A SYSTEM OF MILK PRODUCTION FOR SMALL FARMERS

By

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SUMMARY

The socio-economic and biologic basis for the development of a prototype of a milk production system for the tropics is given. The system takes into account the resources and constraints that are characteristic of the small farmer in Central America. Ample use of pastures, moderate use of agricultural by-products and minimum use of whole milk are the characteristics of the feeding components. Moderate milk production levels per cow, but high production per unit area are possible by using crossbred cattle of small or moderate body size and a fast-growing grass species. The system produces 15,000 kg of milk/ha/year. Economic analysis under Costa Rican conditions indicates a net profit of 35 % including all operational and fixed costs.

INTRODUCTION

Central America is a region where the livestock development potential is high. Although there are specific differences among countries, the region, as a whole, exports beef at a total value of US $ 192 million/year (FAO, 1978). The calculated deficit in milk in Central America is 1,045 MT/year (SIECA-GAFICA, 1974). This deficit, coupled with the projected increase in population from 17 million in 1975 to 36 million in the year 2,000 (IDB, AID and IBRC, 1977), has prompted a change in agricultural policies seeking an increase in milk production. Unfortunately, there is a dearth of information regarding milk production under tropical conditions. Most of the available information on the subject has been produced in Australia (Swain, 1971; Stobbs and Thompson, 1975).

As stated by Swain (1971), an animal production system in any environment requires a large, evenly distributed and reliable supply of feed that can be efficiently utilized by the animal. The evolution of the system depends on the interaction of the climate, the farmer's managerial and technical skills, the available technology, the social and economic status of the producer and the incentives and marketing systems present.

The development of appropiate dairy production systems, therefore, must be based on the consideration of the individual components of the system. This paper illustrates an effort to achieve an understanding of the major aspects that determine the biologic and economic feasibility of a milk production system prototype, as well as its suitability for small farmers in Central America.

SMALL DAIRY FARMING IN CENTRAL AMERICA

Most of the economically active population in Central America is in the agricultural sector. Within this sector, there are wide differences in the distribution of income, as seen in Table 1, such that while 6 % of the population receives 45 % of the total income, small farmers having up to 35 ha, and representing 94 % of the rural population receive only 55 % of the total income.

Table 1. Rural population and agricultural income by socio-economic strata in Central America*

	Population		Income	
	In thousands	%	US $	%
Total rural population	10,062	100	1,245	100
Landless to 4 ha	7,640	76	371	30
Farms 4 to 35 ha	1,835	18	315	25
Farms with more than 35 ha	587	6	559	45

* SIECA-GAFICA (1974).

In a study (CATIE, 1978) of Costa Rican farms having less than 50 ha in size or less than 50 head of cattle, it was found that three-fourths of all farms mixed the livestock activities with either perennial crops (37 %) or annual crops (10 %) or both (29 %), with the remaining 24 % raising only cattle. For half of the farmers involved in the study, the cattle enterprise was considered to be the most important source of income; 47 % pointed to perennial crops (coffee, sugarcane) as the major source of income and only 3 % derived most of their income from annual crops (corn, beans and others).

Looking into the cattle component, the most prevalent form is the so-called dual-purpose system (Table 2), characterized by once-a-day milking of Zebu crossbred cows which are allowed to nurse their own calves an average of 6 hours daily (Pezo, Avila, Ruiz and Ruiz, 1980).

Table 2. Type of livestock enterprise in relation to farming system*, percentage of all farms

System	Beef (cow-calf) production	Specialized dairy	Dual-purpose
Only cattle	2	36	62
Cattle + annual crops	0	3	97
Cattle + perennial crops	2	14	84
Cattle + annual + perennial crops	0	2	98

* Pezo, Avila, Ruiz and Ruiz (1980).

The Costa Rican farmer, like his other Central American counterparts, makes ample use of pastures to feed his cattle. However, a meaningful proportion of farmers also use other feed resources (Table 3).

Table 3. Feed resources, other than pastures, used by small farmers in milk production systems

Feed resource	Specialized dairying %	Dual-purpose enterprise %
Proportion of total population using feed resources additional to pastures	41	37
Of those using such resources,		
-Use commercial feeds	75	12
-Use sugarcane molasses	50	25
-Use banana pseudo-stem and fruit	62	65
-Use sugarcane	12	28
-Use other materials	19	17

Although the proportion of farmers using additional feeds is not affected by the type of dairy enterprise, those who have specialized dairy operations use energy-rich feeds more so than those with dual-purpose operations. This is an indicator of better animal husbandry and technical knowledge of farmers with specialized dairy operations.

Obviously, straight dairying involves more investment (an average of US $ 14,506 per farm) than the dual-purpose enterprise (US $ 10,710 per farm); however, gross income from specialized dairies far exceeds that obtained from the dual-purpose system as evidenced in Table 4.

