MILK PRODUCTION BY DUAL PURPOSE COWS GRAZING UNSUPPLEMENTED PANGOLA OR FED IN DRYLOT ON SUGARCANE AND MOLASSES/UREA BASED DIETS

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Summary

A crossbred Holstein/Zebu herd was used to compare: (A) unsupplemented grazing on pangola pasture: (B) drylot feeding with chopped sugar cane and liquid molasses/urea (50 g urea/kg) both available free choice in separate feeders, and 600 g/d cotton seed cake and minerals; and (C) the same as in (B) but with restricted grazing from 8 to 11 a.m. Cows were milked twice daily by hand, allowing the calf to be suckled before,for a few seconds to stimulate letdown and for 30 minutes after milking was finished. The trial began on 5 August 1975. Results from the drylot treatment (B) were inferior to the other two, mainly due to extremely bad conditions in the corrals caused by accumulation of mud and inadequate feed trough facilities. There were no important differences between the unsupplemented grazing and the restricted grazing plus sugar cane, molasses/urea treatment. Levels of production for these latter systems were of the order of 9 kg milk daily (including milk consumed by the calf) while body weight was maintained or increased slightly.

All of the dietary treatments were associated with moderately high levels of butyric acid production (16 to 20% molar) while samples taken from the cows immediately after they had been in drylot for 4 hr show molar butyric as high as 32%. There were no holotrich protozoa in the sugar cane group and relatively small numbers of entodinea. Both of these organisms were present in much larger numbers in the animals on unrestricted grazing.

Key words: Sugarcane, milk production, system

Introduction

It has been argued that technologies for production of beef and milk as independent specialised systems, as have been developed almost exclusively in temperate regions of North America and Europe, are perhaps not so appropriate to the needs of developing countries situated in the tropics (Preston 1976).

Specialised milk production is almost invariably associated with the use of the Holstein breed because of its high genetic capacity to convert food into milk. However, the use of this breed in the tropics presents two major problems The first relates to difficulties of adaptation, in terms of the climatic and parasitic elements in a humid tropical region: while the second is based on the fact that most feeds that can be grown in these regions are relatively low in nutritive value, specifically protein. As a result, in order to feed the Holstein sufficiently well for it to express its genetic capacity requires the use of large quantities of cereal based concentrates which usually have to be imported.

The alternative approach which has been proposed (Preston 1976) for milk production in the tropics envisages the use of adapted native cattle partially upgraded with European dairy breeds such as Holstein, Brown Swiss or Simmental, to produce dual purpose animals with a moderate milk production combined with the capacity to raise a calf of excellent attributes for beef production. By set-ting the production ceiling at a moderate level it is easier to adjust the system to the available resources in tropical regions, taking account of their limitations in nutritional, climactical and human terms.

The theoretical production targets are that each breeding cow should yield about 1,500 kg of milk for sale, while suckling her calf on a restricted system to a weaning weight of some 200 kg at 300 days. After weaning, the calf is expected to fatten at an average live weight gain of 850 g/d to reach a slaughter weight of 400 kg at about 18 to 20 months of age.

The experiment described in this paper is the first of a series designed to evaluate this concept and to produce the appropriate input/output data on which technical coefficients can be based, thus providing both a basis for economic evaluation as well as a model for future development and investment plans.

Materials and Methods

Treatments and Design:

The three treatments were: supplementation; (A) grazing on pangola with no supplementation (B) drylot feeding with chopped sugar cane and molasses/urea (50 g urea/kg molasses) both offered in separate troughs and available free choice; (C) the same as (B) but with restricted access to pangola pasture from 8 until 11 a.m. daily. Both groups (B) and (C) received cotton seed cake at the rate of 600 g/d and 50 g/d minerals.

In fact, the experiment as such was conducted in three phases. For the first 15 days the available cows were distributed equally over the three treatments; for the next 55 days , groups (B) and (C) were interchanged: in the third phase the animals which had previously been on the drylot treatment (B) were allocated equally to the other two treatments (A) and (C).

Animals:

The cows were Holstein x Zebu with an estimated 50 to 75% of Holstein "blood". An initial groups of 30 animals which had been calved for a period varying from 7 to 90 days, were allocated to the treatments according to their previous production and stage of lactation. Subsequently, new animals entered the experiment according to calving date, being introduced to the experimental treatments 7 days after calving prior to which they had been grazing pangola pasture with no supplementary feed, The calves ran with the cows on a full time basis during this period.

Phase 1 of the experiment was started on 5 August 1975 with 10 animals in each group but during this period there was almost continuous rainfall providing go d pasture growth but adverse conditions for the drylot treatments. Because of this, and as a direct result of a rapid fall in milk production, groups B and C were interchanged after 15 days. More animals entered the experiment and phase 2 began with 19 animals per treatment. Continuing rain over the second part of this stage appeared to contribute to a further fall of milk yield in the drylot cows (B) and at this point (phase 3) this particular treatment was reallocated between groups (A) and (C). The trial was continued with 31 cows in each of these two treatment groups .

Procedure:

The cows were hand milked twice daily first letting the calves suck each teat for a few seconds to stimulate let down. After each milking, cows and calves were run together for approximately 30 minutes in an adjoining corral for suckling to take place.

Diets:

The age of the sugar cane used in the trial varied at times but was generally about 12 months old. The whole cane, including the tops and stalk, were passed through a Gehl forage chopper to give a particle size of approximately 15 mm. The proportion of top to stalk was estimated on average to be 25:75.

Measurements:

Saleable milk and that consumed by the calf (by weighing before and after suckling) was recorded daily. The cows were, weighed at approximately 7 day intervals. The dry matter content, and the Brix of the juice, were recorded on sugar cane tops and stalk throughout the experiment.

Rumen samples:

During the last week of the experiment, samples of rumen fluid were taken by stomach pump from 4 cows selected at random in each of the two treatment groups; samples were taken at 11 a.m. immediately after treatment (C) had returned from grazing and again at 4 p.m. when this group was in drylot eating sugar cane and molasses/urea . Treatment (A) was on pasture at both sampling times. pH was recorded immediately as was the protozoal population. The packed cell volume method, outlined by Leng et al (1976), was used to determine the large holotrich organisms while the smaller protozoa mainly entodinea were estimated by direct counting. Other samples of rumen fluid were preserved with concentrated sulphuric acid for subsequent analysis for volatile fatty acids (VFA) according to the methods described by Gonzalez and MacLeod)1976).

Results and Discussion

Cow performance:

Mean values for total daily milk yield (saleable plus milk consumed by the calf) and average live weight during the experiment are set out in figures 1 and 2. The regression coefficients for change in the parameters, together with the mean values in each phase of the experiment are given in tables 1 and 2. Figure 3 shows the variation in Brix and dry matter in the cane stalk and tops during the trial while figure 4 illustrates the effect on milk production when the treatment (B) cows, previously fed in drylot, were divided equally between the pasture only and drylot plus restricted grazing treatments in phase 3.

