301 days	[illegible]	[illegible]	[illegible]
	Peak[1]	13.0 (0.2)	14.5 (0.4)	13.0 (0.8)
Northern Area	301 days	2889 (216)	2536 (124)	2459 (156)
	Peak[1]	12.1 (0.4)	12.4 (0.6)	10.3 (0.7)

[1] Mean daily production in the 2nd month of lactation

OBSERVATIONS ON THE INTAKE OF FORAGES

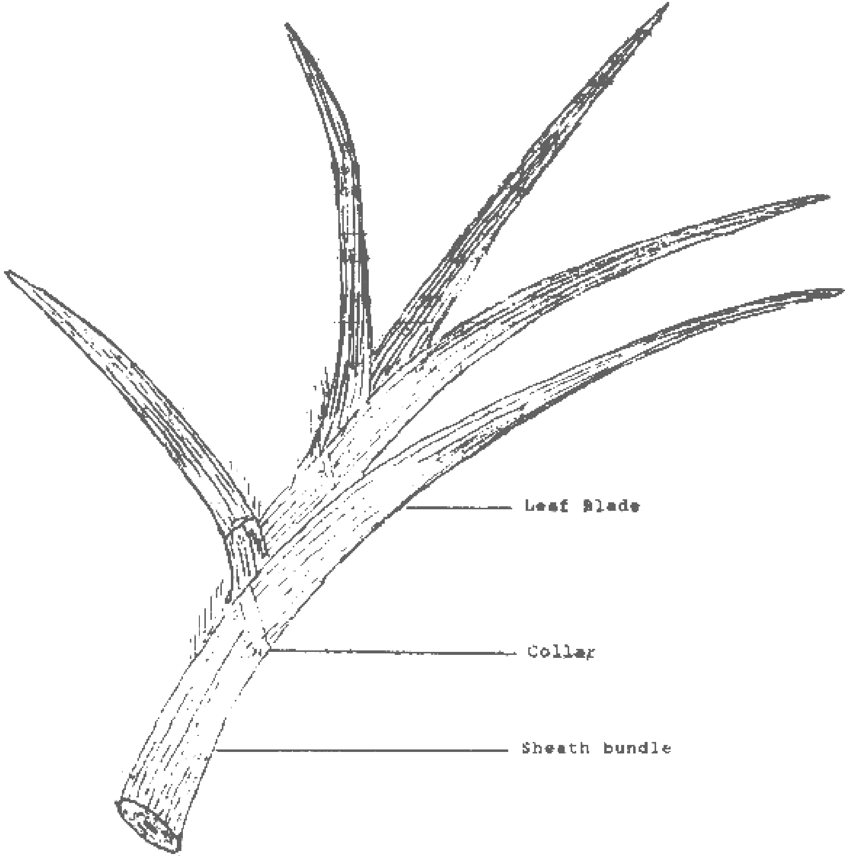
The cane tops that were collected by the cowkeepers did not include any flowering ones. In addition, the cowkeepers carefully selected the cane tops and discarded the very mature ones. From those selected, the outer older leaves and all dry ones were discarded. Some cowkeepers had the habit of chopping off and discarding about a third of the leaf blade at the tapering end when they were collecting their bundle of cane tops in the field.

The cows' eating behaviour, as noted during the farm visits, was confirmed in numerous interviews with the cowkeepers. The cows consistently started to consume the cane tops at the sheath bundle end. They consumed the whole of the sheath bundle portion first, then started to eat the leaf blade (Figure 1). They consumed only part of the leaf blades on both sides of the midrib. It was estimated that from one third to one half of the leaf blade was thus consumed.

It was observed in the wet uplands that Ischaemum aristatum (herbe d'argent) generally formed the bulk of the fodder that was given to cows during the sugar cane inter-crop season whereas other assorted forages, singly or mixed, were given in small amounts of a few kilograms per cow. In the drier area, Plantago lanceolata, Digitaria didactyla, Stenotaphrum dimidiatum and young cane regrowths (about 50 cm high) generally formed the bulk of the fodder in the inter-

crop season. A few kilograms of other assorted forages, singly or mixed, were also given to the cows.

Figure 1. Sheath bundle and leaf blade fraction of cane top.



Chemical composition

The sheath bundle fraction had a lower dry matter and crude protein content (19.3% and 5.5% respectively) than the leaf blade (31.3 and 7.3%) or the assorted forages (23.1 and 9.7% respectively). The crude protein content of the assorted forages and crop residues (9.7%) was quite interesting. The leguminous forages contained up to 14% crude protein (Table 3).