Table 4. Farm income according to milk production systems in Costa Rica, all values in US dollars

Source of income	Specialized dairying	Dual-purpose enterprise
Milk sales	3625	1040
Beef sales	19	159
Other farm products	2166	3320
Total gross income	5810	4519

Although it is recognized that the dual-purpose system is the most prevalent form of milk production in Central America (refer to Table 2 for an example), a shift in favor of the specialized dairy will occur if there is a good road network linking the farms to the major markets or processing plants.

An example of this situation can be observed at the Monteverde-Santa Elena area in northwestern Costa Rica, which includes a large milk-processing plant. Despite the distance from any major population center (San Jose, the capital city is about 250 km away), the most common livestock enterprise is the specialized dairy (58 % of all farms with cattle), followed by the dual-purpose enterprise (34 %), the remainder being specialized in beef production (Table 5). In fact, it seems that when a farmer decides to undertake the specialized dairy enterprise, he often makes this his sole agricultural activity.

Table 5. Distribution of milk production enterprises across farming systems in the Monteverde-Santa Elena area of Costa Rica*

Farming system	Specialized dairying % of all farms	Dual-purpose enterprise % of all farms
Cattle only	53	22
Cattle and annual crops	33	33
Cattle and perennial crops	0	11
Cattle, annual and perennial crops	14	34
	100	100

* Francisco Romero, unpublished results, 1980. CATIE, Turrialba, Costa Rica

The thesis that if credit and appropriate technical assistance are available, the farmer will change from dual-purpose to straight dairying, is based on three bits of information. The first of these is that of all small farmers surveyed in four different regions of Costa Rica, 63 % desire to change their present farming practices and would do so by accepting both credit and technical assistance (CATIE, 1978). Secondly, as represented in Table 6, it is obvious that those involved in specialized dairying are more prone to use credit and accept technical assistance than farmers with the dual-purpose enterprise.

The third evidence for the readiness of farmers to change to specialized dairying is the result of a joint effort by the Central Bank of Honduras and the Tropical Agricultural Research and Training Center (CATIE) to provide technical assistance to farmers, on the northern coast of Honduras, who have received loans from the bank. These include mostly dual-purpose enterprises where 32 % of all farms are between 5 and 50 ha in size and 56 % are farms between 51 and 200 ha, the remaining 12 % having between 201 and 500 ha. Nevertheless, regardless of farm size, there has been an accelerated rate of adop-

Table 6. Farmer's attitudes toward development factors, % of all farmers*

Criteria	Specialized dairying	Dual-purpose enterprise
Use credit	60	40
Receive technical assistance	31	13
Keep farm records	31	15
Wish to improve	69	63
Belong to cooperatives	37	32

* Monteverde- Santa Elena region of Costa Rica. (Francisco Romero, unpublished results).

tion of techniques related to specialized dairying, over a period of one to two years (Proyecto BCH-CATIE, 1979). For example, in 1977, 76 % of all loan-recipient farmers had 7, or less, basic improved practices for milk production already established in their system; in 1979, this group was reduced to 35 %, while the proportion of farmers with more than 12 improved practices rose from 8 % in 1977 to 30 % in 1979. Accordingly, milk production increased 45 % (from 6,524 kg/day to 9,472 kg/day) as produced on 37 farms.

Against the background just described it is clearly evident that the dual-purpose (milk and beef) production system is the most common one found in Central America. Research efforts are being conducted to improve this type of enterprise not only due to its popularity, but also because of its resiliency to changes in beef and milk prices and its low investment rates. However, it has been pointed out that farmers do tend to change to specialized dairying if appropiate credit, technical assistance and marketing conditions are given. In view of this, and in response to national policies favoring milk production in Central America, a milk production system was designed based on both technical considerations and economic appraisals, as described in the following pages.

BIOLOGICAL BASIS FOR A SYSTEM PROTOTYPE FOR MILK PRODUCTION IN THE TROPICS

The system prototype was developed in the Valley of Turrialba, Costa Rica, an area that is ecologically classified as humid tropical forest (Holdridge, 1959). Climatic characteristics are shown in Figure 1. Although fairly uniform, solar radiation decreases both at the onset (June) and at the end (December) of the wet season. This is due to heavy cloud cover which becomes the main limiting factor affecting grass availability. Nevertheless, Cubillos, Vohnout and Jimenez (1975) have estimated that the rate of growth of pasture species may be reduced to 30 % during the months of January to April, which is the period with less rainfall, in relation to the maximum growth obtained in May and June (Figure 1).