Table 1: Mean values for daily milk yield and changes in daily milk yield during the experiment

	Pasture only	Sugarcane: molasses/urea		Significance level (P<)
		Drylot	Restricted grazing	
5 to 19 august 1975				
No of cows	9	9	9	
Mean milk yield, kg/d	11.1	7.54	8.72	
Change in milk yield, kg/d	.073	-.17	-.054	.001
r^2	.45	.48	.50	
20 August to 21 October				
No of cows	15	16	15	
Mean milk yield, kg/d	10.1	7.5t	8.69	
Change in milk yield, kg/d	-.051	-.045	.013	.001
r^2	.50	.52	.08	
22 0ctober to 14 January 1976				
No of cows	31		31	
Mean milk yield, kg/d	8.77		9.44	
Change in milk yield, kg/d	.0108		.0085	MS
r^2	.23		.15	

Table 2: Mean values for live weight and changes in live weight during the experiment

		Sugarcane: molasses/urea		Significance level (P<)
	Pasture only	Drylot	Restricted grazing	
5 to 19 August 1975				
No of cows	9	9	9	
Mean live weight, kg	409	372	365	
Change in live weight, kg/d	1.62	-1.64	.74	P<.001
r^2	.88	.93	.28	P<.001
20 August to 21 October				
No of cows	15	16	15	
Mean live weight, kg	428	384	405	
Change in live weight, kg/d	.032	.014	.072	
r^2	.005	.004	.019	P<.001
22 October to 14 January 1976				
No of cows	31		31	
Mean live weight, kg	411	41	412	P<.11
Change in live weight, kg/d	.038		.288	
r^2	.01		.69	

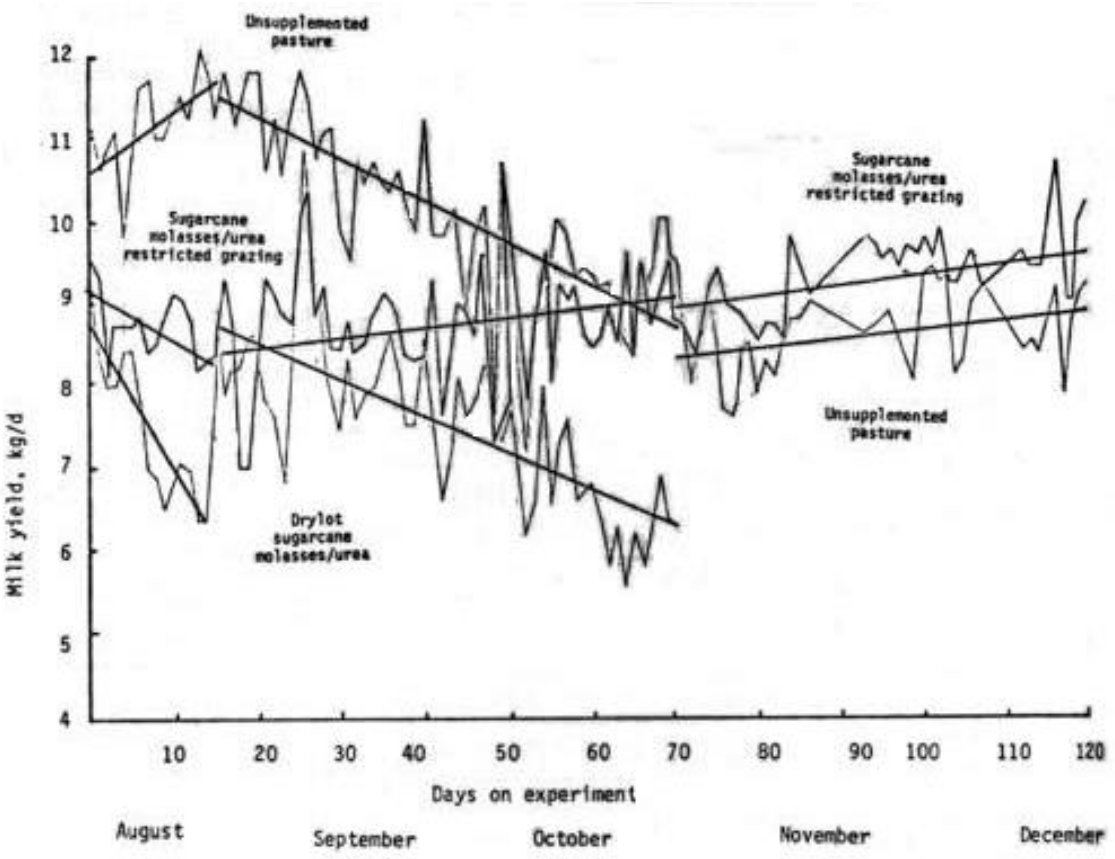
In the first phase of the experiment the cows on, unsupplemented pasture performed better, in terms of milk yield and live weight change,than either of the groups receiving sugar cane. Between the latter two treatments restricted grazing was obviously superior to the drylot treatment. It was observed that the quality of the pasture at this time (early August)was probably at its optimum, due to the recent onset of rain, while in contrast, conditions for the cattle in the drylot groups were at their worst partly due to lack of shade and also to accumulation of mud.

Table 3:
Rumen fermentation parameters (samples taken at the end of the trial)

Treatment	Unsupplemented Pasture		Sugarcane , molasses/urea, restricted pasture		SE_x	Significance level (P<)
Time, hr	1100	1600	1100	1600		
pH	7.43	7.14	7.35	7.00	±.17	.35
VFA, %molar						
Acetic	54.6[c]	59.7[b]	64.4[a]	51.2[c]	±2.02	.01
Propionic	21.4[a]	21.8[a]	19.5[a]	16.4[b]	±.72	.001
Butyric	24.2[b]	18.6[c]	16.2[c]	32.5[a]	±1.85	.001
Protozoa, X 10 5/ml						
Entodinea	2.53[a]	2.50[a]	.86[b]	1.13[b]	±.28	.001
Holotrichos	.12[b]	.28[a]	0.00[c]	.03[c]	±.04	.002

In the second phase of the experiment during which the two sugar cape groups were transposed, the drylot group continued to perform less well than the others, with loss in live weight and in milks yield. The cattle on restricted grazing plus sugar cane and molasses/urea in drylot performed better than the group on unsupplemented grazing, in both milk yield and change in live weight, but this probably reflected a degree of compensation, since half of the animals in the restricted grazing group had previously (in phase 1) been losing weight and falling in milk yield at a precipitate rate. Conditions in the drylot were still relatively bad, and it is difficult to draw reliable conclusions as to the extent to which environmental conditions as opposed to diet,were having the determining effect on animal performance. In any event, the results during this stage showed ;quite clearly that provision of a limited grazing period was more than enough to compensate any negative factor of the drylot per se since this group (C) had the best performance in phase 2.

