The Impact of Crossbred Cows in Mixed Farming Systems in Gujarat, India: Milk Production and Feeding Practices

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ABSTRACT : Holstein Friesian and Jersey crossbreds are being widely introduced in the state of Gujarat in India. This paper evaluates feeding practices at farm level and examines whether the crossbreds fit into the existing mixed farm systems. Over a period of four years milk-offtake and feeds offered were recorded for 1331 cows at fortnightly intervals. The breed and the amount of concentrates fed contributed most to the variation in milk offtake. The introduction of crossbred cattle has a major impact on smallholder mixed farming systems. Crossbreds produced, on average, 1.8 times more milk than Desi, Gir, and Kankrej cows. They were fed 1.4 times more concentrates, and about 1.2 times more green and dry feeds than local cows. The major limiting constraint is the quality of the roughages offered. Farmers with crossbreds try to adjust their feeding of concentrates according to the needs of their cows. On tribal farms, local cows produced less milk than on non-tribal farms, whereas crossbreds produced the same amount of milk on both tribal and non-tribal farms. Crossbreds fit into the farming systems of both tribal and non-tribal farmers. The differences in agro-climatic characteristics between different areas in Gujarat were not reflected in differences in milk offtakes.
(**Kew Words**: Cattle, Crossbreeding, Milk Offtake, Feeding, Mixed Farming, India)

INTRODUCTION

In Gujarat, on the West coast of India, cattle are the most important type of livestock on the traditional crop livestock smallholder farms. Cattle are kept for milk, draught, manure, and as security in case of crop failures. The total cattle population is about 6.24 million. The state can be divided into different agro-climatic zones, on the basis of its climate and soil types, for planning location-specific research and development programmes (Ghosh, 1991). About one-sixth of the farming households belongs to tribal groups; these socio-economically less favoured groups have low literacy rates (21% versus 50% for non-tribals), and live mostly in and around hilly forest areas, so-called tribal areas, in the Eastern and Northeastern part of the state (Masawi, 1988). Preliminary results of a farm survey indicate that tribal farmers farm, on average, only half of the crop land of non-tribal farmers and their farm income also is about 50 per cent less than that of non-tribal farmers. The agricultural development programmes in Gujarat are targeted at the different agro-climatic zones and social groups.

A baseline survey (done in 1988) indicated that around 75 per cent of the rural households keep cattle and that animal feeding and management practices are some of the constraints to increase livestock production levels in the mixed farm systems in the area, in addition to the common problem of underemployment. Still, the farm survey showed that livestock contributed substantially to farm income: 32% and 20% for tribals and non-tribals, respectively.

The BAIF development research foundation is an NGO (non-governmental organization) that carries out cattle development programmes directed at promoting the socio-economic development of the less favoured sections of society. Back in 1985, BAIF opted to introduce crossbred cattle to increase the income of smallholder farmers, since milk is considered to be the most important contribution of livestock to regular cash income, particularly for the farmers with limited or no land (Mangurkar, 1990; Patil et al., 1993). Cattle can provide employment opportunities to the extent of 80 to 140 man-days per cow per year (Apte, 1989; Mangurkar, 1990). The introduction of crossbred cattle also provides a basis

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for establishing rapport with the farmers and an entry point for extension activities (Rangnekar et al., 1993). Therefore, each farmer who requested crossbred cattle was supplied with semen from Holstein Friesian or Jersey bulls to inseminate his cows, irrespective of the specific conditions in the various farming systems.

It is generally accepted that crossbred cows can produce considerably more milk, but the use of crossbred cattle in Indian farming systems is also queried because of the extra feed needed, and doubts about whether such cattle fit into existing mixed farming systems (McDowell, 1983; Rao et al., 1995). There is, however, no detailed information available concerning the performance of crossbreds in different farm systems and the extent to which farmers succeed in meeting the extra feed requirements for crossbreds. The study reported in this paper aimed to assess milk production performance of Desi, Gir, Kankrej, Holstein Friesian crossbred and Jersey crossbred cattle in relation to feeding practices in different farm systems of Gujarat, India.