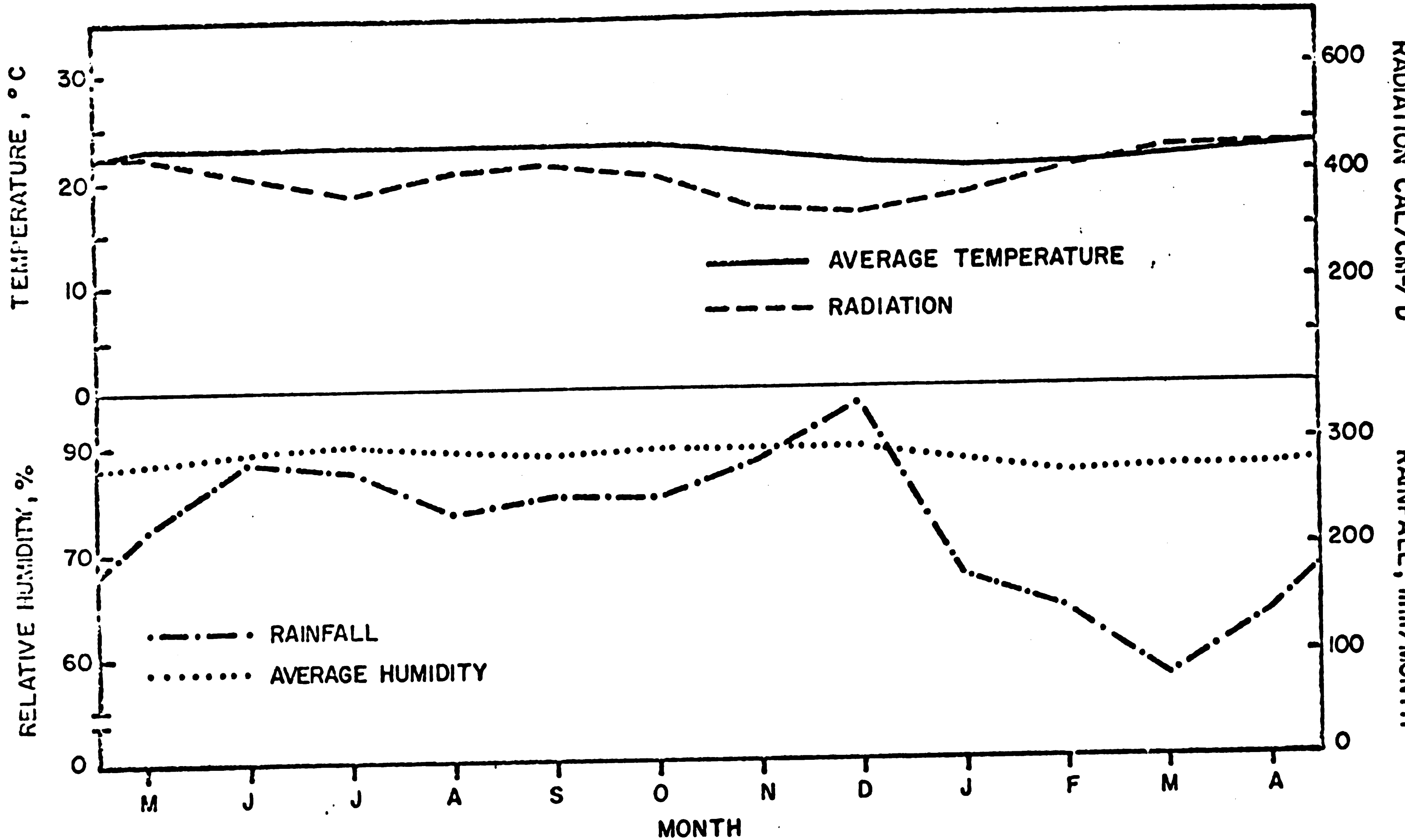

FIG. I CLIMATIC CONDITIONS FOR TURRIALBA. ALTITUDE 600 M, LATITUDE 9° 53', LONGITUDE 83° 38'

Most of the pasture experiments leading to the integration of the milk production system under consideration have been conducted on soils of the Juray series, classes I and II, as described by Berlanga (1972).

Pasture management

There are several management factors influencing productivity and persistence of a pasture. Among them, grazing pressure, length of the grazing period and length of the rest period are important. In addition, in the tropical areas, due to the lack of nitrogen in the soil, fertilization with this element significantly affects both production and quality of the herbage.

Although each management factor has separate effects on the pasture, it is necessary to know their combined effects on productivity. In Table 7, the effects of grazing pressure and the length of rest periods on the growth rate of African Stargrass (*Cynodon nlemfuensis*), are shown.

Table 7. Effect of grazing pressure upon growth rate (kg of dry matter/ha/day) of African Stargrass under different management systems*

Days of rest	Grazing pressure, kg DM/animal/day				
	5	10	15	20	25
7	-1.4	4.3	9.0	12.8	15.7
14	6.6	10.5	13.4	15.5	16.6
21	11.8	13.9	15.1	15.4	14.7
28	14.3	14.6	14.0	12.5	10.1
35	14.0	12.5	10.2	6.9	2.7

* The management system involved 7 days of grazing and the application of 250 kg N/ha/year.
From Cubillos (1977).