Figure 1:
Daily milk yields during the experiment (mean values for each treatment)

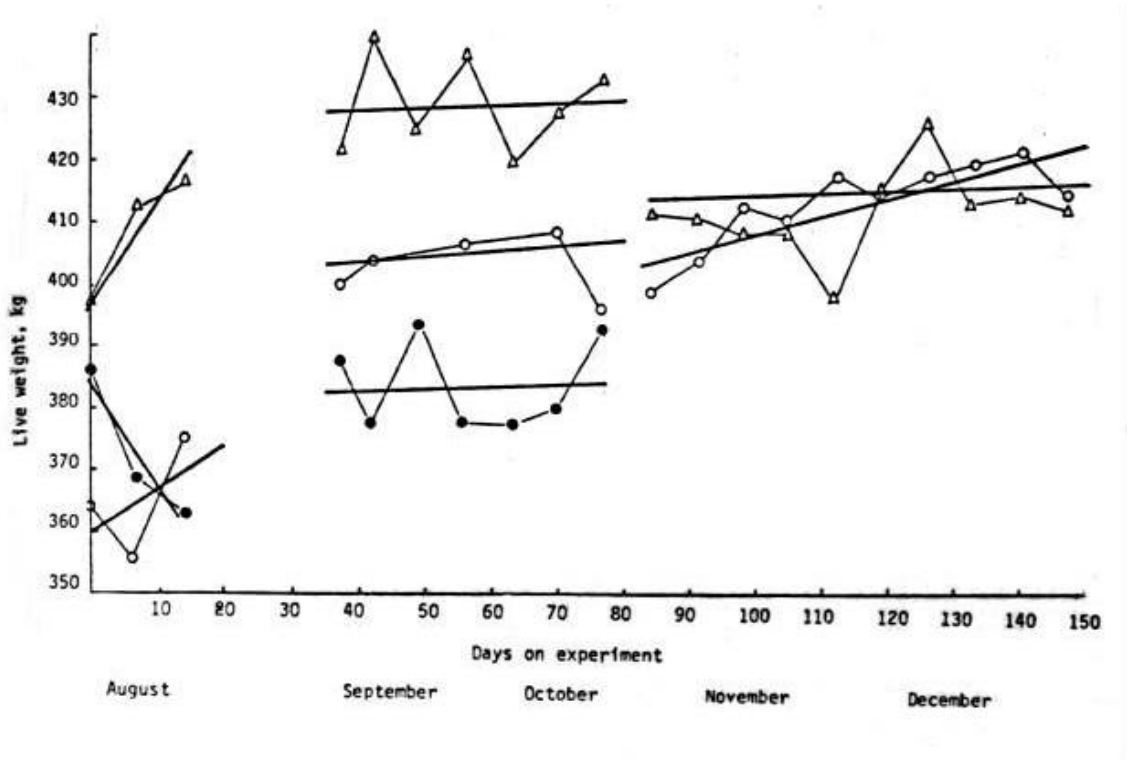


In phase 3 two comparisons are:possible. The first relates to: all the animals divided between the two remaining treatments of unsupplemented grazing (A),and sugar cane, molasses/urea and restricting grazing (C). There were no differences in milk yield response, both groups showing a slight increase over this period with a slightly:higher average milk yield for the groups on restricted grazing. The data for body weight change indicate a slight advantage to cows on restricted "razing,: both in terms of the daily change in live weight and the mean overall live weight.

With respect to the cows which previously (phase 2) were in drylot on treatment (B) and were then divided equally between unsupplemented grazing and restricted grazing and drylot, the pattern of response (figure 4)when the animals were changed to the new treatment was very similar, indicating little

difference between the two systems fin terms of maintaining milk production

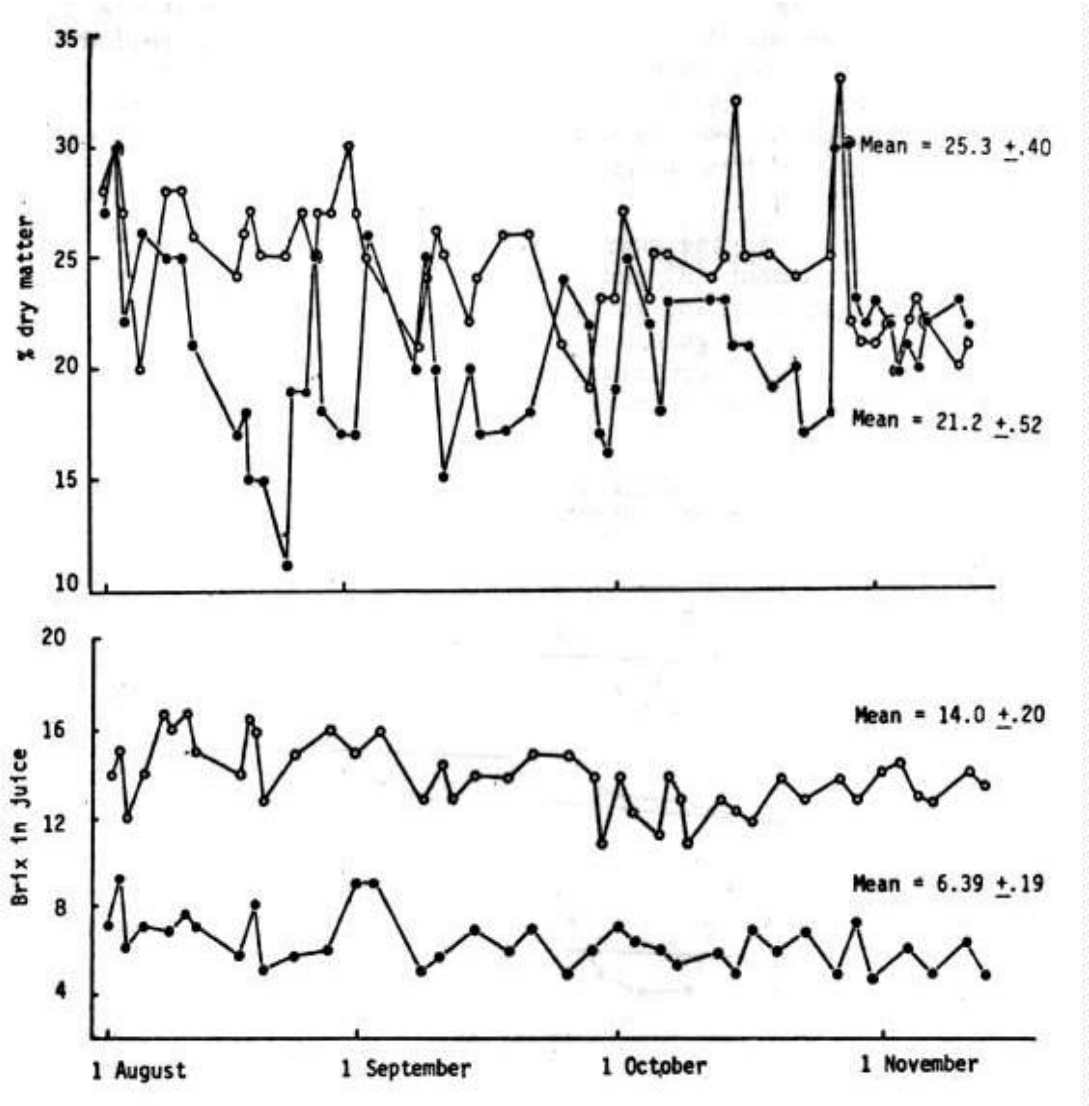
Figure 2: Mean live weights of cows in pasture only (△), drylot sugarcane, molasses/urea and restricted grazing (○), drylot sugarcane and molasses/urea (•)



