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Practicalities of sustaining a goat-crossbreeding programme in eastern Ethiopia

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Abstract

Crossbreeding of goats in traditional subsistence flocks had been promoted in selected villages of eastern Ethiopian highlands as a means to quick genetic progress based on the thesis that crossbreeding can increase the net contribution of goats. Observations on flock dynamics patterns of smallholder flocks with crossbred goats showed that the desirable attributes of crossbreeding had not been maintained after the promotion phase because: 1) the pool of crossbred goats was too small to maintain 50% exotic blood level in the crossbreds; 2) shortages of crossbred breeding males also led to gradual backcrossing of the does, resulting in an increasingly mosaic mix of crossbreds; 3) the small size of flocks as well as their rapid turnover limited the scope for any selective breeding and the maintenance of superior breeding animals; and 4) loose control on the breeding of various classes of crosses with indigenous goats posed undesirable dissemination of introduced genes into the indigenous genetic pool. Therefore it was concluded that crossbreeding of indigenous goats with exotic breeds, as a technology for genetic improvement of smallholder goat flocks of Ethiopian highlands, is not sustainable under subsistence mode of production.

Keywords: **C**rossbreeding, indigenous goats, goat production, subsistence, sustainability,

Introduction

There is a widely held belief in Ethiopia that, in the mild tropical climate of the highlands, modification of the traditional husbandry practices alone cannot bring about satisfactory increases in livestock production to meet the fast growing demand for milk and meat (McDowell, 1988; Teffera and Abay, 1995; Alemu et al., 1998; Getachew, 1998). Genetic improvement of indigenous

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livestock breeds by way of selection is also considered too slow to achieve desired levels of production. Consequently, crossbreeding of some native breeds under smallholder farmer management with selected exotic breeds has generally been practised as a shortcut to genetic improvement to increase their net contribution to family welfare, as in the case of the Chilalo Agricultural Development Project (CADU), the Dairy Rehabilitation and Development Project (DRDP), the Smallholder Dairy Development Project (SDDP) (Hizkias, 1998) and the on-going National Livestock Development Project (NLDP). This was also the concept of the Dairy Goat Development Programme (DGDP), which implemented improved management along with crossbreeding (indigenous x imported Anglo-Nubians) in selected sites of Ethiopian highlands between 1989 and 1997 (FARM-Africa, 1997). This paper will examine if this genetic improvement has been achieved.

Background and Organization of the Goat Breeding Programme

The DGDP was designed to increase the contribution of goats to subsistence household welfare through crossbreeding of indigenous goats (in this case Long-eared Somali and Hararghe Highland) to increase milk and meat production. The main reasons for adopting crossbreeding for improving particularly milk production from goats were (FARM-Africa, 1990): (1) there was (and still is) little quantitative information on milk production characteristics of Ethiopian indigenous breeds of goats and so there was no way of knowing if any of the indigenous breeds would reward selection, and (2) it is likely that the variability of milk production within indigenous breeds when combined with the likely heritabilities of milk traits is not sufficient to achieve the level of desired improvement within a reasonable time. The heavy thrust on milk was later relaxed and meat was also given as much emphasis after recognizing that the subsistence farmers realize considerable benefits from sale of goats as well.

The initial plan of the DGDP included testing a number of exotic breeds for their suitability for one-way (simple) crossbreeding. However, delays in implementation with the first exotic breed (the Anglo-Nubian) as well as the long time it took to resolve policy issues related with crossbreeding did not encourage importing other exotic breeds. Therefore, the DGDP worked with only the Anglo-Nubian breed throughout the three phases of operation. This breed was selected for crossbreeding on the ground that it has proved to be well suited to tropical climates and has been used widely for the same purpose in other tropical countries like India, West Indies, Mauritius, Malaysia and the Philippines (Devendra and Burns, 1983) as well as Thailand (Saithanoo *et al*., 1993) and Kenya (Ruvuna *et al*., 1995). It also has a tropical ancestry (Peacock, 1996).