In Table 7, it can be seen that high grazing pressure has a marked negative effect when it is combined with a short rest period, resulting in a low production of pasture. Recovery after defoliation requires adequate plant nutrient reserves which are not allowed to accumulate with this management. On the other hand, a longer rest period will have no effect on plant growth rate when the grazing pressure is high, but will negatively affect the growth rate when grazing pressure is low. The excessive accumulation of older, highly lignified plant tissues tends to decrease the growing points in the plant.

Figure 2 illustrates the effect of the amount of nitrogen fertilization applied when different periods of rest are used in a pasture. It is shown that when no fertilizer is applied and resting periods are very short, very low growth rates (or actual degradation of the sward) occur, due to insufficient soil nutrients. The only means for increasing production under zero-fertilizer conditions is to increase the rest period. Obviously, as nitrogen is applied, more grass is available and, therefore, intensification of animal

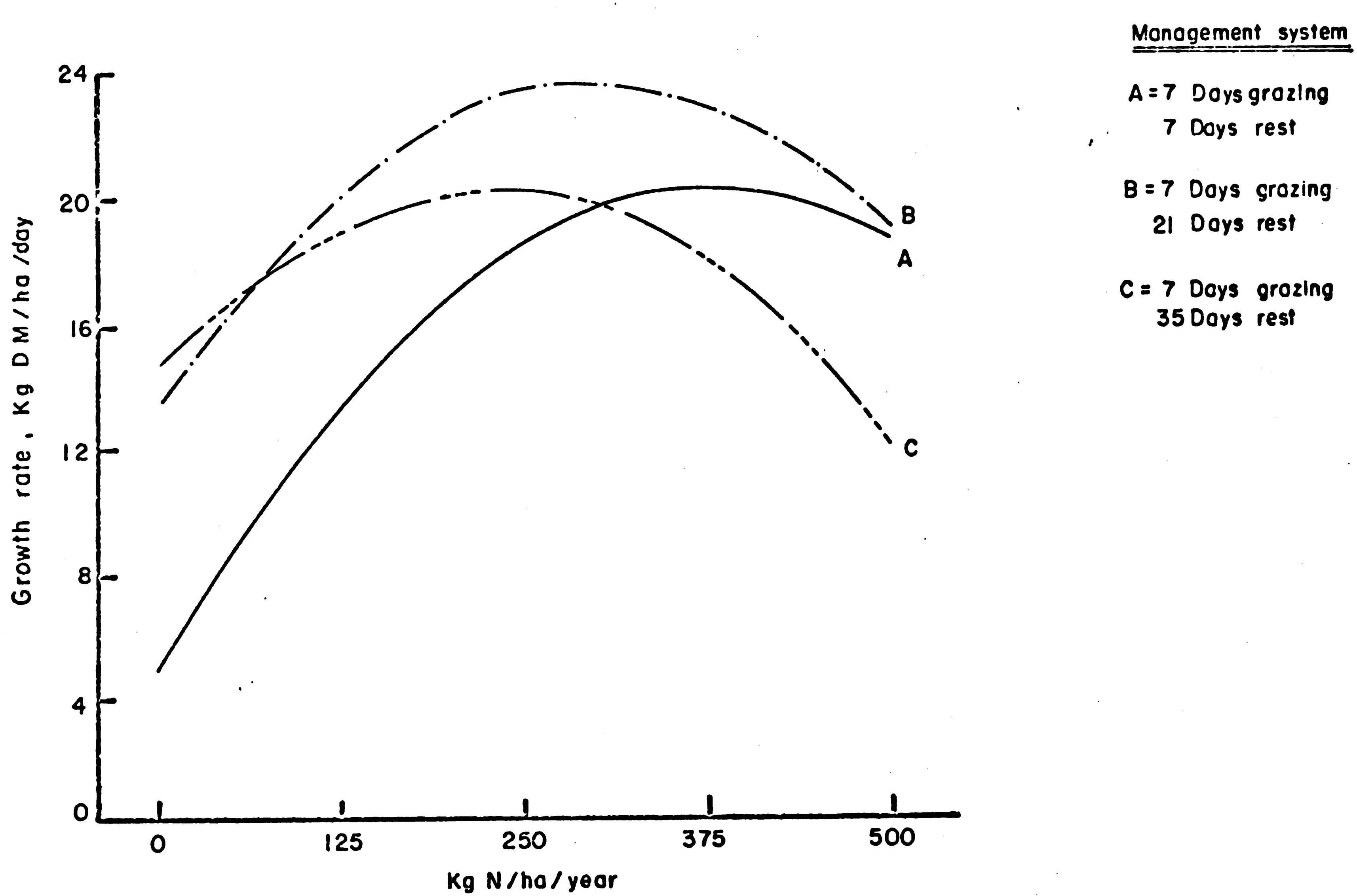

Fig. 2 Effect of nitrogen dosis on production of stargrass pastures under different management systems

production is possible; however, care must be exercized to avoid a combination of high levels of nitrogen and long resting periods, since this will tend to depress the growth of pasture plants. The reason for this behavior is that fertilized plants tend to mature faster than non-fertilized ones, thus causing a decrease in the growing points. It is apparent from Figure 2 that maximum production of African Stargrass is obtained by grazing it for 7 days, allowing a 21-day resting period and applying 250 kg of nitrogen/ha/year.