Rumen fermentation:

The data on rumen fermentation parameters are set out in table 3. There were significant differences in several of these measurements' both due to time of sampling as we 1 as to feeding system. The most noteworthy findings were the almost complete absence of the large holotrich protozoa on the sugar cane treatment. This is in marked contrast with what is normally found in fattening cattle kept entirely in drylot conditions, and with no access to grazing (Leng and Preston 1976: Valdez et al 1976). It is not known whether the absence of protozoa reflected the effect the restricted grazing or the fact that the samples came from lactating animals. The former explanation seems the more likely.

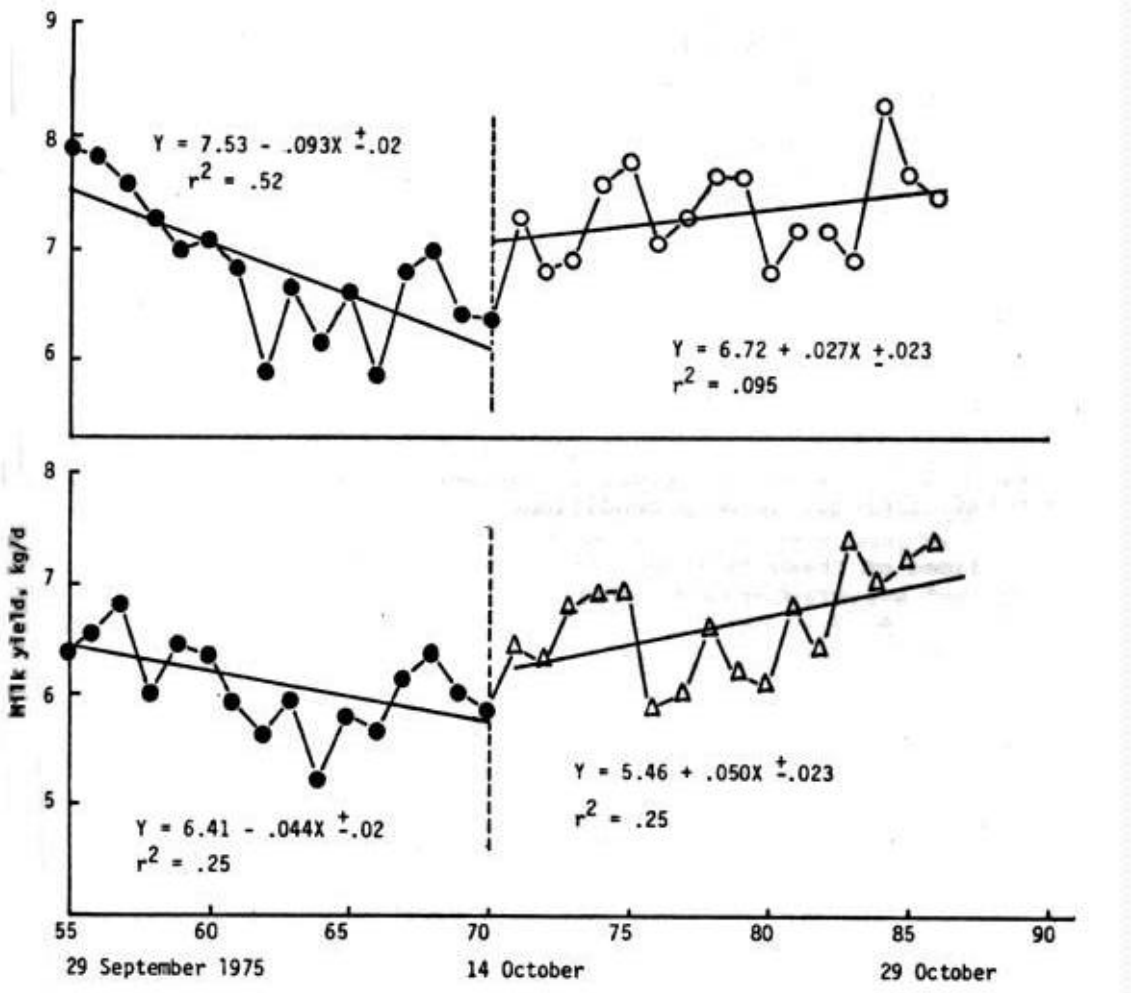
Figure 3 : Variarions in brix and dry matter content of cane stalk (◦) and tops (•) during the experiment



Surprisingly, the molar proportion of butyric acid was quite high in the cows on unsupplemented pasture. Levels for propionic acid, on the other hand, were comparable with the what would be considered normal for this feed. The marked contrast was in the VFA data for the cattle fed sugar cane and restricted pasture. Butyric acid was at a moderate level, similar to that in the grazing group, for the morning sample taken immediately after the animals had returned from their period of restricted grazing. However, after having had access to the molasses and sugar cane there was an immediate reaction to the

diet, in terms of an almost twofold increase in butyric acid at the expense of both propionic and acetic . A much higher production of butyric acid, when large amounts of molasses are fed has been reported consistently in other experiments (see Preston 1972).

Figure 4 :
Milk yields of treatment (B) cows (sugarcane and molasses/urea in drylot) before (•) and after being reallocated to treatments (A) of pasture only (△) and treatment (C) of sugarcanem molasses/urea and restricted grazing (○)



The general consensus on the rumen fermentation data is that these do not represent the most desirable combination of end products for high level milk

production (too high in butyrate and too low in acetate and propionate). However, they present no serious limitations to the level of production aimed for in the dual purpose system which is considered to be most appropriate for the tropics.

Calf performance:

These data are reported in a companion paper (Giraldez et al 1976).

Conclusions

This experiment was carried out during the rainy season when it is not normally intended to use a drylot system of feeding. This treatment was included in order to gain some experience of the feeding of large quantities of sugar cane to cattle on a dual purpose management programme. For these reasons, an assessment of the drylot treatment, in which the cattle had no access to grazing, is not relevant at this stage.

What is obvious however, is that even in the wet season, production from sugar cane,molasses/urea, limited supplementation with cotton seed mea, (600 g/d) and restricted grazing for 3 hr daily, will give the same performance in terms of milk production and maintenance of body weight as unrestricted grazing. Infact, there was some suggestion, from the results at the end of the experiment when pasture quality was obviously deteriorating, that the sugar cane/grazing treatment was superior at least in terms of promoting body condition.

