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ANNUAL MILK YIELDS AND REPRODUCTIVE PERFORMANCE ON SMALL-SCALE DAIRY RANCHES IN TROPICAL BOLIVIA

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Milk recording was carried out on 16 small-scale dairy ranches stocked with mixed herds in the Bolivian lowland humid tropics for three years. Cows were milked once daily with calf at foot. The overall calculated annual milk yield per cow in herd was 712 kg in 244 days. The overall annual calving rate per cow in herd was 80.6%. Annual culling and mortality rates were 11.0 and 1.3% respectively. The range in mean annual milk yields per cow between breeds was only about half that between farms. Exotic and high grade Exotic animals were less fertile than Crillo/Zebu and low-grade Exotic animals. There was a pronounced effect of season on calving rates and milk production. It was concluded that management factors exerted more influence on milk yield than breed of animal.

Key words: milk production, reproduction of Exotic animals, crossbreeds, Criollo cows, small farms, tropics

Traditional milk production in the tropical lowlands of Santa Cruz is based on milking with calf at foot at daybreak, keeping cows and calves separated from each other in corrals at night. During daylight hours the cows are run with their calves on natural pasture. Rock salt is fed ad libitum in the corrals.

The traditional breeds of the Santa Cruz area are Criollo, Zebu and Criollo/Zebu. The latter is defined as the result of crossing Zebu and Criollo cattle and the random mating of their porgeny. During the past 25 years Friesian and Brown Swiss cattle, have been imported into the area and crossbreeding between these breeds and traditional breeds has become widespread.

The National Dairy Development Plan aims at raising the level of milk production from an estimated annual consumption of 12kg per capita(Barrón 1977). As part of this scheme a para-statal dairy plant (PIL -Santa Cruz) came into operation in 1977. PIL has been endowed with an extension service.

Consequently it was decided to set up a field monitoring unit aimed at collecting economic and production data, under conditions of intensive advising and provision of rudimentary veterinary assistance, amongst a group of dairy ranchers who lived on, and themselves worked their farms.

Materials and Methods

A group of 16 farms was selected for the Project. The farms are located some 140 km to the West of the town of Santa Cruz, and centrally along the track connecting Villa Bush with Puerto Grether. The maximum distance between any two farms is 7 km.

The area was opened to colonization in 1960. Agriculture is based on the slash-and-burn technology whereby, at first, the high forest is felled

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and burnt. Rice is sown in the ashes. After 2 - 3 years of cultivation the area is either abandoned or sown to new pasture and a new area is cleared. Later the same process takes place in the forest regrowth areas. Some of the Project farmers had brought along with them Friesian cattle from the highland valleys. These animals suffered initial high mortality rates and were partially replaced with local cattle and local breed bulls were used for breeding. Once a market for milk had been established, interest in keeping dairy-type cattle reappeared.

Grazing is based mainly on volunteer species appearing in rice - fields and, in some areas *Hyparrhenia rufa* is sown together with rice . Overgrazing is almost universal and *Hyparrhenia rufa* generally dis - appears within 3 - 4 years. Forest regrowth , if uncontrolled, causes the pastures to disappear within 3 years.

Meteorological data were collected from an experimental station 40 km to the East of the Project, Table 1 shows a summary of these.

Table 1:
Summary of meteorological data. (Figures in brackets indicate month)

	Annual mean	Monthly max.	Monthly min.
Precipiation, mm	1825	296 (1)	51 (6)
Maximum temperature, °C	29.7	31.6(11)	25.8(6)
Minimum temperature, °C	18.8	21.6(11)	15.1(6)

Source: Estación Experimental Agricola de la Colónia de San Juan de Yapacani 17.15°S, 63.50°W (Years 1960-1980

The altitude of the area is approximately 350 m above sea-level.The soils are alluvial with a pH in the range of 4.2 and 5.0 and are deficient in phosphorus (Paterson and Horrell 1981).