Gutierrez (1974) found that daily rotation of the paddocks permitted an increase in stocking rate without sacrificing individual milk output, thus causing a 30 % increase in milk production per unit area (Table 8).

Table 8. Milk production from intensively managed African Stargrass*

Grazing period days	Milk production kg/cow	Stocking rate cows/ha	Milk production kg/day/ha
1	5.69	7.47	43.0
5	5.71	5.88	33.7

* Resting period: 21 days; N application: 250 kg/ha/year.
From Gutierrez (1974).

Supplementation of milking cows

Seasonal variation in quantity and quality of grasses demands precautionary measures to avoid declines in milk production on pasture. Unfortunately, the few trials that have been conducted in this area have shown no clear results as to the benefit from the use of supplements. As an example, Molina (1973) offered *ad libitum* amounts of a molasses-based supplement to grazing milking cows. Variation in the intake of the supplement was achieved by varying the number of hours spent by the cows in a dry-lot where the supplement was available. The results are shown in Table 9.

Table 9. Milk production by grazing Criollo, Jersey and crossbred cows supplemented with various levels of a molasses-based diet*

Hours in dry-lot	Supplement intake kg/cow/day	Milk production, kg/cow/day	
		Initial	Increase
18	13.0	7.1	2.2
16	12.0	7.4	2.0
12	8.5	7.6	1.5
8	8.6	7.5	1.0
2	4.8	7.6	0.5
0	0.0	7.1	0.0

* On as-fed basis: blackstrap molasses, 74%; cottonseed meal, 18%; meat meal, 8%

Other experiments at Turrialba (Lazarte, 1978; Villegas, 1979) have shown responses of only 14 % to 18 % additional milk production when supplementing cows grazing African Stargrass pastures with starch-rich feeds.

The results described above are in line with a recent review by Combellas, Baker and Hodgson (1979) on milk yield response to supplementation (Table 10).

Table 10. Results of experiments on tropical pastures showing the milk yield response to supplementation in mid-lactation*

Country	Mean level of supplementation kg/day		Period of lactation weeks	Milk yield of low level of supplementation kg/day	Response kg milk/kg supplement
	High	Low			
Trinidad	2.4	0	27	6.9	0.33
	2.5	0.5	27	6.7	0.20
Brasil	3.8	0	11-23	10.0	0.42
	1.9	0	11-23	10.0	0.37
	4.1	0	10-22	10.8	0.35
	2.2	0	10-22	10.8	0.34
	3.3	0	-	8.6	0.33
Cuba	3.6	0	10-30	9.5	0.21
	2.7	0	10-30	9.5	0.28
	11.8	0	10-30	9.5	0.31
	6.0	0	8-23	7.9	0.07
	3.0	0	8-35	7.9	0.27
	3.7	0	9-24	14.1	-0.16
Australia	3.8	0	17-30	8.8	0.48
	2.7	0	17-30	8.8	0.4.
	1.1	0	17-30	8.8	0.64
	3.0	0	-	13.6	0.37
	3.0	0	-	11.4	0.50
Venezuela	2.0	1.0	>6	8.7	0.29
	3.0	1.0	>6	8.7	0.34
	6.9	0	14-28	7.6	0.40
	3.7	0	14-28	7.6	0.40
	3.1	0	14-28	7.6	0.66
Uganda	2.7	0.7	9-26	8.6	0.25
Mean ± s.d.					0.34 ± 0.17

* Adapted from Combellas, Baker and Hodgson (1979).

The substitution of concentrate for herbage appears to be the main reason for the low milk yield responses to level of supplementation (Combellas, Baker and Hodgson, 1979; Villegas, 1979). Most of the response of milking cows to supplementation is in the form of weight gain (Molina, 1973; Combellas, Baker and Hodgson, 1979).

Although the responses to supplementation are modest, the use of supplementary feeding during the milking operation is of value since it quits down the animal and facilitates its handling. Obviously, to achieve this, it is not necessary to use high levels of high-quality concentrates.

Calf feeding and management

Several experiments (Torralba, Ruiz and Vohnout, 1974; Villegas and Ruiz, 1976; Leal and Ruiz, unpublished results; Ruiz, Medina and Perez, unpublished results) have shown the feasibility of raising dairy calves with restricted milk intake (180 kg/calf), using a concentrate based on tropical by-products and with grazing initiated at an early age. Table 11, for example, shows growth data of Criollo, Jersey and crossbred calves put out to pasture at various ages, with milk intake restricted to 160 kg per calf, and concentrate consumption not greater than 1.5 kg/head/day.