Based on these findings it would seem reasonable to conclude that a system of restricted grazing, plus free access to chopped sugar cane, molasses with 10% urea and the equivalent of some 200 g/d of true protein, is a satisfactory feeding and management programme for dual purpose cattle expected to produce about 9 kg milk daily.

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RUMEN FERMENTATION IN CALVES REARED ON RESTRICTED SUCKLING, SUGARCANE AND MOLASSES/UREA

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Summary

Rumen fluid was taken from 12 calves of different ages in the range 23 to 266 days. The animals were from a dual purpose milking herd of crossbred Holstein/Zebu. The feeding system was based on restricted suckling twice daily, the calves having access to their dams for a few seconds before milking to stimulate let down and after milking for 30 minutes. The rest of the time they were housed in shaded pens where they had free access to chopped whole sugar cane and a mixture of molasses/urea (100 g urea/kg of solution). They also received 250 g/d of cotton seed meal and minerals. The rumen samples were taken with a stomach tube at 1100 hr, approximately three hr after the morning feeding of sugar cane. The pattern of fermentation was uniform in all the animals older than 60 days . Mean value for pH was 6.93 , and % molar VFA's were: acetic 50, propionic 35 and butyric 15. Packed cell volume of holotrichs was .32 (% of rumen fluid) and entodinea 1.25 X 105/ml. There was a significant relationship between daily live weight gain and molar proportion of propionic acid (r2 = .71). The results indicate that by 60 days of age, calves raised by restricted suckling and supplemented with sugar cane and molasses/urea reach a degree of rumen development typical of adult animals.

Key words: Sugarcane, calves, rumen fermentation

Introduction

Most studies on rumen development in calves have related to systems of artificial rearing, usually with milk substitutes and/or early weaning.

Few studies has been made on calves reared by suckling, and specifically the system of restricted suckling combined with normal milking which was developed in Cuba (Preston and Ugarte 1972), and which forms the basis of the calf rearing method in the dual purpose integrated milk and beef programme proposed by Preston (1976).

The objective of the study reported here was to measure certain parameters of rumen fermentation in calves raised by restricted suckling and having free,access both to chopped sugar cane and molasses/urea.

Materials and Methods

Animal and Diets:

The 12 calves used in the experiment were from the same herd and under the same management system described in a previous paper (MacLeod et al 1976). They were Holstein/Zebu crosses in the age range 23 to 130 days and with a range in live weight from 41 to 180 kg.

All the calves were suckled by their dams twice daily for approximately 30 minutes after the morning and afternoon milkings; on average,the daily quantity of milk consumed was 2.5 kg . Chopped sugar cane was offered ad lib as was molasses/ urea (100 g urea/kg molasses). 250 g/d of cotton seed meal and 50 g/d of minerals were also given. Housing was in shaded corrals adjoining the milking parlour and the feed and molasses troughs had adequate protection against the rain.

Rumen samples:

These were obtained with a hand pump and stomach tube at 1100 hr, approximately 3 hr after the calves had been offered the chopped sugar cane. pH and protozoal counts were determined immediately on the freshly strained rumen fluid. Holotrich protozoa were determined by the method of Leng et al (1976) using a packed cell volume technique, while the entodinea were counted directly. Other samples were preserved with concentrated sulphuric acid for subsequent volatile fatty acid (VFA) analysis according to the method described by Gonzalez and MacLeod (1976).

Results and Discussion

The data on the performance of the selected group of calves are summarised in table 1, while rumen fermentation parameters are in table 2. Some relationships between these different paramenters are given in figures 1 and 2.

The pH value is probably unreasonably high in view of the samples having been taken by stomach tube and the risk of contamination with saliva. The molar proportions of VFA are similar to,those found normally in weaned calves reared on mixed diets of concentrates and roughage . They vary slightly from the normal picture in fattening cattle receiving sugar cane based diets, where average values (24 hr sampling) were acetic 62, propionic 24 and butyric 14 (Leng and Preston 1976); thus propionic was considerably higher and acetic lower in the young as opposed to the adult animals.

Table 1: Age and live weight of calves

	Mean	Range
No	12	
Live weight, kg		
At birth	38.1	32 - 45
At sampling	104.9	41 - 187
Daily gain	.43	.17 - .66
Age at sampling, days	139	23 - 240
Intake, kg/d		
Milk		2.5 - 2.8
Sugarcane		1 - 5
Molasses/urea[1]		.3 - 1.5

[1] Contains 10% urea.

There was a wide range in concentrations of protozoa. The maximum values observed were lower than has been reported in adult animals fed sugar cane (maximum values were as high as 4 and the average in a group of slaughter animals was 2.6 PCV, % rumen fluid) (Minor et al 1976). There was a tendency for protozoa counts to increase with age (r^2 = .61 for entodinea and .214 for

holotrichs; figure 1). This supports the suggestion that the values recorded were lower than would be expected normally in adult animals fed sugar cane diets. .

There was a positive relationship between molar proportion of propionic acid and rate of live weight gain (r^2 = .71), which is in line with reports on sugar cane where these two parameters have been related (Alvarez and Preston 1976; Ferreira and Preston 1976). Such relationships are in line with the hypothesis that availability of glucose precursors is a constraint to animal productivity on sugar cane based rations (Leng and Preston 1976).

Conclusions

The data show conclusively that calves raised by restricted suckling, and receiving the major part of their diet in the form of sugar cane and molasses/urea, have normal rumen fermentation parameters by 60 days of age . In this respect they differ from adult animals fed the same ration only in the ratio of the end products and in the numbers of protozoa. This conclusion is substantiated by the shape of the growth curve (figure 3), which shows a marked acceleration of growth at the 50 to 60 day of age mark, indicating higher intakes of the basal ration of sugarcane and molasses/urea, commensurate with achieving full rumen function.

