The Impact of Crossbred Cows at Farm Level in Mixed Farming Systems in Gujarat, India

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ABSTRACT : This study aimed to quantify the impact of crossbreeding at farm level, in mixed farm systems in Gujarat. Households with crossbred cattle did not differ from households without crossbreds in terms of farm resources, crop gross margins and off-farm income. The use of crossbred animals did increase livestock gross margins by 64% and household income by 22%. The three agro-ecological zones included in this study differed considerably according to farm system and household income. However, in all three zones, households with crossbreds had higher livestock gross margins than households without crossbreds.

There was no real difference in work load and labour division between households with and without crossbreds. There was also no difference in the use of bullocks for draught purposes between the two types of households. In particular buffaloes are being replaced by crossbred cattle. There was a large variation in farm income, largely because of land area. The milk offake per average cow and the number of buffaloes also related positively to farm income in both types of households. Crossbreeding has proved technically and financially viable in different Gujarat mixed farming systems. It can be concluded that crossbreeding is an important development option for landless farmers.

(**Key Words:** Cattle, Crossbreeding, Farming Systems, Economics, India)

INTRODUCTION

Rural areas in Gujarat are characterized by subsistence-oriented, smallholder farms. Whereas, in the past, nomadic herders used to travel with their herds and flocks, using local crop residues and then returning manure to the crop farmers, livestock are now an integral part of mixed farms. In Gujarat, as in the whole of India, the interest in crossbreeding is increasing and the introduction of Holstein Friesian and Jersey crossbreds is emerging as a major activity in development programmes (Patil and Udo, 1997). Each farmer who requests crossbred cattle is supplied with semen from Holstein Friesian or Jersey bulls to inseminate his cows, irrespective of the specific conditions in the various farming systems. Continued population pressure will entail continued decrease in farm sizes. The introduction of crossbred cows could be a suitable development option for farm households with little or no land, provided that these households have access to sufficient feed sources.

A previous paper (Patil and Udo, 1997) evaluated milk offake and feeding practices at the animal level. Crossbreds produced, on average, 1.8 times more milk than local Desi, Gir, and Kankrej cows. They were fed 1.4 times more concentrates, and 1.2 times more green and dry feeds than local cows.

The use of crossbred cattle in Indian farming systems is currently being debated, due to some undesirable consequences, such as the extra costs for feed and veterinary treatments, the capability of crossbred bullocks for draught purposes, the expected increase in labour for women, and doubts about whether such cattle fit into all existing mixed farming systems (McDowell, 1983; Jackson, 1982; Rao et al., 1995). Thus, added to the evaluation of crossbreeding at an animal level, a systems approach is needed to evaluate the consequences of crossbreeding at the farm level.

We studied existing mixed farms with and without crossbred cattle, and quantified some of the economic components, to evaluate the impact of crossbreeding at farm level in Gujarat, India.

MATERIALS AND METHODS

The study area

The Gujarat area has already been described by Patil

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and Udo (1997). 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 belong to the socio-economically less-favoured tribal groups.

For this study we selected three zones (zone no. 1, 3 and 6) out of the eight zones of the Gujarat Plains and Hills Region (Ghosh, 1991). Table 1 gives some of the characteristics of these three zones. Mixed farming with rainfed crop production is predominant, although the use of irrigation is increasing, in particular in zone 1.

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

zone	1	3	6
Physiography	plain-hilly	plain-hilly	plain-hilly
Soils types	coastal alluvial	sandy loam	black
depth (cm)	> 100	> 100	50-100
Rainfall (mm)	1,000-1,500	700-1,000	625-750
Temp. range (℃)	15-40	15-42	15-42
Cropping System			
rainfed	+	++	++
irrigated	++	–	–
Crops	paddy, sugarcane sorghum, fruits	paddy, millet sorghum, maize	groundnut, pulses, wheat, sorghum

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

Cattle management

Livestock farmers keep mainly cattle and buffaloes. Catlle breeds are Desi, Gir, Kankrej, Holstein Friesian crosses and Jersey crosses. In crossbred animals the exotic blood level is maintained at 50%. Buffaloes belong to the Surati, Mehsani and Jafrabadi breeds or are so-called non-descript. Livestock are fed crop by-products (sorghum, millet, paddy and maize straws), green feeds (weeds, forest grass, tree leaves and cultivated forages), and concentrates (brans, damaged grains and broken pulses with kernels). Herds are routinely grazed on government and village common lands. Animals are generally housed in mud sheds in the backyards of living quarters. Cattle management is described in detail by Patil and Udo (1997).