The Project commenced on June 1st 1978. The slash-and-burn system together with the traditional system of milk production was practised on all of the 16 farms. The Project encompassed a total of 840 ha of which 234 ha were utilized for grazing at the start of the Project. The sizes of the farms ranged between 30 and 130 ha and they were surveyed during the months of June, to assess the stocking rate.

Project animals were classified into the following groups: Exotic (Friesian and Brown Swiss), 3/4 Exotic, 1/2 Exotic, 1/4 Exotic, Criollo/ Zebu and Criollo. Animals which did not fit any of these groups were termed "Other", of which about half were Zebu. Records were kept on economic and animal transactions. Milk recordings were carried out at 28 day intervals as from October 1978. At Project commencement 20 of the serving bulls were Exotic, 40% were crossbred and 40% local breed. The bulls were permanently run with the herds.

The first Project year was regarded as an observation period. During the second and third years efforts were made at introducing improved pasture species, mainly *Brachiaria decumbens* and the legume *Macrotyloma axillare*. Herbicide for bush control , tick control measures, vaccination, feeding of mineral-mix salt in addition to teaching the farmers simple veterinary skills such as de-worming , disinfection of wounds and treatment of diarrhoea. Furthermore the farmers were induced to keep AI-sired Exotic bulls.

Results and Discussion

Table 2 outlines the pattern of cow herd size development.

Table 2:
Cow herd size developments

Number of cows					
1/1/79	1st calving	Purchased	Culled	Died	31/12/81
146	149	33	61	7	260

Table 3 shows the cow herd production characteristics.

Table 3:
Cow herd production characteristics

Milk recording status	Cows in herd		Calculated kg milk	Days in milk
	days	%		
Whole-year cows, milk recorded	150,515	74.6	293,206	100,616
Part-year cows, milk recorded	34,992	17.3	79,411	27,475
Cows milked, incomplete records	3,376	1.7	-	-
Cows not milked	12,841	6.4	-	-
Total	201,724	100	372,617	128,091
Total milk sales	-	-	324,380	-

Animals which were cows throughout any calendar year were defined as being whole-year cows during that year. Animals which entered or left the cow herd during any one year were defined as part-year cows in respect of that year. Some cows were not milked for reasons of recalcitrance. The estimated milk yield of the cows with incomplete records was 678 kg.

The annual culling and mortality rates were 11.0 and 1.3% respectively calculated on the basis of cow-days.

At the start of the Project, pastures were native grasses and run-down *Hyparrhenia rufa*. Most of the sowings after 1979 were of improved pasture species. Visual assessment indicated that all but one of the farms were overgrazed throughout the year. Table 4 outlines the pattern of pasture expansion and stocking rates.

Table 5 shows the pattern of concentrate consumption.

During 1981 the supply of concentrate became erratic. Concentrate was only fed to cows and Exotics were given preference.

Table 6 shows annual milk yields, days in milk and calving rates of the whole-year cows, by calendar year. "Dry" cows, habitually milked, were included.

Table 4:
Pasture expansion and stocking rates

Date	31/5/79	31/5/80	30/5/81
Total pasture, ha	280	330	375
No. of cattle	406	495	575
Stocking rate, head/ha	1.45	1.50	1.53
% cows in herd	36	35	35

Table 5:
Pattern of concentrate consumption

Year	1979	1980	1981	Total
Calculated milk yields, kg	92,965	124,279	162,154	379,398
Kg concentrate consumed	8,569	12,279	6,242	27,090
kg concentrate/kg milk	0.09	0.10	0.04	0.07

Table 6:
Mean annual milk yields, days in milk, their standard errors and calving rates of whole-year cows, by year

	No. of cows	Kg milk	Days in milk	% calvings
1979	110	649 ± 25.4	248 ± 7.0	80.0
1980	135	724 ± 27.3	238 ± 6.3	76.3
1981	167	742 ± 21.8	247 ± 5.3	84.4
All	(412)	712 ± 14.4	244 ± 3.5	80.6

The rise in milk yield from 1979 to 1980 was significant at the $P < .05$ level and the difference between the milk yields of 1979 and 1981 was significant at the $P < .01$ level. No other significant differences were found.