The DGDP was set to test (on-station and on-farm) F1, F2 and 75% Anglo-Nubian crosses, and effectively develop a gene pool of crossbreds around 50% Anglo-Nubian blood level. However, the small capacity to produce the first generation crosses and ambiguities on the appropriate level of exotic blood to maintain in the crossbreds limited the scope for any performance comparison between the crossbreds. Consequently, all the available F1 crosses were distributed to selected participant farmers (Workneh, 1996).

The DGDP wound down the scale of its involvement from March 1997 and finally phased out in June 1997 after having duly handed over all financial and supervisional responsibilities to local collaborating institutions.

The net benefits of the project to the smallholder were the subject of a PhD study (Workneh, 2000). In the process of the study, it was possible to observe the practicalities and organisational issues associated with the concept of exotic crossbreeding. These observations are presented below.

The Study Area and Data Collection

The study was conducted in Gursum and Kombolcha districts of Eastern Hararghe. This area represents only the eastern wing of the DGDP, which had progressed better than the southern wing; however, the DGDP implemented its programmes using the same strategy and guidelines, and hence the concepts discussed are equally applicable.

Detailed data collection in flock dynamics of crossbred goats was done between July 1998 and June 1999 from a total of 121 DGDP participant (improved management) and 37 control households (traditional management) in the two districts. Out of the DGDP participants, 90 households owned crossbred goats and the other 31 households owned only indigenous goats. Previous population trends for the different classes of crossbreds during the DGDP promotion phase (1989-1997) were established from available background information and own observation. Descriptive statistics was used to compare attributes of flock dynamics between study groups.

Observations on Sustainability of Crossbreeding in the Village Flocks

Inadequate supplies of crossbred goats

During lifetime of the DGDP, a total of 914 F1 and F2 crossbreds were distributed to participant households in the east and south of the country. About 38% of these came from two crossbreeding stations (Alemaya University of Agriculture and Awassa College of Agriculture), 46% from 15 Anglo-Nubian buck stations set up in the villages, 14% from 12 private contract producers and the remaining 2% from farmer credit repayments. All these sources of improved stock were expected to continue to operate after the DGDP, under the supervision of the regular extension services (FARM-Africa, 1997).

However, in the eastern wing of the DGDP these sources of improved stock have been declining since the DGDP phased out, and particularly during this study period (1998-9). Unlike the pace during the lifetime of the DGDP when 40 to 70 crossbreds were distributed per annum around the study sites, only 14 crossbreds were distributed to farmers during the study period. The extension services were unable to maintain the flow of crossbred goats from commercial producers and the crossbreeding station at Alemaya University to the villages.

The production of crossbred goats in the crossbreeding stations had already been observed to have required strong technical and financial support, and made the cost of crossbreds too high for the smallholder farmers; for instance the average cost of production of crossbred yearlings was observed to be two to three times higher than the market price of similar local goats (Wagayehu and Habte-Mariam, 1994), which forced the project to set a highly subsidised price tag for crossbred goats of only 125% of the current market price of local breeding goats. Even at these subsidised prices, the transaction costs (organisation, transport and financial management) of delivering the crossbreds to the villages proved to be too high to bear for both the producers as well as collaborating institutions.

Setting up Anglo-Nubian buck stations provided cheaper and quicker means of producing and delivering F1 crossbreds than the crossbreeding stations. The initial costs of procuring the Anglo-Nubian bucks (the subsidised project price of Birr1600) and setting up the buck stations could easily spread over a large number of offspring born and managed in the villages. However, there had always been a high health risk for the bucks, and buck stations required central management for rotating the bucks in order to control inbreeding. Furthermore, shortage of Anglo-Nubian replacement bucks limited their continuity. Only one Anglo-Nubian buck station continued to operate in the study area out of six established in the villages.

The seven small commercial crossbred producer farms initiated with the support of the DGDP could not sustain their operations. Each of them had acquired the initial exotic stock of three to four female and one male Anglo-Nubian goats on credit. Gradually they procured indigenous does for crossbreeding. The DGDP had initiated a system of contractual agreement whereby these private producers would supply the DGDP with F1 crossbred and pure Anglo-Nubian goats at fixed prices. By the time the DGDP phased out, arrangements were made for similar contracts with the department of agricultural extension services to use some credit fund set aside by the DGDP for this purpose. The idea was the revolving credit funds with the farmers' groups could gradually be used in the same manner to procure improved stock through the extension services. However, none of these group funds were ever mobilised for the procurement of improved stock, although some crossbreds were made available at the nearby crossbreeding station as well as at two of the commercial producers. This failure was explained by the high transaction costs of operating the group funds as well as procuring and distributing the crossbreds. In fact, two of the private producers decided to quit before the DGDP phased out, for reasons of high management costs and shortage of feed. The remaining five farms, which continued to operate after the DGDP, have gradually scaled down their operations, to the extent that none of them supplied the villagers with crossbred goats during the study period.