Data collection

Agricultural activities and off-farm activities were monitored in 15 villages during the period June 1993 - May 1994. The stratification of farmers as tribals and non-tribals was based on family information. In total, 311 households were randomly selected (nine per cent of the total households, with a minimum of 20 households per village), representing both social groups proportionately in each village. Data were collected on the family structure, assets, livestock, land area, land use, and labour in June 1993. Detailed recording of all inputs and outputs of crop and livestock was done regularly every week during the cropping and harvesting season (June to October) and fortnightly in the other months until June 1994.

Procedures and assumptions in the economic evaluation:

– inputs to the livestock sub-system were crop byproducts (such as straw, husks, weeds, brans, damaged grains), labour, concentrates, treatment costs, and buying of animals

– output from the livestock sub-system were milk, draught, manure, and sale of animals

– inputs to the crop sub-system were seeds, fertilisers, pesticides, draught, manure, hired labour, and threshing costs

– outputs from the crop sub-system were food grains (maize, rice, millet, pulses) cash crops (cotton and vegetables), and straw, husks, weeds and brans for livestock

– actual farmgate prices were used for accounting in Rupees (Rs)

– household consumption was expressed in farmgate prices

– draught and manure opportunity costs were based on market rates

– gross margins of the two sub-systems were calculated on the basis of output minus cash inputs including hired labour

– farm income was calculated as the gross margins from crops and livestock

– household income was calculated as farm income plus off-farm income.

Farm income combined two main functions of agricultural activities: the supply of food for home consumption, and generation of a cash income. We used least squares methods to explain the variation in farm income in terms of differences in farm resources.

The analytical model included the effects of zone and social group, and the covariables were land area, cropping intensity, labour force, number of cattle, number of buffaloes, number of bullocks, milk offtake for the

average cow, cash input per unit crop land, and cash input per livestock unit. The above-mentioned covariables were calculated as follows:

– land area; land holding per farm in ha

– cropping intensity; average percentage cropped of the agricultural area

– labour; labour force employed for crops and livestock, including family labour as well as hired labour, in full-time equivalent of 7 h d^{-1}

– number of cattle, buffaloes or bullocks; number of these types of animals per farm

– average milk offtake; average milk offtake per animal (lactating and dry cows, including buffaloes) in kg per year

– cash input per animal was calculated as the amount spent annually per adult animal on concentrates, treatments, and hired labour

– cash inputs per ha; amount spent annually on seed, pesticides, fertilisers, hired labour, hired bullocks, manure, and irrigation.

RESULTS

Table 2 shows the means and coefficients of variation for farm resources, crop and livestock gross margins, off-farm income, and household income for households with or without crossbred cattle, subdivided in landless households and households with land. Average family size was 6.0 in households with crossbreds and 6.5 in households without crossbreds. Average farm size, labour employed per year, cropping intensity, the use of bullocks, and the number of large ruminants, were about the same in households with and without crossbreds. Herd composition differed between the these two types of households. In households with crossbreds, buffaloes made up 14% of the herd, in households without