Table 7 shows the mean annual milk yields, days in milk and annual calving rates of the whole-year cows, by breed.

The milk yield of Exotic was significantly higher than that of Criollo/Zebu and Other breed cows at the $P < .05$ level. Days in milk of Criollo/Zebu was significantly fewer than both those of Criollo ($P < .01$) and 3/4 Exotic ($P < .05$). Chi-square analysis showed Criollo/Zebu fertility to be significantly higher than that of Exotic ($P < .001$), 3/4 Ex-

otic, (P <.01) and Criollo (P < .05). Exotic fertility was significantly lower than that of 1/2 Exotic and 1/4 Exotic (P < .05). No other significant differences were found.

The rise in milk yield from 1979 to 1981 was not ascribed to change in herd composition as the proportion of Exotic cows reamined 14% and that of Criollo/Zebu rose from 22% to 27%.

Table 7:

Mean annual milk yields, days in milk, their standar errors and annual calving rates of the whole-year cows by breed

Breed	No. of farms	No. of cow-years	Kg milk	Days in milk	% calvings
Exotic	12	64	804 ± 52.4	249 ± 10.9	64.1
3/4 Exotic	8	32	739 ± 56.0	258 ± 12.6	71.9
1/2 Exotic	14	76	713 ± 32.5	237 ± 8.7	82.9
1/4 Exotic	10	30	748 ± 39.7	239 ± 11.6	86.7
Criollo	16	94	690 ± 25.8	258 ± 6.3	78.7
Zebu/Criollo	15	99	669 ± 24.1	229 ± 6.6	91.9
Other	4	17	613 ± 58.1	254 ± 20.0	82.4

Wilkins et al (1979) investigated the annual milk yields on 19 commercial farms, in the Santa Cruz area, representing five different production systems. The highest mean annual milk yield was 3041 kg under con - ditions of zero grazing, concentrate feeding and twice daily milking. The lowest mean annual milk yield was 183 kg under conditions of grazing natural pasture, no concentrate feeding and once daily milking when the cows had milk surplus to the requirements of their calves. It was found that over the whole range of systems Exotic cows yielded less milk and had a lower calving rate than the crossbreds which yielded more milk than both Zebu and Criollo/Zebu cows.

Despite receiving more concentrate, the Exotic cows did not outyield the crossbred cows significantly, but the crossbreds had a higher fertility than the Exotic cows, and this is in agreement with the findings of Wilkins et al (1979).

The mean annual milk yield per cow ranged between farms from a minimum of 553 ± 55.4 kg to a maximum of 922 ± 89.4 kg based on the whole-year cow records. The difference was highly significant (P < .001) and greater than that due to weeds. Milk yield was highly correlated with lactation length (r = 0.597, P < .001). The mean days in milk ranged between farms from 194 ± 20.2 to 270 ± 11.4, the effect of farms being highly significant (P < .001). Mean calving percentages for whole-year cows ranged from 59.1 to 100%, with differences between farms significant at the P < .05 level .

Table 8 shows mean annual milk yields and days in milk of the whole-year cows, by breeding status.

The difference in milk production was insignificant, but the difference in days in milk was significant at the P <.001 level. The Table

Table 8:

Mean annual yields and days in milk and their standard errors of the the whole-year cows, by breeding status

Breeding status	No. of cow-years	Kg milk	Days in milk
Cows calving	328	711 ± 14.9	233 ± 3.3
Cows not calving	84	713 ± 40.1	285 ± 10.4

shows that mean annual milk yield per cow will not rise as a result of a shortened calving interval.

Table 9 shows the monthly calving pattern of the whole-year cows .