MATERIALS AND METHODS

The study area

The study area was in the state of Gujarat. Gujarat is situated on the West coast of India, covering 196,000 km^2, between 20.1° and 24.4° North latitude. The state has 50% of its area under cultivation, 10% is under forest, 4% is grazing land, 23% is waste land (Ghosh, 1991). Rainfed crop production occupies most of the 9.67 million ha of cultivable land, although 23% is already used for irrigated crop production. Average annual rainfall varies from 300 mm in the North West arid zone to 1,500 mm in the South, with monsoon rains from mid-June to September. Winter (dry, relatively cold) extends from October to February, summer (hot and dry) is from March to June. Mean daily temperatures vary from 15℃ (January) to 42℃ (May).

For this study we selected 5 agro-climatic zones (zones 1, 2, 3, 6, and 7) out of a total of 8 zones in the Gujarat Plains and Hills Region (Ghosh, 1991). Table 1 gives some characteristics of these zones.

Table 1. Characteristics of the five Gujarat agro-ecological zones included in this study (after Ghosh, 1991)

	Zone 1	2	3	6	7
Physiography	plain-hilly	undulating	plain-hilly	plain-hilly	plain-hilly
Soils types	coastal alluvial	black	sandy loam	black	black
depth cm	> 100	50-100	> 100	50-100	50-100
Rainfall mm	1,000-1,500	1,000-1,200	700-1,000	625-750	625-750
Temp. range ℃	15-40	15-40	15-42	15-42	18-40
Cropping system					
rainfed	+	+	++	++	++
irrigated	++	++	–	–	+

++ : major cropping system.
+ : second cropping system.
– : hardly present.

Cattle management

Livestock farmers keep 3 to 8 animals, predominantly cattle (65%), followed by buffaloes, goats and sheep. Livestock are fed a basic diet of straw. Herds are routinely grazed on government and village common lands. Some farmers cultivate forages to supplement milking and working animals. In tribal areas farmers collect weeds and tree leaves to feed the milking and working animals. Animals are generally housed in mud sheds in the backyards of living quarters.

Farmers obtained crossbred cattle via AI with semen from HF and Jersey bulls. Thereafter, crossbred bulls were used to maintain the exotic blood level at 50% to prevent problems of adaptation, as experienced in animals with higher exotic blood levels (Katpatal, 1977; Cunningham and Syrstad, 1987).

Data collection

The field recording covered a period of four years. It began in 1988 at six BAIF dairy cattle production centres, i.e. centres with an extension officer supplying breeding and other services to the farmers in a 10-15 km radius. The number of centres was subsequently increased to 24. The monitoring covered 1331 cow records, representing all breeds, such as Desi, Gir, Kankrej, Holstein Friesian (HF) crosses, and Jersey (J) crosses. The average weights

vary from around 325 kg for local Desi animals to 350 kg for Gir, Kankrej and J crosses, and 375 kg for HF crosses.

Data collected included:

– milk offtake (morning and evening) for each cow, every 14 days

– type and quantity of fresh feeds consumed for each cow (feeds offered minus feed refusals), every 14 days

– breeding information (e.g. pregnancy diagnosis, calving; mainly to help farmers in breeding management)

– disease problems and mortality

– grazing period in hours for the community herd

– family background: tribal or non-tribal.

Feeding practices

The feeds offered were subdivided into three categories: dry feeds, green feeds, and concentrates. The dry feeds fed were mostly sorghum, millet, paddy and maize straws, and dry grass. The green feeds were weeds, forest grass, tree leaves, and cultivated forages such as napier, lucerne, and maize. Concentrates were a mix of compound feeds, brans, damaged grains, and chuni (broken pulses with kernels). The year was divided into two seasons: monsoon season (July to January) with relatively ample grass and other green feeds available, and dry season (January to July) with minimum grazing available.

The estimated composition of feeds was

– concentrates: 90% DM (dry matter), 18% CP (crude protein) and 65% TDN (total digestible nutrients) on DM basis

– green feeds: 26% DM, 9% CP, 55% TDN

– dry forages: 85% DM, 4% CP, 50% TDN.