Table 3. Chemical composition of the sheath bundle and leaf blade fractions of cane top, the assorted forages and crop residues (on dry matter basis) (Boodoo et al., 1988b).

	Dry Matter			Crude Protein			Crude Fibre		
	(n)	Mean	SE	(n)	Mean	SE	(n)	Mean	SE
1. Leaf blade*	(23)	31.3	0.9	(25)	7.3	0.4	(22)	32.9	0.8
2. Sheath bundle*	(23)	19.3	1.0	(24)	5.5	0.3	(22)	31.9	0.5
3. Assorted forages and crop residues	(49)	23.1	1.0	(49)	9.7	0.5	(15)	31.0	1.2
Range for assorted forages etc.									
Min.		13.3			5.0			14.5	
Max.		40.9			14.6			37.2	

*** These fractions were prepared from one original big bundle (about 7kg) of cane tops.**

<u>Rate of degradation in nylon bag</u>

Results of the nylon bag study of the various types of forages are shown in Table 4. These data show that the sheath bundle fraction degraded much faster than the leaf blade at all the time intervals studied. On the other hand, the sheath bundle and assorted forages show remarkably similar DM degradabilities from the 16, 24, 48 and 72 hour incubations. The rate and extent of degradation supports the view that the sheath bundle and assorted forages are good quality

roughages in this environment. Their potential degradability is approximately 26% higher than that of the leaf blade.

Table 4. Mean dry matter degradability values of the cane top fractions and assorted forages at various intervals in nylon bags (Boodoo et al., 1988) SE in brackets).

	Incubation Time (h)					
	n	**0**	**16**	**24**	**48**	**72**
Leaf blade	18	12.0	27.0	34.3	47.0	53.4
		(0.6)	(1.1)	(1.0)	(1.1)	(1.1)
Sheath bundle	18	21.5	46.7	55.5	62.6	67.2
		(0.7)	(1.5)	(1.3)	(1.1)	(0.8)
Assorted forages	18[1]	16.4	44.5	54.6	63.5	66.4
		(0.7)	(1.6)	(5.2)	(1.3)	(1.3)
LSD (5%)		2.2	5.3	4.7	4.2	3.8

[1]These 18 samples were a random selection from 49 original ones.

Intake

Table 5 summarizes the data on forage consumption, liveweight and DM intake.

Table 5. Quantity of forage offered and eaten. Liveweight of the lactating cows and their DM intake on diets consisting predominantly of (a) cane tops and (b) mixed grasses with crop residues (Boodoo et al., 1988b). (SE in brackets).

	Wet uplands		Dry Area	
	Cane tops	**Mixed grasses**	**Cane tops**	**Mixedgrasses**

n	7	7	9	5
Fodder offered	69.3	68.0	73.1	62.6
(kg fresh/day)	(4.11)	(4.3)	(1.0)	(4.2)
Fodder eaten	43.6	57.2	52.1	49.2
(kg fresh/day)	(3.5)	(2.2)	(1.8)	(2.2)
Surplus feed (% of amount eaten)	58.9%	18.9%	40.3%	27.2%
Liveweight of cows (kg)	342	353	364	311
	(21.8)	(13.3)	(11.4)	(16.0)
Fodder intake	11.8	13.5	14.1	11.0
(kg DM/day)	(0.9)	(0.7)	(0.5)	(0.5)
Concentrate intake	2.7	3.3	3.5	2.9
(kg DM/day)	(0.3)	(0.4)	(0.4)	(0.5)

The cows were offered forages ad libitum such that the surplus amounted to 19–58% of the amount eaten, especially sugar cane tops which are abundant during the harvest season. This surplus gave them plenty of scope to select the best parts and this resulted in a high intake of fodder dry matter (about 3.7% of body weight).

DISCUSSION AND CONCLUSION

Cottonseed cake provided slightly more protein than cowfeed at the levels used. However, cowfeed, because of its molasses content would have provided more energy than cottonseed cake. It is therefore interesting to note that similar levels of milk were obtained with these two supplements, which point to protein being the primary nutrient limiting milk production under these conditions.