Table 11. Performance of dairy calves under grazing conditions*, g/day

Resting period of pasture, days	Age of calf when first put out to pasture, weeks				
	2	6	10	14	Avg.
21	314	296	262	399	318
42	401	282	248	296	307
Averages	358	289	255	348	312

* Leal and Ruiz, unpublished results.

Genetic component

For some twenty-five years, CATIE has been involved in a breeding program to improve the local indigenous Criollo (*Bos taurus*) cattle of the Tropical Americas. More recently, the Jersey has been introduced as has crossbreeding by the use of Ayrshire or Red Danish semen in a 3-breed rotational system (the Red Danish group has been discontinued). The Criollo and Jersey as well as their crosses have been shown to excel the larger breeds in reproductive performance in warm climates under pastoral conditions. As their size can be considered medium to small it is possible to carry high numbers of cows per hectare and, therefore, attain high output per unit area, although the per cow production is modest. This would not be possible, however, if a reasonably short average calving interval could not be maintained.

Table 12 gives the information relative to milk and reproductive performance in the CATIE herd. Apparently, the Jersey x Criollo shows considerable heterosis for yield, whereas the rotational crossbreds surpass the F_1 levels as a combined effect of heterosis and the additive contribution of the more productive breeds. No advantage in reproduction is notable in the 3-breed rotational crosses although their performance is satisfactory.

Table 12. Comparison of the performance of dairy breeds at CATIE*

Breed group	No. of lactations	Calving interval months	Milk production kg/lactation, $\bar{x} \pm$ sd
Criollo	1,117	12.6	1,382 ± 600
Jersey	433	12.7	2,180 ± 510
1/2C 1/2J = F_1	397	12.4	2,221 ± 410
Ayrshire x F_1	58	13.2	2,469 ± 460
Red Danish x F_1	30	13.0	2,112 ± 470

* Alvarez, Deaton and Muñoz (1977).

The system of breeding is sufficiently simple as long as artificial breeding is available for all the breeds, but a simpler system (perhaps a 2-breed alternation plan) would be needed if natural service was necessary.

The system of the prototype unit involves the growing of herd replacements from within the unit. Thus it is not feasible to produce all the potential replacements until first lactation before selection is applied. The majority of the selection must be done on the basis of the dam's production and alloting only the minimum portion of area in the unit for heifers. Bull calves are disposed of during the first 2-3 days after birth. The relatively short calving intervals are in part the result of using adaptable breeds and crosses and in part due to the management practice of inseminating cows early post-calving (the first heat after 35 days). Imported Jersey and Ayrshire semen is used and Criollo semen is produced at CATIE.

THE MILK PRODUCTION MODULE

The information on the feeding, breeding and management of a dairy herd, at Turrialba, has been integrated into a prototype of a milk production system, commonly known in the Central American Isthmus as CATIE's Milk Production Moduel. This module is a production unit suitable for small farmers since it is based on a small area, employs family labor, and is highly efficient both in biologic and economic terms.

Description

The Module of Milk Production is based on the intensive use of a fast-growing grass which requires moderate amounts of fertilizer and rotational grazing. It occupies an area of 3.8 ha of flat but poorly drained land, divided into 25 paddocks of 1,200 m^2 each and 8 paddocks of 643 m^2 each. The larger paddocks are grazed by 20 adult cows and 8 heifers while the smaller paddocks are used for calves and younger heifers. As a result, stocking rate is 6.5 cows/ha.

Feeding component

Both cows and calves graze African Stargrass. The milking cows change paddocks daily although dry cows and heifers graze the paddock left by the milking cows for one additional day. After the paddock is completely vacated fertilizer is broadcast. The rate of fertilization is 500 kg of a 20-10-6-5 mixture and 545 kg of urea/ha/year. The applications are made only during the wettest 8 months in the year; therefore, after each grazing cycle, the equivalent of 50 kg of urea is applied per ha. In addition, the manure is evenly distributed in each paddock as it is vacated. Weed control is carried out by machete.

The milking cows receive a total of 3 kg of molasses containing 3 % urea, divided into two equal parts, each part administered at the time of milking. No supplements, other than mineralized salt and bone meal are otherwise provided.

With respect to the feeding of the calves (Figure 3), these receive approximately 180 kg of whole milk during the first two months of age, at which time milk is withdrawn from the feeding program. When the calves are one week old, they begin grazing during the day. Each paddock is grazed for 3 consecutive days. Supplementation with a 24 % crude protein ration (Table 13) is provided, not exceeding 2 kg/calf/day. A night-time shed is available until they become one year old.

Table 13. Composition of the concentrate used for feeding calves from birth to 6 months of age*

Ingredient	%, as-fed basis
Yellow corn	44
Peruvian fishmeal	20
Meat and bone meal	4
Blackstrap molasses	18
Wheat bran	10
Bone meal	1
Common salt	1
Vitamin and mineral complex	2

* Calculated crude protein content: 24 %.