Grazing intake during the monsoon season was estimated to be 2.5 kgd^{-1} DM per cow and CP and TDN as for green feeds (Patil et al., 1993). Grazing intake during the dry season was estimated to be negligible. Maintenance requirements of a cow for energy and protein were estimated to be 30 g TDN and 5 g CP per unit metabolic body weight. The requirements for milk production were assumed to be 350 g TDN and 87 g CP per kg. Nutrient balances were calculated for the different breeds in the two seasons. Total milk production was defined as the milk offtake by the farmer plus the milk intake by the calf. Milk intake by the calf was estimated to be around one third of the milk offtake, as calves were allowed to suckle one teat.

Data analyses

Least squares methods (Harvey, 1977) were used to analyse the variation in daily milk offtake. The analytical model included the effect of social group, agro-climatic zone, breed, calving season, year, parity, interaction breed × social group, the covariables amount of green feeds, dry feeds, concentrates, and the interactions breed × amount of concentrates and social group × amount of concentrates.

RESULTS

Table 2 gives the average amount of daily DM intake (excluding grazing) for the five breeds. The HF crossbred and J crossbred cows consumed significantly ($p < 0.01$) more DM than the Desi, Gir and Kankrej cows. The amount of dry feeds was significantly higher ($p < 0.01$) for crossbred cows than for local cows. HF cross and J cross cows consumed also significantly ($p < 0.01$) more concentrates than the Desi, Gir and Kankrej cows. Desi cows were offered the lowest ($p < 0.01$) amount of concentrates. Desi and Gir cows consumed significantly ($p < 0.01$) less green feeds compared with HF cross, J cross and Kankrej cows. On non-tribal farms cows were fed, on average, 8.1 kgd^{-1} DM (66% dry feeds, 13% green feeds and 21% concentrates), whereas on tribal farms cows were fed, on average, 6.8 kgd^{-1} DM (54% dry feeds, 24% green feeds and 22% concentrates).

Table 2. DM (kgd^{-1}) intake per lactating cow for different breeds in Gujarat

Breed	n	Total DM		Dry feeds		Green feeds		Concentrates	
		mean	s.e.[1]	mean	s.e.	mean	s.e.	mean	s.e.
Desi	648	6.6^{a}	0.19	4.2^{a}	0.18	1.3^{a}	0.04	1.1^{a}	0.04
Gir	202	7.4^{a}	0.30	4.4^{a}	0.28	1.4^{a}	0.06	1.6^{b}	0.05
Kankrej	210	7.2^{a}	0.32	3.8^{a}	0.30	1.7^{b}	0.06	1.7^{b}	0.05
HF cross	181	9.5^{b}	0.32	5.8^{b}	0.30	1.7^{b}	0.07	2.1^{bc}	0.05
J cross	90	9.0^{b}	0.44	5.2^{b}	0.41	1.7^{b}	0.09	2.1^{bc}	0.08

Means with different subscripts are significantly different at $p < 0.01$.

[1]s.e.: standard error.

Average milk offtake for the two seasons was the same: 5.2 kgd^{-1} per cow. On average, DM intake was 7.5 kgd^{-1} per cow (52% dry feeds, 27% green feeds and 21% concentrates) in the monsoon season and 7.0 kgd^{-1} (67% dry feeds, 11% green feeds and 22% concentrates) in the dry season. The daily grazing hours were 4-8 h in the monsoon season and 4-6 h in the dry season. In the dry season there is hardly anything to graze. So, only for the monsoon season 2.5 kgd^{-1} DM per animal was added to the amount of feed fed to provide the nutrient balances. Figure 1 shows the TDN and CP balance as a percentage of the requirements for the different breeds in the two seasons. Protein was a limiting nutrient in both seasons and in all breeds. Figure 1 shows that there was also an energy shortage in the dry season. The nutrient balances were more negative for J cross cows than for cows of the other breeds.