The traditional practice of selectively feeding a variety of forages has sound scientific basis. With time, the cowkeepers have developed an appreciation of forage quality. The present data show that the rate and extent of degradability of the sheath bundle fraction of cane tops and the assorted forages are the basis for good milk production in the villages, compared to the larger systems of production where there is less attention to forage selection.

The local Creole breed has sufficient potential for milk production, given the climate and the resources available on village smallholdings in Mauritius. There would therefore appear to be no advantage to be gained from the importation of exotic breeds for milk production.

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TRAINING IN THE DEVELOPMENT OF FEED RESOURCES

by

R. W. Froemert

INTRODUCTION

The FAO Regional Dairy Development Training Team for Asia and the Pacific has been engaged since 1972 in training of extension workers and milk plant personnel. Some 2500 officers from 15 countries of the Asia and Pacific region have been participating in specialized courses of 2–6 weeks duration and self-teaching programmes. Training of smallholder milk producers consists of short courses and demonstrations at dairy development training units (small demonstration

farms) in Sri Lanka, Thailand and Indonesia and the operation of mobile dairy extension units in selected areas of Thailand and Indonesia.

Having noted the lack of specialized knowledge and experience of field extension workers in forage preservation, the Team designed training activities in making silage and hay, which provide the trainee extension worker with adequate practical experience to handle these subjects competently on the village level. The Team has contributed to the development of small scale preservation practices: silos, hay drying racks, hay stores and feeders, which fit the means, skills and requirements of the small farmer. A better utilization of various field crop residues and industrial by-products as cattle feed has been promoted.

The successful introduction of new practices benefitting the village community depends a great deal on the proper presentation to the farmer. Part of all training activities in forage production/ preservation and use of alternative feed resources is the development of training material, "persuasive" posters and handouts for the farmer.

DEVELOPMENT WITH AND FOR THE SMALLHOLDER

Sites and Modes of Training

A sound development of smallholder (dairy) farming and the designing of realistic extension and training programmes supporting this development require, first and above all, to listen to the farmer. The small farmer is a professional. His profound knowledge of his environment, his experience and practical skills are valuable assets of development.

The researcher (extension worker) must realize that it is no use to drop a new idea (farming practice) on the practical man and hope for the right adjustments at the practical level.

Developing his ideas requires the researcher (extension worker) to take into account the height of the hill to be reached, the obstacles in its way and the weight of the idea or recommendation.

Introducing to smallholder farmers a new method of forage utilization, such as silage or hay making, requires considerable experience on the part of the extension worker. A through analysis of training courses, conducted in 7 countries of the region for extension workers in dairy husbandry, reveals that the time allocation for practical forage preservation is completely inadequate. The lack of experience endangers the success of extension activities on the village level.

To reinforce practical training facilities for trainee extension workers and smallholder milk producers, the RDDTTAP (Team) has set up small scale demonstration farms (Dairy Development Training Units) in 3 countries of the region: Sri Lanka, Thailand and Indonesia. It is here that small numbers of farmers gather for repeated one-day training activities and are acquainted with new farming practices and developments. They include aspects of forage production/preservation.

Besides training rendered by extension workers operating from DDTUs, training is being extended to other areas relevant for dairy development through mobile extension units (Thailand and Indonesia). The Team developed and is developing a special tool for mobile operations: the training kit. It contains a comprehensive collection of equipment and training material required by the extension worker to demonstrate particular points of the subject matter and to enhance the understanding of it by the farmer. Training kits on forage production and preservation are in the state of being completed.

An integration of DDTUs, mobile dairy extension units and agricultural colleges in support of the resident extension worker is envisaged as part of the development strategy pursued by the

Team.

On the basis of encouraging experiences in South America with self-teaching programmes, the Team has introduced self-teaching programmes on ration formulation in Sri Lanka. The programme is aiming at a better knowledge of the field extension worker on ruminant nutrition and balanced feeding, as well as to encourage the establishment of a closer network for his support by research and teaching institutions.

SILAGE MAKING

A Technology for the Smallholder

If silage making and feeding is to be introduced to smallholders, the extension worker tends to organize a "Field Day" on one of the nearby government farms. What does the small farmer observe? An impressive technology - but nothing which could fit his own farming conditions. The extension worker, with the tower silo in his mind, may even build one on his own. It is too big for one farmer, so he calls it "community silo." But is it practical? A more simple and inexpensive approach to "persuade" smallholders to adopt silage making is still the famous pit silo. But what about silage quality? What about losses reducing the amount of feedable plant matter?