Figure 1: Effect of age on protozoal population

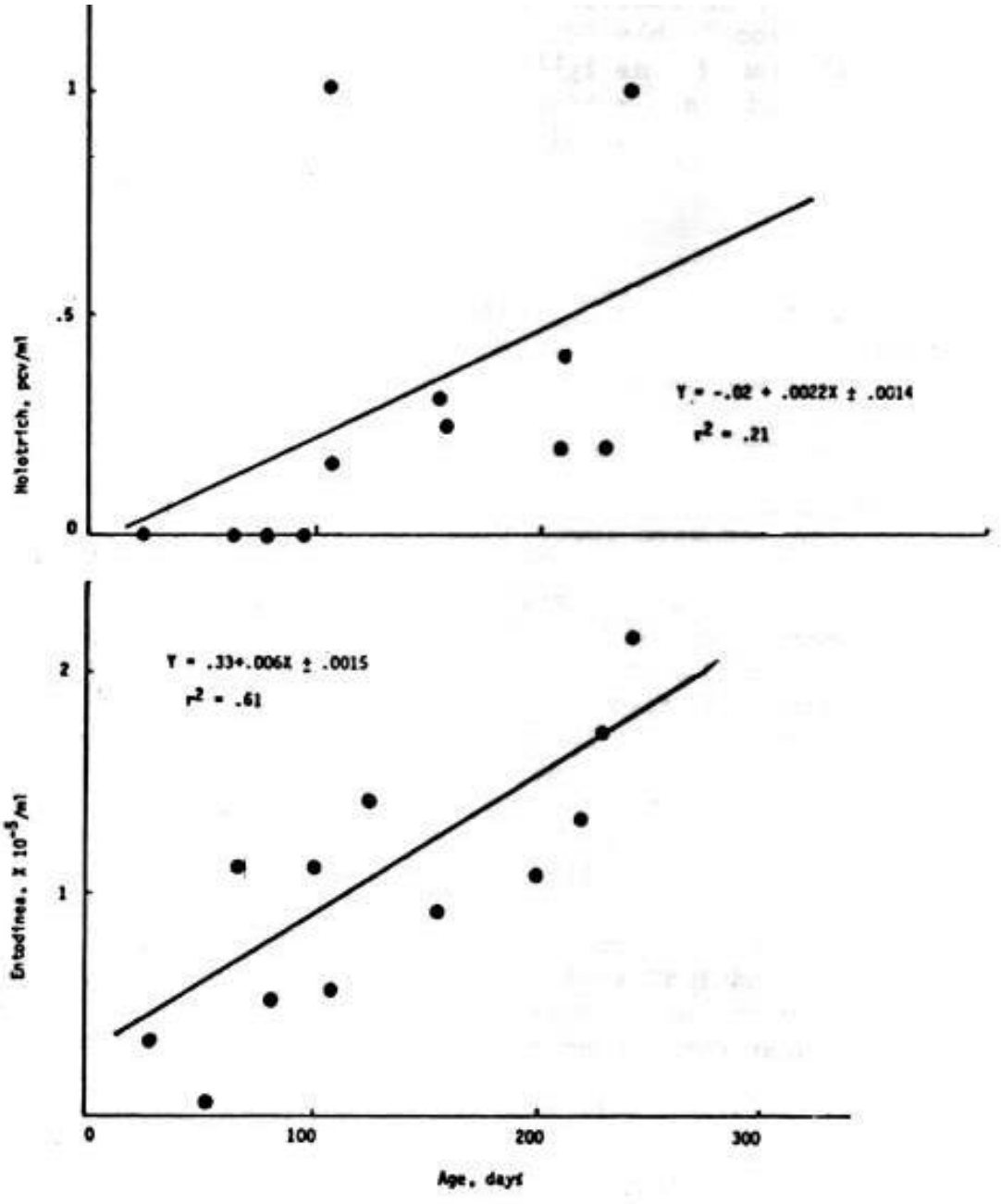

Figure 2: Relationship between gain in live weght and molar % propionic acid in rumen fluid

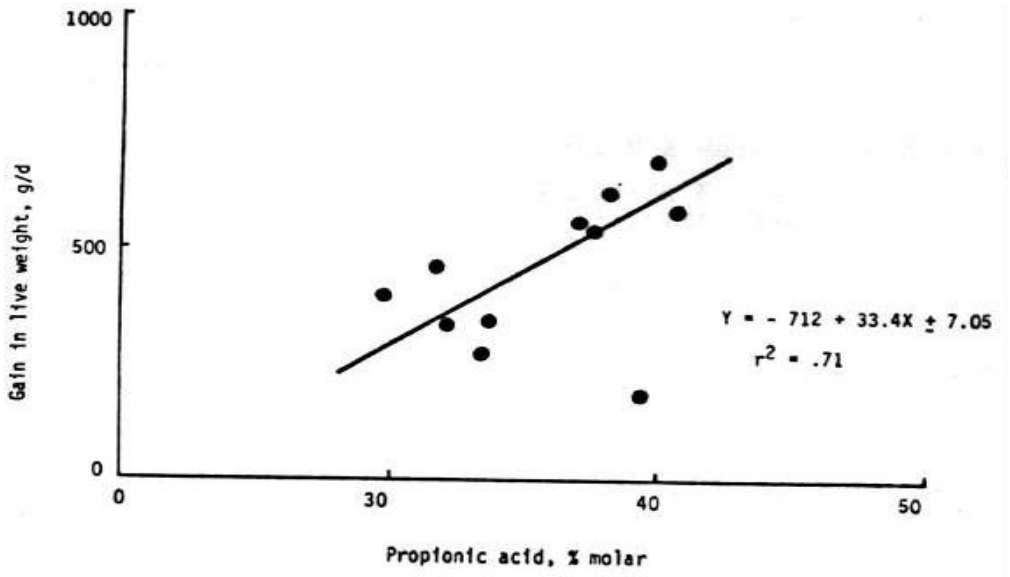

Figure 3: Growth rate of crossbred calves reared by restricted suckling, supplemented with sugarcane and molasses/urea (from Giraldez et al 1976)

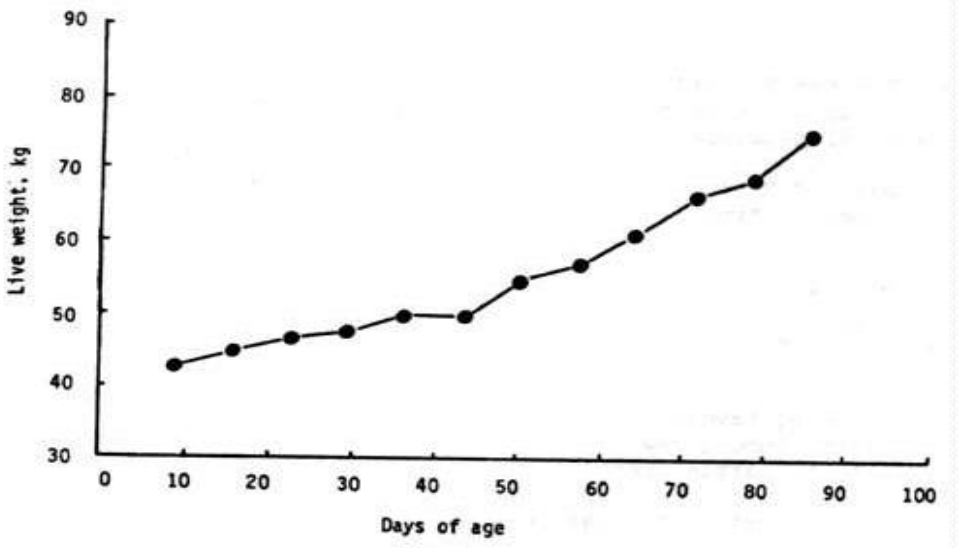

Table 2: Fermentation parameters

	Mean ± SE_X	Range
pH	6,93 ± ,24	5.7 - 7,6
VFA, % molar		
Acetic	50 ± 1,4	36 - 55
Propionic	35 ± 1.0	31 - 36
Butyric	15 ± 1.1	11 - 24
Protozoa Holotrich PCV[1], %		
rumen fluid	.32 ± .10	0 - 1.0
Entodinea, X 10^5/ml	1.25 ± .15	.3 - 2.1