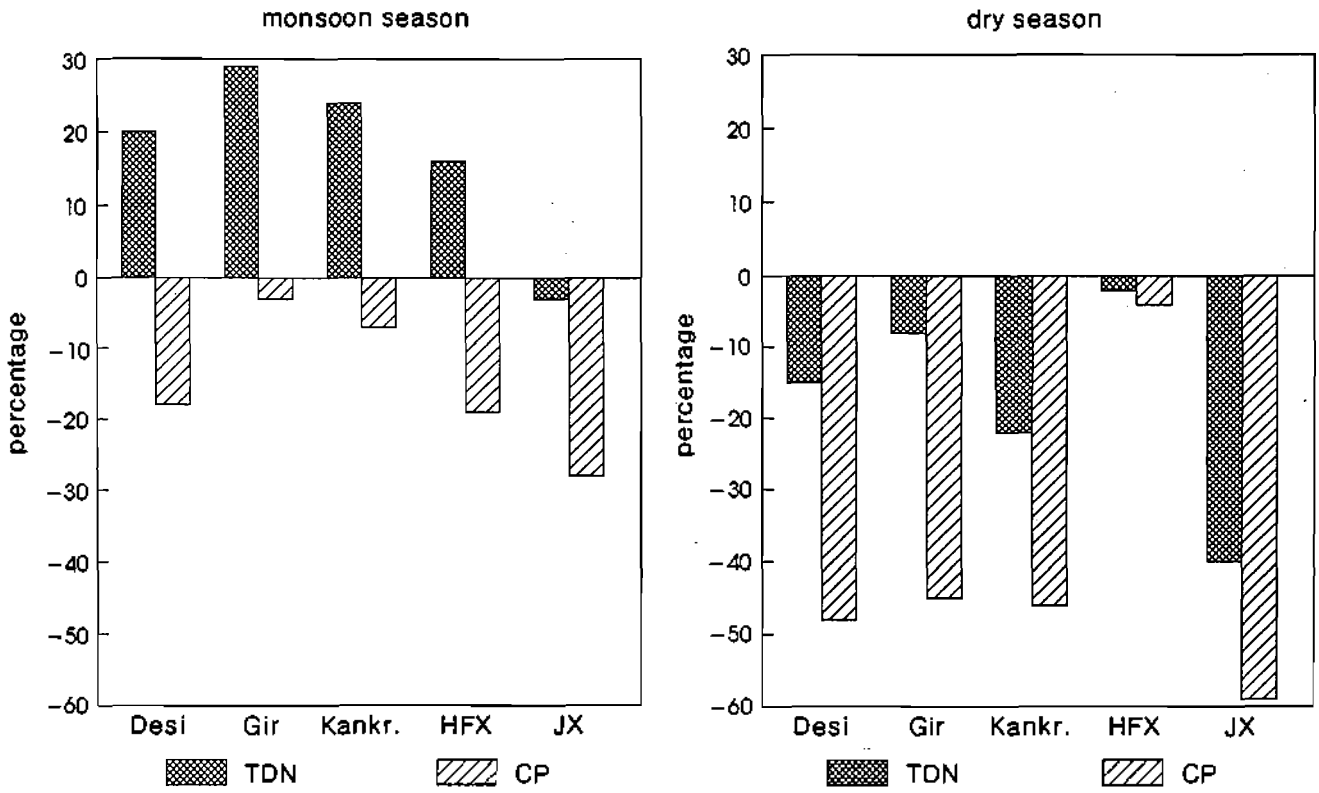

Figure 1. TDN and CP balances as a percentage of the requirements for a lactating Desi, Gir, Kankrej (Kj), HF cross (HFX), and J cross (JX) cow in the monsoon and dry season in Gujarat.

Table 3 gives the corrected means and standard errors for milk offtake. Cows of non-tribal farmers produced significantly more milk than cows from tribal farmers ($p < 0.001$). The performance of HF and J crossbred cows did not differ between tribals and non-tribals but the Indian breeds produced better on non-tribal farms. Overall the differences in milk offtake between zones were small. Zone 7 had significantly ($p < 0.001$) lower milk offtake than the other zones. The effect of parity on production shows that milk yield gradually increased from the first to the fourth lactation. The year effect shows that the calving year of 1989 had significantly higher production than 1988 and 1990 ($p < 0.001$). The regression coefficients for green feeds and dry forages indicate that these feeds had a small negative ($p < 0.001$) effect on milk production. An increase of 1 kg of concentrates gave an increase of 1.28 kg in milk offtake in HF crossbreds. This regression coefficient was significantly different ($p < 0.001$) from the regression coefficients for the other breeds. In Desi, Gir, Kankrej and J cross cows the milk offtake increased by only 0.84, 0.58, 0.54, and 0.56 kg, respectively. On non-tribal farms cows responded more ($p < 0.001$) to feeding concentrates than on tribal farms. The coefficient of determination for the model used was 54%. The breed and the amount of concentrates fed contributed most to the variation in dairy milk offtake.