Silo pits are of temporary nature. When not reinforced (costs!), they may even encourage erosion and their walls collapse during the rain. If silage making becomes a regular practice on a smallholding, other building materials may be considered, e.g. bamboo. Silos must be airtight to provide anaerobic conditions for fermentation. Wire netting (chicken-wire) can be connected to the inner wall of the silo, to provide the reinforcement for a thin layer of concrete. A plastic jacket may provide for the same conditions, but lasts only through one silage campaign and

feeding period. Even after years, when the bamboo structure may have disintegrated, the concrete wall is still intact, the silo still usable.

The time which is required to fill a silo and seal it appears to be the most decisive factor for the production of quality silage. Chopping of forage is a necessity for appropriate compaction of the forage mass. But chopping by hand needs many hands and is time consuming.

Forage choppers of many kind are available. They often exceed the capacity which is required for the smallholder's operation: chopping of forage for fresh feeding <u>and</u> ensiling. Animal driven forage choppers have been successfully used for many years in India and Pakistan. The two-wheeler tractor is a common piece of equipment for the small farmer in Thailand as elsewhere in the region. It is used for all the land tilling operations connected with the cultivation of paddy. A technology, which is not to burden the small-holder and to increase his cost of production, must be linked to existing elements and resources. Two-wheeler tractors can be engaged as power source in forage chopping (e.g. in Sri Lanka).

<u>Training and demonstration methods which can persuade the smallholder</u>

Methods and practices used in training of smallholders must help the trainee to identify the demonstrated practices and techniques as within his reach and means. To introduce silage making on smallholdings through the use of big machinery and equipment is a didactic mistake. Sometimes also too many trainees are gathered, too many trainees not occupied. The demonstration, more often than not, has no follow-up. The farmer observes that grasses can be "buried". Since he does not see the result, he may think: 'What a waste!'.

TOPIC: INTRODUCING SILAGE MAKING

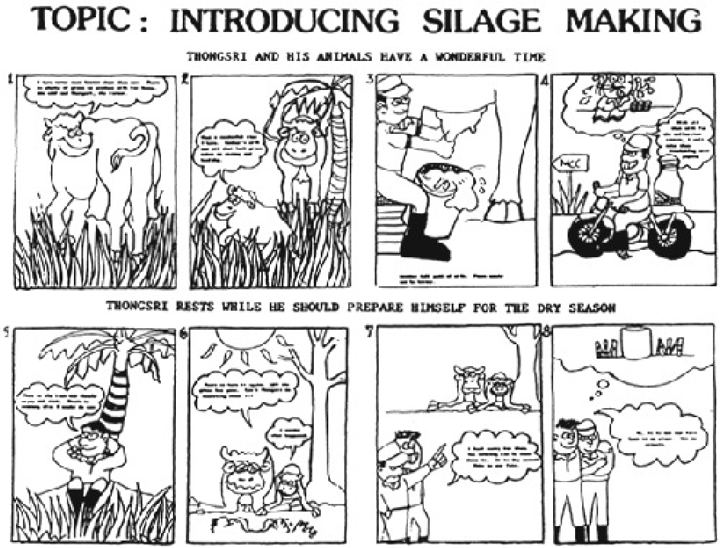
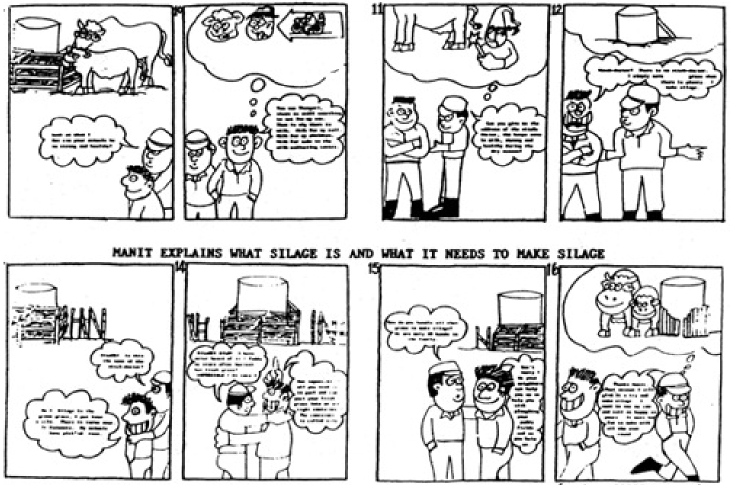


Figure 1a.