[1] Packed cell volume

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STUDIES ON THE GROWTH OF CALVES REARED ON RESTRICTED SUCKLING SUGAR CANE AND MOLASSES/UREA

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Summary

Analyses were made on 33 calves from a herd of crossbred Holstein/Zebu cows which received the following treatments: (A) grazing on pangola pasture without supplementation; (B) feeding in drylot with chopped sugar cane, molasses/urea (50 g urea/kg of molasses) and 600 g/d cotton seed cake with restricted grazing for 3 hr daily. The cows were milked twice daily by hand, being allowed to suckle their calves for a few seconds prior to milking to stimulate let down and for 30 minutes after milking. In general, the cows suckled only their own calves but there were some instances of crosssuckling. The calves were kept in open shaded pens with free access to chopped sugarcane, morasses with 10% urea and 250 g/d of cotton seed cake . They were mostly crossbred by Zebu and Holstein sires. Analysis of regression of live weight on age for these two groups of calves gave daily live weight gains of 419 - 28 g/d for crossbred calves and 260 ± 11 for Holstein calves, significantly in favour of the former. Milk intake was in the range 2.88 to 2.4 kg/d and was related to age (days) by the equation Y = 2.76 - .002X. Average intakes of the nonmilk components of the ration at three months of age were 3.5 kg /d of sugar cane and 1.01 kg/d of molasses/urea, the last representing a daily intake of 101 g urea. Predictions from these data indicate that the calves should reach a ,live weight of over 170 kg at 300 days.

Key words: Sugarcane, calf growth, suckling

Introduction

It has been proposed that an important component in a dual purpose scheme for milk and beef production under tropical conditions is the rearing of the calf by restricted suckling (Preston 1976). The justification for restricted suckling as

a rearing system in the tropics is based on the findings reported by Preston and Ugarte (1972) that for cows which suckle their calves on this system: (1) there is up to 20% more total milk per lactation than in cows that are milked without calves; (2) there is less mastitis (3) the growth rate of their calves is higher and mortality and incidence of diarrhoea is reduced; (4) apparently there are no effects on cow fertility.

Rearing calves by restricted suckling is a traditional system in many tropical countries and therefore more likely to be adopted at the practical level;an important factor in developing countries where the technical level of workers is relatively low.

The objective of the study described in this paper, which is the first in a series, was to obtain preliminary data on the performance of calves raised by restricted suckling as part of a dual purpose management system (MacLeod et al 1976) where the diet is based on sugar cane and molasses/urea.

Materials and Methods

Animals:

A total of 33 calves was used in the study. These were the progeny of crossbred Holstein/Zebu cows (60 to 80% Holstein "blood") sired by either Zebu or Holstein bulls. The calves were born over the period April to December 1975.

Management and Feeding:
The calves were suckled by their dams for a few seconds prior to milking in order to stimulate let down and then for a period of 30 minutes after hand milking was completed. At this time the cows and calves were held in one large group and there were some instances of cross suckling. Milking and suckling was twice daily at 6 a.m. and 3 p.m.. After suckling, the calves were separated from the cows and put in a shaded corral with a cement floor where they had free access to chopped sugar cane and molasses with 10% urea, fed on a free choice basis in separate troughs. In addition, 250 g/d of cotton seed meal was given and there was free access to minerals. Milk consumption was determined by weighing the calves before and after suckling at each milking/suckling period.

Measurements:

Weekly live weights were computed as the mean of 4 measurements daily carried out 7 times per week. Group intakes of the different diet components were determined daily.

Statistical Analysis:

The data were grouped according to age of calves at weekly intervals. The means of these measurements were then calculated and regressed against the average age (in days). This was done for the complete group of animals and separately (for live weight) for those judged to be crossbred as opposed to mainly Holstein (more than 75% Holstein breeding).

Results and Discussion

The mean values for the different parameters are given in table 1. Figure 1 shows the average growth rate for the total group of calves and for the two breed groups separately. Figure 2 is feed conversion ratio. Table 2 summarises the relationships between feed intake components and age.

Rate of growth was essentially linear up to 100 days of age and significantly higher for crossbred as opposed to Holstein type calves. The growth rate of the crossbred animals (490 g/d) is only slightly less than was reported by Alvarez and Preston (1976) for similar animals over a slightly older age range. There was a tendency for daily milk consumption to decrease with increased age of calf, while intake of fresh sugar cane and values was linearly related to age (table 2).

The intake of milk by the calf represented approximately 27% of the total milk production (total milk yield of the dams was 9.5 kg/d; see MacLeod et al 1976). On the assumption that suckling stimulates total milk production by 20% (Preston and Ugarte 1972), then it would appear that only some 10% of potentially saleable milk was lost by the restricted suckling programme. Or, to put the matter in another way, if the calf had been raised by bucket feeding using liquid milk, than the true quantities of saleable milk would have been only some 3 kg/d.

Table 1: Mean values for live weight and feed intake

			Feed intake			
No of calves	Age	Live weight	Milk	Sugarcane	Molasses/ urea	Total DM
	days	kg		kg/d		
33	9	40	2.9	0.75	0.33	0.44
33	17	42	2.8	0.73	0.32	0.43
33	24	44	2.6	0.76	0.44	0.50
33	31	45	2.7	0.73	0.41	0.50
33	38	47	2.6	0.81	0.30	0.42
33	45	48	2.7	0.82	0.43	0.53
26	52	52	2.6	1.20	0.48	0.66
26	59	55	2.7	1.24	0.58	0.74
26	66	58	2.6	1.50	0.61	0.84
22	73	61	2.5	2.05	0.56	0.93
22	80	66	2.5	2.66	0.76	1.23
20	87	69	2.4	3.48	1.01	1.63
12	94	69	2.6	3.88	0.98	1.71
11	101	74	2.7	3.91	1.05	1.76
10	108	78	2.5	4.05	1.07	1.82
9	115	80	2.6	4.38	1.04	1.87
9	122	86	2.5	4.70	1.28	2.14
6	129	94	2.8	4.60	1.02	1.91
6	136	98	2.3	5.01	1.12	2.09

Table 2: Relation between age (X = days) and daily intake of the different diet components

Y	Equation	r^2
Intake, g/d		
Milk	Y = 2760 - l.98X ± .75	.29
Molasses/urea	Y = 151 + 7.85X ± .65	.90
Sugarcane	Y = 450 + 40X ± 2.7	.93
Total DM	Y = 5.9 + 16.0X ± 1.1	.93

According to the regression equation of live weight on age, it can be estimated that by 300 days the crossbred calves would reach 179 kg live weight. In fact, this is almost certainly an underestimate as the data show a tendency to curvilinearity in the higher age range. Moreover, the mean weaning weight of the first calves produced on the system (Giraldez J, unpublished data 1976) was 210 kg at 300 days.