Table 3. Least squares means and regression coefficients for various factors with milk offtake (kg) per lactation day as the dependent variable

	n	l.s. mean	s.e.[1]	regression	s.e.
Overall average	1,331	4.60	0.16		
Social group -non-tribals	478	5.00[a]	0.20		
-tribals	853	4.21[b]	0.19		
Agro-ecological zone - 1	133	4.79[a]	0.25		
- 2	478	4.98[a]	0.20		
- 3	427	4.75[a]	0.17		
- 6	222	4.63[a]	0.20		
- 7	71	3.89[b]	0.31		
Social group × breed					
non-tribals - Desi	179	4.03[a]	0.21		
- Gir	160	4.64[b]	0.22		
- Kankrej	59	3.96[a]	0.26		
- HF cross	52	6.63[c]	0.31		
- J cross	28	5.73[df]	0.35		
tribals - Desi	469	3.16[e]	0.19		
- Gir	42	2.78[e]	0.29		
- Kankrej	151	2.78[e]	0.23		
- HF cross	129	6.46[cdf]	0.24		
- J cross	62	5.88[cdf]	0.27		
Lactation - 1	303	4.24[a]	0.11		
- 2	516	4.54[ab]	0.10		
- 3	323	4.67[b]	0.12		
- 4	125	4.89[b]	0.16		
- 5	39	4.35[ab]	0.26		
- 6	25	4.81[ab]	0.40		
Calving year - 1988	176	4.26[a]	0.22		
- 1989	457	4.94[b]	0.18		
- 1990	562	4.62[ac]	0.16		
- 1991	136	4.60[abc]	0.21		
Season - monsoon	598	4.62[a]	0.17		
- dry	733	4.59[a]	0.17		
Dry feeds kgd^{-1}				−0.05***	0.01
Green feeds kgd^{-1}				−0.05***	0.02
Concentrates kgd^{-1}				0.76***	0.07
Breed × concentrates - Desi				0.84***[a]	0.08
- Gir				0.58***[a]	0.13
- Kankrej				0.54***[a]	0.18
- HF cross				1.28***[b]	0.14
- J cross				0.56***[a]	0.12
Social group × concentrates					
- non-tribals				0.96***[a]	0.10
- tribals				0.56***[b]	0.08
R^2 full model[2]: 54%					

Means with different supersripts are significantly different at $p < 0.001$;

*** Significance regression coefficients $p < 0.001$.

[1] standard error.

[2] coefficient of determination.

The lactation periods for Desi, Gir, Kankrej, HF cross, and J cross cows were 254, 246, 236, 264, and 264 d, respectively. The intercalving period could be estimated in only 108 cows. For Desi, Gir, Kankrej, HF crosses, and J crosses the intercalving periods were 540, 556, 534, 488, and 485 days, respectively. During the monitoring period no systematic health problems occurred and only very few deaths (5 animals) were recorded.

DISCUSSION

The differences in agro-climatic characteristics between zones were not reflected in differences in milk offtake. Zone 7 is located near the coast. In this area the milk marketing infrastructure is poor. The Gir breed originated in this area. Gir breeders are more interested in selling of breeding stock than in a high milk offtake. The likely reason that the milk offtake was significantly lower in zone 7 than in the other zones (table 3), is that farmers prefer to give their calves a bigger share of the milk than in the other zones. So, our estimate that the milk intake by the calves was one-third of the milk offtake was questionable for zone 7. Our findings agree with the conclusion of de Boer et al. (1994) that for livestock, the use of agro-climatic macro-regions to target development activities can be questioned. Feed availability at farm level, marketing infrastructure, and socio-economic parameters are some of the additional factors to be considered.