TOPIC: INTRODUCING SILAGE MAKING



(poster: RDDTTAP, 1988)

The chart (Figure 1) demonstrates the need for a well timed and organized training activity on small scale silage making, during which all steps from silo construction to silage feeding are shown. Trainee extension workers work together and learn together with the farmer during a field day on a smallholding.

Prior to the introduction of silage making, farmers are taught the basic requirements for the production of quality silage (chopping, quick filling, compacting, sealing). Chopping by hand can be employed for handling smaller quantities of forage to produce sample silage. Well cleaned, 44-gallon oil drums furnished with a plastic jacket may be used as silos. In connection with the Team's work at DDTUs linked to agricultural colleges, concrete sewage pipes (height 1 m, diameter 1 m) have been used as silos.

With a sufficient number of experimental silos, the impact of various processing practices of forage on the quality of silage can be demonstrated (e.g. unchopped = insufficient compaction = continued respiration of plant matter = suppression of lactic acid producing bacteria). The proper closing (sealing) of the silo immediately after completing the fill is demonstrated.

Silos need to be identified with regard to the plant matter ensiled, its quantity and the treatment applied. Brief descriptions, on boards of the silo wall, also make it easier to explain new developments and practices to the visitor to the demonstration site.

The circular silo erected from bamboo poles (height 1.80 m, diameter 2 m) can be filled to contain around 2 tons of forage. A compaction of 300–350 kg/m^3 by treading is only possible if the forage is chopped.

Trainee extension workers and farmers are made acquainted with the criteria for the wanted fermentation. On the basis of organoleptic tests, they produce a quality score. The decisive test is the animal's intake. Silage of good quality has been produced from sugar cane tops in an experimental silo. Tops were chopped, well compacted and 4% molasses added.

Forage planning and the use of crop residues and industrial by-products

The eager extension worker may wish to do something immediately about forage preservation in his working area. But has he looked carefully into the requirements and conditions for silage making? Above all, has he looked into the farmers' "feeding calendar" to see if silage is really needed and if there is sufficient surplus of forage to make silage preservation feasible?

Once it has been determined that silage needs to be produced, the quantity of forage required has to be specified and the silo capacity and dimensions be calculated. Trainee extension

workers have to be engaged in exercises along these lines. An overestimated forage quantity leads to an only partly filled silo, increasing the surface area for the fodder mass and does often result in inferior silage quality.

Participants of Team-supported training courses are requested to establish an inventory of available feed resources. If there is no surplus of forage crops, field crop residues and industrial by-products can fill the gap. Sugar cane tops have been recognized as a potential feed resource both for being fed fresh and as silage. The vast quantities of sugar cane tops available during the campaign period suggest that they are wasting feed resources by improper feeding practices. Farmers are advised to construct inexpensive feeders (bamboo feeders at DDTU Nakhon Sawan) and to chop cane tops to reduce waste. The Team has encouraged extension workers to make use of pineapple cannery waste as cattle feed. Some years ago, pineapple waste was discarded at dumping places, creating problems of pollution. A number of training activities were conducted to demonstrate silage making from pineapple cannery waste together with paddy straw.

HAYMAKING

"The growing season of grasses coincides with heavy rain. Haymaking is not possible." This statement may justify the common observations made during visits to small and big dairy farms alike in this region that no hay can be found in calf pens. But if so, there is some colourless, stale dry roughage. It deserves to be called straw - but not hay.

Based on hay drying practices experienced earlier in temperate climates, the Team, during training courses for extension workers, attempted to develop a technology of hay curing suitable for the smallholder and applicable during the rains.

The "classical" tripod worked well in Pakistan, (forage crop: Trifolium alexandrinum), but was found unsuitable for the conditions to be encountered during haymaking in countries like Thailand, Sri Lanka or Indonesia. Layers of wilted forage on tripods become too compacted, thus hindering air circulation and causing the development of moulds.

Satisfactory results were achieved with a drying fence. It is constructed by inserting (4) poles in a particular pattern in holes driven (1.10 m apart) into the ground using crowbars. Then layers of shortly wilted forage are placed on ropes connecting the poles. The forage on fences is covered between rains by mats made from palm leaves.