Table 2. Selected variables, Gross Margins, and Off-farm and Household Income for mixed farm households with or without crossbred cattle, subdivided in landless households and households with land in Gujarat, India

	with crossbreds						without crossbreds					
	landless		with land		all		landless		with land		all	
	x	cv[1]	x	cv	x	cv	x	cv	x	cv	x	cv
Number of households	40		114		154		37		120		157	
Number of household members	5.1	36	6.3	36	6.0	37	5.2	36	6.9	47	6.5	48
Labour employed (d y^{-1})												
in crops	–		206	94	–		–		177	76	–	
women (%)			37						41			
hired labour (%)			33						25			
in livestock	223	58	248	60	242	58	230	60	258	50	252	52
women (%)	60		48		51		49		42		43	
hired labour (%)	0		15		11		14		17		16	
Land size (ha)	–		1.5	87	–		–		1.7	85	–	
Cropping intensity (%)	–		120	38	–		–		125	35	–	
Bullock pair used (d y^{-1})	–		21.4	99	–		–		21.2	109	–	
Number of large ruminants	2.6	57	5.8	54	5.0	62	2.5	62	5.9	61	5.1	68
cows plus calves (%)	94		65		69		39		48		48	
buffaloes plus calves (%)	4		15		14		55		26		30	
bullocks (%)	2		20		17		6		25		22	
Milk offtake per average cow (kg)	1,398	72	1,298	81	1,324	78	632	105	812	110	771	111
Cash inputs (Rs. × 1,000)												
per ha	–		4.8	78	–		–		3.9	81	–	
per livestock unit	0.9	102	0.7	104	0.7	105	0.5	137	0.5	113	0.5	119
Crop Gross Margins (Rs. × 1,000)	–		10.9	187	8.1	226	–		11.9	186	9.1	221
Livestock GM (Rs. × 1,000)	9.0	76	13.0	166	12.0	159	4.5	113	8.4	123	7.3	130
Off-farm Income (Rs. × 1,000)	9.7	150	4.3	170	5.7	174	6.1	124	4.2	186	4.5	170
Household Income (Rs. × 1,000)	18.6	89	28.3	105	25.9	106	10.6	102	24.5	111	20.9	121

[1]: coefficient of variation (%).
Rs: Rupees (1 US$ = 30 Rs).

crossbreds this was 30%. Milk offtake per average cow was about 1.7 times higher in households with crossbreds than in households without crossbreds. In households with crossbreds cash inputs per unit of land and per animal were higher than in households without crossbreds. Household income was 22 per cent higher in households with crossbreds than in households without crossbreds. This difference was almost completely due to the higher livestock gross margins in households with crossbreds: Rs 12,000 vs Rs 7,300 for households without crossbreds. Crop gross margins and off-farm income were about the same in both types of households. Only, off-farm income was higher for landless farmers with crossbreds than for landless farmers without crossbreds.

In households with crossbreds and with land, 55% of the labour employed was used for livestock-related activities, and livestock contributed 54% to farm income. In households without crossbreds and with land, 59% of the labour was used for livestock, yet, livestock only contributed 41% to farm income. Women contributed 123 d y^{-1} and 108 d y^{-1} to livestock-related activities in households with and without crossbreds, respectively. In crop-related activities more hired labour was used than in livestock related activities. Both men and women labour was hired for crop-related activities, whereas for livestock-related activities (mainly herding) only men were hired.

The number of large ruminants kept by landless households was, on average, only 40% of the number of large ruminants kept by households with land. In landless households without crossbred cattle, buffaloes are the most important large ruminant. Landless households that have changed over to crossbreds have replaced almost all their buffaloes by crossbreds. The off-farm income for landless households was considerably higher than for households with land, in particular for the group with crossbred cattle. The landless farmers with crossbreds had relatively high livestock gross margins per animal: Rs 3,500 per animal vs Rs 2,200 per animal for households with land and crossbreds. For landless households with local cattle the average livestock gross margins per animal was Rs 1,800 and for households with land this figure was Rs 1,400.

Figure 1 shows that the three agro-climatic zones differ in land area and herd size. However, the differences in farm and herd sizes between farms with and without crossbreds are small. In all three agro-climatic zones, in farms with crossbreds the number of cattle is increased at the expense of the number of buffaloes.