Other potential sources of crossbreds were the farmers themselves, in the form of ordinary sales and re-distribution of credit repayments (in kind). This source of crossbred goats was not strong even during the implementation period of the DGDP. During the study period no crossbred goat was repaid or re-distributed, although in the observed groups a total of 83 crossbreds remain unpaid, and some women farmers were prepared to repay in kind from their current stock of crossbred goats. Neither the extension services nor the private commercial farms could help deliver some improved stock. In fact, even the opportunity of utilizing group revolving funds for the procurement of crossbred breeding males from the nearby commercial producers was lost, as the women groups were unable to mobilize their savings and directly deal with the commercial producers.

The total pool of crossbred goats in the 90 DGDP-participant study households was 158 at the end of the observation period, down from 171 a year earlier. The decline was common to the whole goat population in both DGDP participant and control households (Table 1). In the face of inadequate supplies, crossbred owners tried to maintain crossbreds by reducing voluntary disposals as attested by the observation that only 4.4% of the crossbreds were slaughtered compared to 9.5% for indigenous goats. Similarly the sales rates were 41% less among crossbred than indigenous goats. The reduced sales and slaughter frequencies of crossbred goats could be explained by farmers' interest to maintain them longer. However, the level of exotic blood in the crossbreds was very unstable, with the F1 bucks constituting only 0.6% of the crossbred population at the end of the observation period. This is inadequate to sustain the production and reproduction of 50% crossbred goats in the villages. The crossbreeding station at Alemaya University remains as the only source of Anglo-Nubian and crossbred stock, but could not produce more pure Anglo-Nubians than it needs for its own replacement.

Table 1: Breed composition of the study flocks at the start and end of the study period.

Breed group	DGDP participants			Control households		
	Initial stock (July, 98)	End stock (June, 99)	% Change	Initial stock (July, 98)	End stock (June, 99)	% Change
Crossbreds	171	158	-7.6	-	-	-
Indigenous	215	169	-21.7	98	71	-27.5
Total	387	327	-15.5	98	71	-27.5

Maintaining 50% exotic blood level in the crossbreds

The goal of stabilizing the level of exotic blood in crossbreds around 50% with a maximum safe level of 62.5% had not been attained in the study flocks. The proportion of 50% crosses declined from 72% at the start of the study period to 61% at the end. The extent to which the desired exotic blood level was maintained in crossbreds needs to be viewed in the context of the general pattern during the DGDP implementation period (Figure 1). Some farmers opted to go up to 75% already in 1994, using the Anglo-Nubian buck stations in the villages. On the other hand, a large number of quarter-breds were produced from the F1 bucks, although this class of crossbreds had not been actively promoted. The proportion of quarter-breds reached an annual average of 17% in 1996, and declined thereafter with the shortage of F1 bucks. Quarter-breds emerged mainly out of two scenarios:

1. Some farmers attempted to upgrade their local goats by mating with F1 crossbred bucks put up in the villages. This highlights the practical problems of controlling dissemination of the exotic genes in traditional flocks, on one hand, and farmers' desire for getting hold of higher potential animals, on the other.
2. 50% crossbred does were backcrossed with local bucks in the absence of F1 breeding bucks.