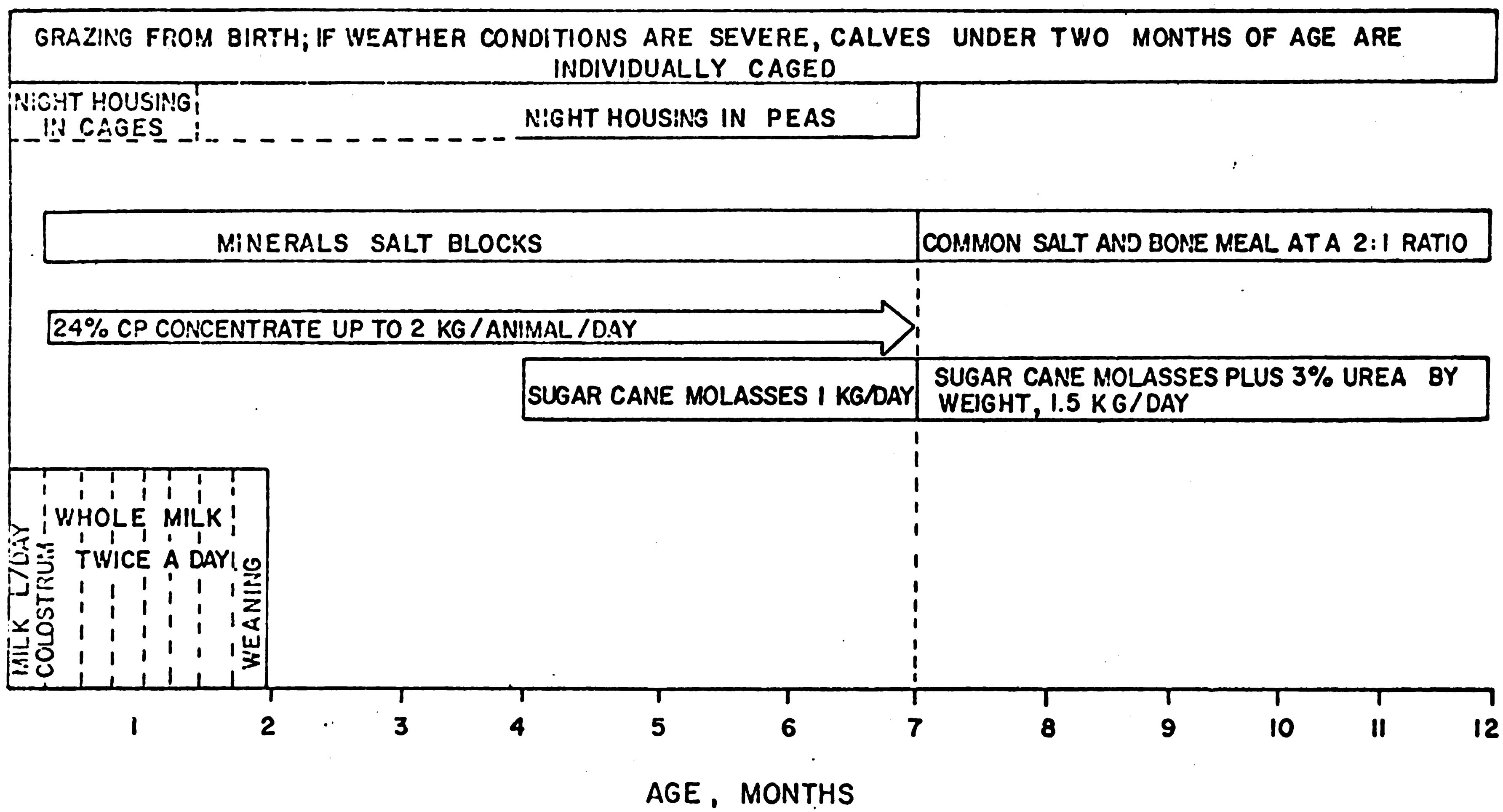

Fig. 3 MILK PRODUCTION MODULE: DIAGRAM OF CALF FEEDING AND MANAGEMENT PROGRAM

Health component

At birth, the navels are treated with an iodine solution and the calves are vaccinated against septicemia, black-leg and malignant edema is applied. Between 4 and 6 months, a vaccine against brucellosis is given. At 8 and 12 months of age, septicemia vaccinations are administered.

The replacement heifers and cows are treated against internal parasites every 3 months. Ticks are controlled periodically, depending on the severity of infestation. The milking cows are tested for mastitis on a monthly basis.

Constructions

The peripheral fence is of the elastic type using smooth wire. The paddocks are divided with electric fences. Two walk-through stanchions are used. Other equipment is standard to dairy farms, such as calf pens and milking machines.

Labor

One farm worker is in charge of all operations: milking, cleaning, fence repair, distribution of manure in the fields, weed control, fertilization, feeding, and disease and parasite control. Occasionally, help is provided to accomplish major tasks, thus resembling actual situations found at a typical small dairy farm.