Figure 2 gives the crop gross margins, livestock gross margins, and off-farm income for the three zones and farms with and without crossbreds. In all three zones the livestock gross margins in farm households with crossbreds were higher than in households without crossbreds. In zone 1 and 6 households with crossbreds showed lower crop gross margins than households without crossbreds. In zone 3 it is the other way around. Zone 3 has hardly any possibilities for off-farm income.

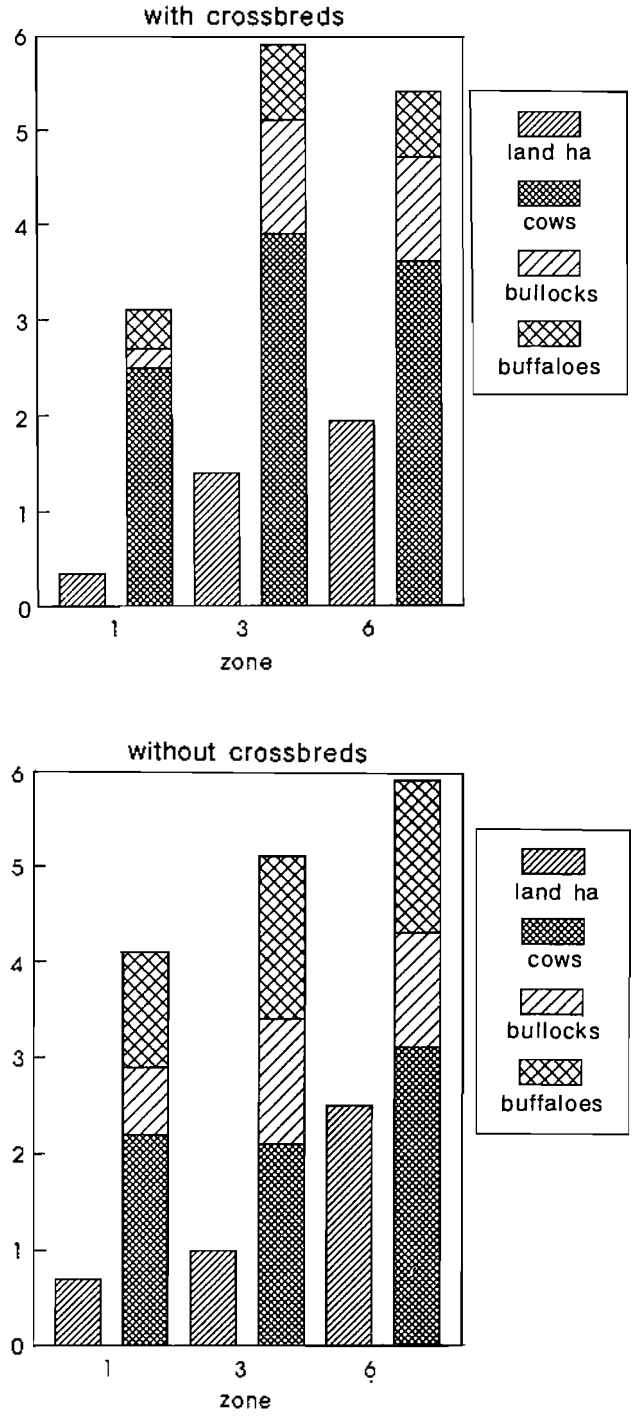

Figure 1. Land area and herd sizes for farms with or without crossbreds in three agro-ecological zones in Gujarat, India.