A drying rack called the "Hurdle" proved to be the most easy to construct and practical means for drying small quantities of hay efficiently during the rains. Hurdles, made from timber or bamboo, can be used in flat as in hilly areas. After a few hours of pre-drying on the ground, encouraged by continuous turning, the forage is packed onto the horizontal runners. For the first or second day the roof may be removed during sunny spells to encourage fast drying. Thereafter, the hood is kept until transfer of the hay to the site of feeding. Permanent shading prevents bleaching (i.e. loss of carotene).

Research workers at the National Dairy Training and Applied Research Institute (NDTARI) in Thailand, supported by the Team, developed an extremely successful drying technique using 1-pole racks ("Heinze") as the basic element. The drying rack consists of poles, a dark plastic sheet in the bottom of the drying rack which collects the suns rays, and transparent plastic sheeting provides protection for the forage mass from the rain. Smaller drying racks of this kind have been developed and are regularly demonstrated by NDTARI to participants of training courses. The drying process takes 1–3 days and produces a green coloured, aromatic hay.

Together with hay curing practices suitable for the small farmer, baling of hay by "baling box"

was introduced, particularly to avoid losses through leaf shattering (fragmentation) during transport.

Hay may be stored in many ways. Since the smallholder is encouraged to produce small quantities of hay for calves as often as possible to avoid spoilage occurring during extended storage periods, only small quantities need to be kept. A combination of a roofed silage pit and a hay drying/ storage platform makes excellent use of limited place on smallholdings (e.g. in Sri Lanka). Hay may also be stored on a well-aired platform established on top of the area, where calves are housed (e.g. DDTU Nikaweratiya, Sri Lanka).

In search of practical, low cost methods for handling, storing and feeding of hay, the Team has utilized the farmer's skills for wickerwork. Hay for a number of calves can be stored in roofed self-feeders which are best placed in exercise yards.

Problems in curing quality hay during the growing season of grasses, which coincides with heavy rain, can be mastered by selecting appropriate drying practices and sticking to a flexible management which makes maximum use of dry and sunny spells. The remaining problem is the storing of hay under condition characterized by a high humidity.

MAKING BETTER USE OF PADDY STRAW THAN BURNING

Cereal straw of different kind forms the bulk of crop residue available immediately after threshing. Draught animals are often fed entirely on straw without losing body weight. Though low in feed value, straw has to be used extensively on many smallholdings to form a major part of the maintenance ration for dairy animals. But straw is also burned, year by year, after harvest and threshing of grain crops.

The Team has encouraged, through training of extension workers and farmers, to better utilize available straws for cattle feeding, either by ensiling it together with low dry matter industrial by-products (cannery waste) or by ammoniation. For the treatment of cereal straws (mainly paddy), the Team promoted, as a temporary arrangement without investment in permanent structures, the covering of treated straw stacks by plastic sheets (6% urea, 3 weeks storage).

Similar to training activities in silage making, demonstrations to farmers on straw treatment have to include all stages from processing to feeding. Trainee extension workers, at the end of the course, develop their own training aids and conduct a field day at a farm site.

Lately, it is being tried in Pakistan to combine the threshing of cereal crops and the treatment of straw with urea, with the aim of making better use of available manpower at the time of threshing.

THE NEED FOR MINERALS AND SMALL-SCALE BLOCK MAKING

The making of mineral blocks was originally introduced as a training activity for extension workers and farmers as a didactic means to make extension workers and farmers aware of the importance of minerals in support of growth, milk production, breeding efficiency and reproductive performance. To talk to farmers about the need of animals for calcium phosphorus, potassium, etc. remains highly theoretical and is generally beyond his comprehension. The presentation, during a demonstration to farmers, of chemical compounds containing the required elements, the weighing (dosing) of compounds and their mixing according to an explained formula, brings them nearer to understanding the complex nature of this feed ingredient.

In following up on this aspect of training, more efficient presses were developed, which have

made it possible to produce mineral blocks in bigger quantities for sale to dairy farmers (e.g. in Thailand). Formulae based on observed mineral imbalances in cattle rations have been developed.

FAO TECHNICAL PAPERS

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20/2. Trypanotolerant livestock in West and Central Africa, 1980 - Vol. 2 - Country studies (E* F*)

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35. Off-tastes in raw and reconstituted milk, 1983 (E* F* S*)
36. Ticks and tick-borne diseases: selected articles from World Animal Review, 1983 (E* F* S*)
37. African animal trypanosomiasis: selected articles from World Animal Review, 1983 (E* F*)
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