The lower milk offtake of cows of tribal farmers compared to cows of non-tribal farmers was caused by the low milk offtake of indigenous cows on tribal farms. This may be due to the management and genetic background of local animals in the areas where tribals live. In the non-tribal areas, one finds traditional breeding practices and specific breeders for Gir and Kankrej cattle. In the tribal areas, most local animals are so-called "nondescript" Desi and they tend to be smaller than in non-tribal areas.

Crossbred cows were fed 1.4 times more concentrates, and about 1.2 times more green and dry feeds than the local cows. The higher amounts of feed fed to crossbreds compared to the other animals illustrates that the farmers with crossbred cows try to adjust their feeding of concentrates according to the needs of the animals. We could only give a general estimate for the DM intake via grazing. Also the nutrient balances do not consider differences between zones in grazing availability. So, our feed balance estimates are only rough approximations. Still, the results (figure 1) indicate that there are TDN and CP deficiences in the dry season. In all breed groups except the HF crossbreds, the CP deficiency is substantial. CP also is deficient in the monsoon season.

Average milk offtake was about the same in both seasons, although the nutrient balances indicate a severe protein and energy shortage in the dry season. One reason why milk yields were not higher in the monsoon season, may have been that farmers are mainly occupied with crop activities. Changes in body weights could not be monitored, but, it is well known that lactating cows loose weight in the dry season. In the monsoon season, cows can recover some of their weight loss from the dry season. However, most of the weight gain will occur in the 7.5-10 month period between two lactations.

In reality, the dry period will be even longer beacause the estimates of intercalving periods are based solely on cows with two consecutive calvings during the monitoring period. Thus, these estimates will be too optimistic, because cows with only one calving or no calving in the monitoring period are not included. Nevertheless, the 2 months shorter intercalving periods of crossbred cows compared to cows of the Indian breeds are in accordance with the experiences of the farmers that locally born crossbreds (the great majority of the crossbreds in this study) show less fertility problems than cows of the Indian breeds or crossbred cows imported from other states.

The feed deficiencies can be corrected by adjusting the feeding practices. Feeding additional concentrates, such as bran plus urea, can compensate for both the TDN and CP deficiencies in all breeds, except the J crosses. This is more feasible for non-tribal farmers, because of their higher farm incomes. Urea treatment of straws can help to correct the CP deficiencies, particularly in the monsoon season and in zones where high amounts of straws are fed. The CP deficiencies in the dry season are too high to be corrected by straw treatment. Straw treatment is not economically feasible for cows with low milk yields (Schiere and Nell, 1993). One option for tribal farmers could be leguminous tree leaves, because, in greneral, tribal farmers have excess labour and therefore the labour-intensive practice of planting trees and collecting leaves every day is not an obstacle for them.

Both social groups are interested in using crossbreds as dairy animals. And crossbred cows perform equally well on tribal and non-tribal farms. In Gujarat the total number of crossbreds has increased from 1% to 7% of the total cattle population in the period 1982-1992 (Anonymous, 1993). Our results indicate why farmers are interested in obtaining crossbred cows. Farmers prefer HF crosses over Jersey crosses, because of their higher milk

yields. The very negative feed balance estimates for Jersey crosses also indicate that these animals are less appreciated. More research is needed into changes in herd composition and allocation of feed resources to other types of animals resulting from keeping crossbred cows. Added to this, the sociocultural implications need to be studied, e.g. the increase in labour for women as they do the majority of the cattle management chores.

Disadvantages of crossbreeding programmes are the risk of the loss of local genetic resources and the reduction in hybrid vigour in the later generations of crossbreds. Since 1994, BAIF supplies Gir semen to Gir breeders to try to maintain the quality of the Gir breed. Syrstad (1989) reviewed dairy cattle crossbreeding in the tropics. She concluded that milk production was, on average, 24% lower in the F_2 than in the F_1. The great majority of the crossbreds in this study were F_1 animals. As yet, no field data are available on production performances of F_2 crossbred cattle. Monitoring the performances of F_2 crossbreds is strongly recommended.

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