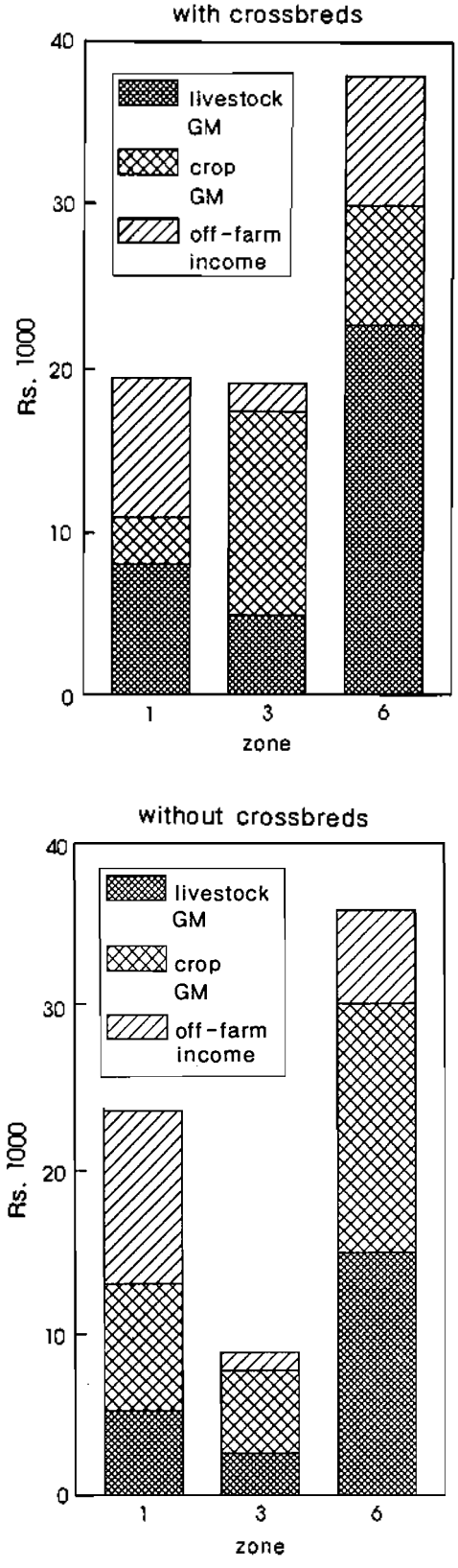

Figure 2. Livestock Gross Margins, Crop Gross Margins and Off-farm income for farms with or without crossbreds in three agro-ecological zones in Gujarat, India.

In zone 1 extensive use of irrigation is made. In zone 6, farms are larger than in the other two zones and farms without crossbreds have, on average, more land than farms with crossbreds.

Table 3 shows the amounts of crop by-products produced, and the amounts of concentrates, green feeds and crop by-products fed per farm per year. Grazing intake is not included in this table. As could be expected, on farms with crossbred cattle more feed was offered to the animals. On farms without crossbreds not all crop by-products produced were used to feed the cattle. The green feeds (roadsides, communal lands, weeds) are cut-and-carried to the animals. Landless farmers have to buy some of the crop by-products or are allowed to take some crop by-products home when some of their household members are working as labourers in harvesting crops.

Table 3. Amounts of crop by-products produced, and concentrates, green feeds and crop by-products fed per farm per year (excluding grazing) for mixed farm households with or without crossbred cattle, subdivided in landless households and households with land in Gujarat, India

	with crossbreds		without crossbreds	
	landless	with land	landless	with land
produced (kg y^{-1}) :				
crop by-products	–	3,193	–	3,124
Fed (kg y^{-1}) :				
concentrates	558	639	133	439
greens	5,140	4,113	2,123	4,042
crop by-products	1,853	2,621	1,086	2,113
Number of large ruminants	2.6	5.8	2.5	5.9

The very large coefficients of variation in most on the variables presented in table 2 indicate that the two groups are not very homogeneous for the variables selected. In table 4 the variations in farm income are analysed by least squares methods. In households with crossbreds the analytical model contributed 66% to the total variation in farm income. Tribal households with crossbreds had a significant ($p < .05$) higher farm income than non-tribals with crossbreds. The magnitude of the regression coefficients indicates the extent to which specific farm resources increase or decrease farm income. Land area, labour force, number of buffaloes, and average milk