Figure 2: Regression of cumulative feed intake on live weight (coefficient of X is feed conversion)

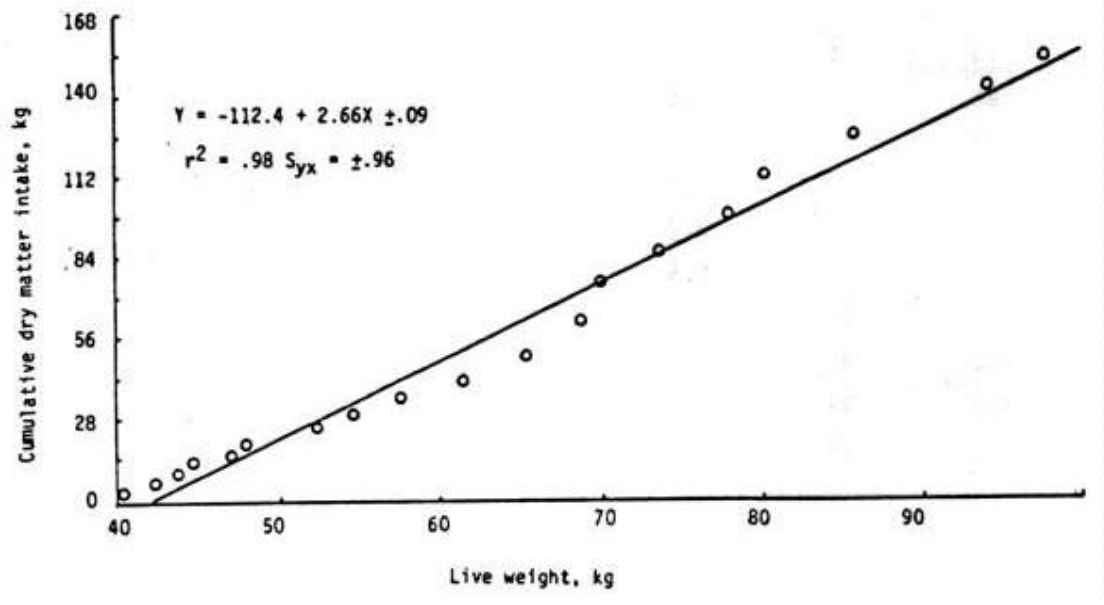
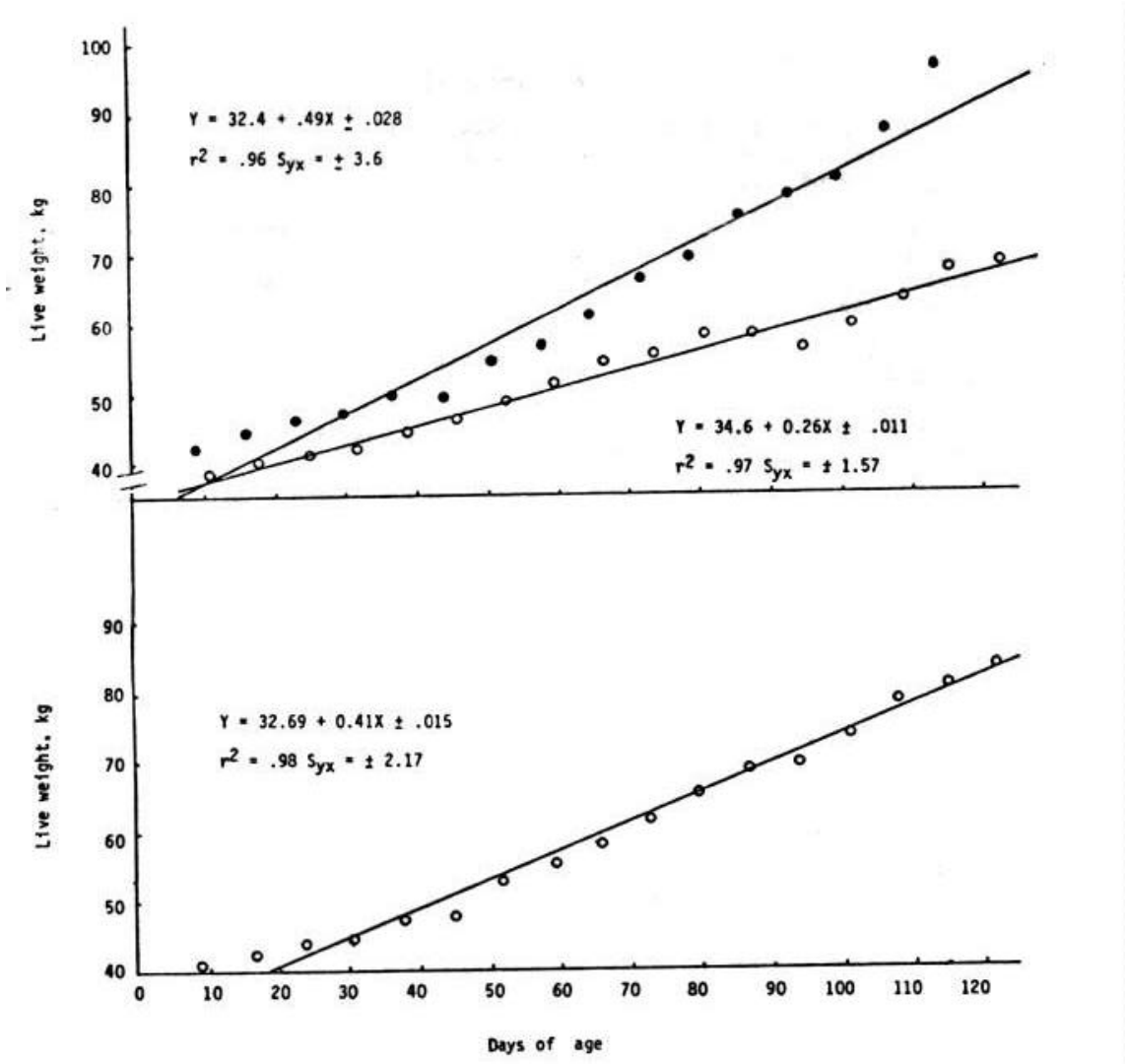


Figure 1: Regression of live weight on age for the total group of calves (lower graph) and for crossbred (•) and Holstein type (◦) calves (upper graph)



The mean daily milk intake was relatively low (2.6 kg/d) and considerably less than required for the maintenance requirements of the calf . This indicates a relatively high efficiency of utilization of the other supplements of the ration, which was principally sugar cane and molasses/urea. In view of its composition and the fact that suckling provokes an efficient closing of the oesophageal groove with direct passage to the abomasum, milk is thus a perfect supplement

for a sugar cane, molasses/urea based ration, in view of the metabolic limitations of this feed requiring supplementation with sources of amino acids and precursors of glucose (see Leng and Preston 1976).

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