Performance data of the Milk Production Module

The module was established in 1976 and the following results are the average of observations through 1979. The biological performance of the prototype is summarized in Table 14.

Table 14. Production performance of the Milk Production Module encompassing the period 1976-1979.

Criteria	Averages
Milk/cow/year, kg	2,805
Milk/cow/lactation, kg	3,039
Milk/ha/year, kg	15,000
Milk/milking cow/day, kg	9.1
Milk/cow in herd/day, kg	7.7
Stocking rate, head/ha	6.5
Calving interval, months	13.0
No. of services/pregnancy	2.2

From Table 14, it is clear that very high rates of milk yield can be achieved in the tropics and that, biologically, this is possible by taking full advantage of the rapid growth of tropical grasses and by using cows that are rather modest in their level of milk production, but because of this, their nutritional requirements are more compatible to the quality of feeds available.

Economically, the Module has proven to be very stable, showing annual profits ranging from 35 % to 46 % in the period of 1976-1979. The summarized economic analysis that follows corresponds to the period 1978-1979. Needless to say, the extrapolation of the economic evaluation to other areas must consider variations in economic indexes in different areas and at different times. The calculations were based on the indexes shown in Table 15.

Table 15. Costs of main inputs and price of milk in Costa Rica for the period 1978-1979

Item	US dollars
Milking cow, adult	820/head
Farm labor (including vacations, holidays, etc.)	6.9/day
Blackstrap molasses	35/MT
Urea	246/MT
Concentrate, 24 % crude protein	232/MT
Land rent*	70/ha/year
Income from milk sales (less transportation costs)	0.28/kg
Agricultural loan annual interest	12 %

* Due to variations in land value, the cost of renting farm land has been preferred in this analysis.

Combining data shown in Table 15 with the figures which characterize the Milk Production Module results in a total investment of US $ 26,000 to establish a 3.8 ha module and to operate it the first year.

Ninety-two per cent of the income is represented by milk sales. Based on the total Module's production of 57,000 kg of milk in one year, the gross income is US $ 17,000/year. The net annual income is US $ 4,465 for the Module, or US $ 1,175/ha/year.

With the figures given above, it may be calculated that the net profit for the period of 1978-1979 was over 35 %. This is the basic reason for the wide acceptance of this system on the part of farmers and extension workers alike.

THE OUTLOOK

The Milk Production Module described has been the focal point for development projects in the Central American region. For example, in northern Honduras 70 farmers have adopted the technology or are in the process of doing so (Prohecto BCH_CATIE, 1979). A regional research and development project, co-sponsored by the Inter-American Bank, the Tropical Agricultural Research and Training Center (CATIE) and the appropriate national institutions, was initiated in 1979, using the Milk Production System as a model to be tested and adapted to different ecologic and socio-economic environments.

To illustrate the results that are being obtained, and the problems encountered in the adoption of this technological package, a brief description of one of the development projects in Costa Rica follows in text and Table 16.

Table 16. Transfer of milk production technology to settlers of the Rio Frio area in Costa Rica, summary of 2 years work*

Biological information	
Number of settlers involved	9
Increase in number of pasture plots	from 2.3 to 24.8 ha
Increase in cattle/farm	from 4.1 to 25.0 head
Increase in milking cows/farm	from 1.0 to 11.7
Increase in milk production, l/farm/day	from 6.6 to 80.7
Economic information	
Cost of establishment of a Module (parlor, animals, etc)	20,426
Yearly farm expenses	
-12 % interest on capital invested	2.451
-Depreciation	985
-Operational (includes US $ 1,872 for own labor	4,635
-Total	8,071
Yearly farm gross income	
-Milk sales (1,900 kg/cow/year, at US $ 0.27/kg)	10,163
-Sale of male calves and culled cows	982
-Total	11,145
Net farm income per year	3,074
Farmers annual loan amortization	3,023
Time required to pay back loan	8 years
Profitability	38 %

* Proyecto ITCO-CATIE (1980)

Following a diagnosis of physical, biological and human resources, an appropiate devlopment strategy was established which included the selection of participating farmers, preparation of each farm's development plan, purchase of cows apt for dairy purposes, training activities and supervision of each step taken during the evolution of the project.

The initial group was comprised of 9 settlers with an average gross income of US $ 1,022/year. The results obtained are summarized in Table 16. An increase in the gross income from US $ 1,022 to US $ 11,145 has caused a change in attitude in the farmer; he is now more of an entrepeneur than a peon; his projected outlook for his family's future has dramatically changed to one full of expectations.

Despite the positive effects of a project like the one just described, there are problems that have to be solved to ensure success. The experience in the Rio Frio area has helped to detect four major constraints in livestock development: poor or non-existent marketing systems, scarcity of animals with milk production abilities, few professionals properly trained for technical assistance, and restricted bank loans. Improvement of the small farmer's condition and production systems requires the combined efforts of research, development, marketing and financial institutions in direct response to the small farmer's human, technical, physical and economic resources.

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