Table 4. Least squares means and regression coefficients for various farm resources with annual farm income (in Rs) as dependent variable for mixed farm households with or without crossbred cattle in Gujarat, India

		with crossbreds		without crossbreds	
		l. s. mean	s. e.[1]	l. s. mean	s. e.
Overall average		20,926	1,381	17,711	1,339
zones					
– 1		19,480	2,967	27,063[a]	3,539
– 3		19,650	2,635	13,346[b]	2,172
– 6		23,647	3,391	12,724[b]	2,979
Social group					
– tribals		25,076[a]	2,543	13,656[a]	2,215
– non-tribals		16,776[b]	1,981	21,765[b]	1,905
		regression		regression	
land area	(ha)	7,404***	1,340	11,169***	1,191
cropping intensity	(%)	−65	39	−91**	31
labour force	(d y^{-1})	27***	7	5	8
number of cattle		2,918**	942	330	790
number of buffaloes		6,612***	1,048	1,352*	683
number of bullocks		−461**	143	2	106
milk off-take per cow	(kg)	9***	1	5*	2
cash input per LU	(Rs)	−3	2	−5	3
cash input per ha	(Rs)	1	1	1	1
R^2 full model[2]	(%)	66		65	

[1]: standard error.
[2]: coefficient of determination.
l. s. means with different subscripts are significantly different, $p < 0.05$.
* : $p<0.05$, ** : $p<0.01$, *** : $p<0.001$.

offtake per cow had very significant ($p < 0.001$) positive effects on farm income. The number of cattle also related significantly ($p < 0.01$) positively to farm income. The number of bullocks had a significant ($p < 0.01$) negative effect on farm income.

In households without crossbreds, the analytical model explanined 65% of the variation in farm income. The adjusted means for the three zones indicate that zone 1 (with extensive use of irrigation) had a significant ($p < 0.05$) higher farm income. Non-tribals had a significantly ($p < 0.05$) higher farm income than tribals. Land area had a very significant ($p < 0.001$) impact on farm income. Cropping intensity had a negative ($p < 0.01$) effect on farm income. The number of buffaloes and the milk offtake per cow had a significant ($p < 0.05$) positive effect on farm income. Cash inputs per unit area or per animal did not contribute significantly to farm income.

DISCUSSION

In India, milk and milk products are traditional components of the human diet. There also is a relatively well developed marketing infrastructure. Consequently, crossbreeding with dairy type animals is a livestock intervention that could prove relatively more successful than in countries where milk is not a traditional commodity. This study shows that the higher milk offtakes and lower feed costs per kg of milk of individual crossbred animals (Patil and Udo, 1997) can be extrapolated to the farm level. Farms with crossbreds had a 64% higher livestock gross margins and 22% higher household income than farms without crossbreds. In studies where there are differences in technical or economic parameters between adopters and non-adopters it can always be queried what is cause and what is effect. Labour use, land size, land use, use of bullocks, number of large ruminants, and the crop gross margins and off-farm incomes were not much different between the two types of households. So, it can safely be concluded that the higher household income of farms with crossbreds is due to the use of crossbred cows.

Indian rural women consider livestock as their traditional responsibility (Rangnekar, Vasiani and Rangnekar, 1993). Livestock interventions that require more work of the women, are likely not to be accepted (Dieckmann, 1994). It was thought that crossbreeding would be an intervention that increases the work load for women, however, our results do not show any great differences in work load and labour division between households with and without crossbreds. On farms without crossbreds and with land livestock is relatively more labour-intensive than crop production; livestock contributes 41% to farm income but takes 59% of the farm labour.

The three agro-ecological zones included in this study considerably differed in farm size and household income. However, in all three zones households with crossbreds had higher livestock gross margins than households without crossbreds. For two of the three zones it can be speculated that farms with less resources (land size, possibilities for irrigation) for crop production change over to crossbred cattle. In the other zone, with almost no possibilities for off-farm income, it is exactly the opposite. Here, the farmers with relatively more land and higher crop gross margins keep crossbreds.