Chi-square analysis showed that the calving pattern differed at the $P < .001$ level of significance from an expected even monthly calving rate. During the period of June-November 223 calvings took place and during the remaining period only 109 calvings occurred. The difference was significant at the $P < .001$ level. June is the driest month. Hence the majority of conceptions occur during the early rainy season associated with relative herbage abundance and high nutritive value.

Table 9 :

Monthly calving pattern of whole year cows

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
No. of calvings	13	13	15	25	21	31	47	33	32	42	38	22	332

Table 11 shows the pattern of all calvings of all cows milked, together with levels of monthly milk sales to PIL.

Milk sales to PIL accounted for 85% of the calculated milk production and are regarded as a reliable indicator of production levels. The monthly calving rates of the part-year cows did not differ significantly from those of the whole-year cows. The correlation between number of calvings and milk sales was not significant.Milk sales levels during the the period of August - January were significantly ($P < .001$) higher than those of the rest of the year, and were associated with the early part of the wet season.

Seasonality in calving and milk production suggests that nutritional levels are sub-optimal.

The stocking rates on every June 1 st were regarded as being representative for the year calculated. The means of farm stocking rates on June 1st were 1.58 ± 0.145, 1.59 ± 0.104 and 1.60 ± 0.102 beasts per ha in 1979, 1980 and 1981 respectively. Separate correlation analysis for each year

Table 10:
Monthly milk sales to PIL and total calving pattern

Month	kg milk	No. of calvings
Jan.	29,567	18
Feb	18,524	18
Mar.	22,006	24
April	19,160	32
May	19,921	28
June	20,857	51
July	21,967	72
Aug.	26,148	63
Sep.	27,337	54
Oct.	35,251	57
Nov.	40,027	53
Dec.	40,431	25
Total	321,196	495
Mean of total	26,766 ± 2,300	41
Mean, Aug-Jan	33,127 ± 2,584	45
Mean, Feb-July	20,406 ± 592	38

between whole-year cow annual milk yields and total (all cattle) stocking rates showed no significant relationships. The amount of bush regrowth in the pasture varied widely between farms.

The means of farms with improved pasture availability (*Brachiaria decumbens* and *Pacrotyloxa axillare*) corresponded to 0.034±0.0069 and 0.094 ± 0.0176 ha per head of cattle on June 1st in 1980 and 1981 respectively. Separate correlation analysis between whole-year cow annual yields and ha improved pasture per head demonstrated no significant relationships, perhaps because the amounts of improved pasture were low, making up only about 15% of the total pasture on 1981.

The drastic drop in milk sales from January to February coincides with the beginning of the rice-harvesting season. Some of the farmers stop milking once overall yield drops to levels not considered worthwhile selling. Some stop milking poor yielders once they have filled one or milk churns, it not being considered worthwhile to send near-empty churns.

Conclusions

The management system on all Project farms was identical and yet large differences were found between annual milk yields and days milked. During the period studied milk yield per cow rose significantly indicating an overall management improvement. The variation in milk yields between breeds was only about half of that found between farms. Upgrading the local breeds beyond 50% exotic inheritance resulted in a lowered fertility

which is detrimental to long-term milk and beef production, and importing exotic cows into the area would not increase milk production significantly above that produced by crossbreds. Seasonality in calving indicates that nutritional stress occurs. Yet no relationship could be established between milk yields and stocking rates within the ranges found. It is beleieved that milk yields could rise significantly by milking the cows for more days. Probably the price of milk and the price relationship milk:rice influences to some extent the decision as to for how long to milk. However, in a dynamic situation such as the one described, pasture expansion is essential and rice cultivation reduces the cost of pasture expansion. The argument (Pearson de Vaccaro, 1974) that genetic progress in tropical South America has a comparatively minor role to play in the overall improvement of the region's dairy industries, is supported by the findings of this study. Management factors seem to be of more importance at current levels of production.

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