Initially, farmers had some reservations about the use of crossbreds. They objected to the "ugly" appearance of crossbreds. They greatly value the majestic look of their local breeds Gir and Kankrej. A second reservation against crossbreds was that they were afraid that crossbred bullocks would be less suitable for draught purposes, because their hump is smaller than that of local bullocks. At present, farmers use crossbred bullocks for working, but they have to shift the working hours to the early and later parts of the day to reduce their heat load. Our results indicate that the introduction of crossbred animals has not really reduced the use of bullocks on farms with land, as feared by Jackson (1982) and Rao et al (1995). Bullocks comprise about 20-25 per cent of the herds on these farms, but their use (21 d y^{-1}) is limited to the short cropping season. During the other parts of the year they do not have enough work but have to be fed. This might explain that the number of bullocks had a negative effect on farm income in households with crossbreds.

It is notable that, in particular the number of buffaloes is reduced on farms with crossbred cattle, despite the fact that the number of buffaloes per farm had a positive impact on farm income in both types of households. The milk price for buffalo milk is higher than for cow milk. Some of the households with buffaloes sell ghee. Still, most farmers perfer crossbred cows, because of their higher milk yields.

Land is the major resource of mixed farms. An increase of one ha in land area was estimated to boost farm income by 35% and 63% in households with and without crossbreds, respectively. The number of cattle had a positive effect on farm income in farms with crossbreds. Milk offtake for the average cow had a positive impact on farm income in both types of households. Milk offtake is an indicator of the management of the herd. It combines the milk offtake from lactating cows with the percentage of cows in milk. Landless farmers with crossbreds showed the highest milk offtake for the average cow. Table 3 shows that these households also feed their animals relatively better. So, the introduction of crossbred cows is particularly useful, in terms of livestock gross margins, for landless households (table 2).

One of the findings of the animal level evaluation of crossbreeding (Patil and Udo, 1997) was that 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. The adjusted means for tribal and non-tribal farm gross margins indicate that in farms without crossbreds the estimated farm income also was far below the value for non-tribal farmers. However, tribal farmers who changed over to crossbred cattle are doing better than non-tribal farmers. So, crossbreeding can be an important development option for tribal areas.

Hence, ti can be concluded that crossbreeding can be an important development option for different types of farm systems. The use of crossbreds could imply a reduction in herd size, which might also help in preventing degradation of forest and common grazing lands. Indeed, preliminary data of some 270 herds in Gujarat indicate that in the last five years the average number of cattle and buffaloes has decreased by 13%, whereas the percentage of crossbred cattle in these herds has increased from about 6% to 21%.

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REFERENCES

Dieckmann, N. 1994. The integration of social and gender issues in smallholder dairy production. World Animal Review 79:23-33.

Ghosh, S. P. 1991. Agroclimatic Zone specific research. ICAR, Krishi Anusandhan Bhavan, Pusa, New Delhi.

Jackson, M. G. 1982. Cattle breeding in the context of maximum livestock production from minimum land. In: Proceedings Third Seminar Maximum Livestock Production from Minimum Land (eds. T. R. Preston, C. H. Davis, F. Dolberg, Mozammel Haque and M. Saadullah. Bangladesh Agricultural Research Institute, Joydebpur, pp. 183-194.

McDowell, R. E. 1983. Strategy for improving beef and dairy cattle in the tropics. Cornell International Agricultural Mimeograph 100. Cornell University, New York.

Patil, B. R., and H. M. J. Udo. 1997. The impact of crossbred cows in mixed farming systems in Gujarat, India; milk production and feeding practices. AJAS (accepted).

Rangnekar, S., P. Vasiani and D. V. Rangnekar. 1993. Women in dairy production, an initial report of study. In: Feeding of Ruminants on Fibrous Crop Residues (Eds. Kiran Singh and J. B. Schiere). Proceedings of an international workshop held at the National Dairy Research Institute, Karnal, India, ICAR, New Delhi, pp. 429-440.

Rao, S. V. N., V. Venkatasubramanian and J. de Wit. 1995. Consequences of crossbreeding programme in India. Economic and Political Weekly, September: A112-116.