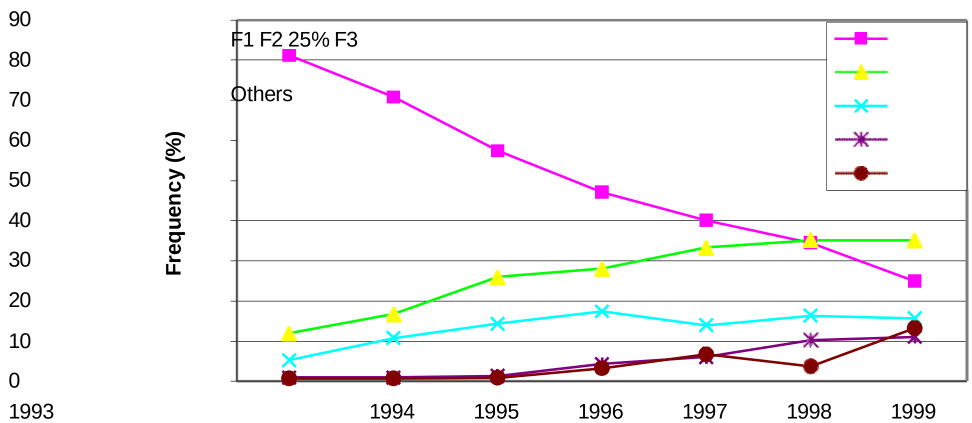

Figure 1. Changes in exotic blood level of crossbred goats between 1993 and 1999

The increase in the proportion of backcrosses and quarter-breds is related to the declining number of F1 breeding bucks. The larger F1 breeding bucks were difficult to maintain in smallholder flocks. The main reason appeared to have been the attractive high prices that castrated and fattened crossbreds fetch during religious festivities. The crossbred goats were observed in this study to reach maximum body weights of 72 kg compared to 41 kg for indigenous bucks. Finished F1 castrates were observed to sell at Birr 600, compared to Birr 250 for the indigenous fattened castrate of the same age in the same market. The smallholder households were therefore occasionally tempted to castrate the F1 bucks. The interest was so strong that young males were castrated at body weights of 8 kg for the F1 and 6 kg for the indigenous goats. As a result shortage of F1 breeding males was felt already in 1996 when the proportion of F1 bucks in the crossbred goat population decreased to 8.7%, compared to 28% in 1993. This shortage of crossbred breeding bucks also persisted during the current study period, and the proportion of F1 bucks in the crossbred population dropped from 5.1% at the beginning of the study to 0.6% at the end of the study (Table 2). The calculated sex ratio dropped from about 2 does to one buck in 1993 to 4.2 in 1997, with a dramatic drop to 75 does to one buck in 1999. Crossbred breeding females have therefore been gradually backcrossed to indigenous bucks; hence the proportion of backcross goats grew from 3.0% to 10.7% during the study period alone.

Table 2: Comparison of the proportion of F1 breeding males in crossbred goat populations during and after the DGDP around the study sites

Indicators	During the DGDP					After DGDP	
	1993	1994	1995	1996	1997	1998	1999
Number of F1 breeding males[1]	62	47	34	21	20	10	1
Total crossbred goat population	219	229	252	240	177	196	158
Proportion of F1 bucks among crosses (%)	28.3	20.5	13.5	8.7	11.3	5.1	0.6
Total breeding crossbred does[2]	125	113	105	96	84	127	75
Average sex ratio (Does to 1 buck)[3]	2.0	2.4	3.1	4.6	4.2	12.7	75.0
Proportion of backcrosses (%)[4]	0	0.4	1.6	2.5	3.9	3.0	10.7

[1]Breeding males are taken to be all non-castrated males above 1 year of age.

[2]Breeding females are taken to mean all females above 1 year of age.

[3]Ratios were calculated from flock structures for June of each year, except for 1997 (March).

[4]Backcrosses are all crossbreds born with exotic blood levels less than their dams. Source: Workneh Ayalew, Christie Peacock, Zewdu Ayele. (Unpublished observation).

The crossbreeding exercise in the villages therefore produced a mosaic of crosses with Anglo-Nubian blood levels ranging from 6.25 to 75% with no signs of stabilizing around 50% blood level (Table 3). The overall average exotic blood level in the crossbred population showed a slight decline from about 48% in 1993 to 43% in 1999. More importantly, the proportion of F1 stock declined from 80% in 1993 to about 22% at the end of this study. Owing to the dwindling supplies of crossbreds to the villages, the number of F1 and crossbreds in general is bound to decline even further.

Table 3: Frequency distribution of various crosses in study flocks at the start and end of the observation period

Breed class	Initial stock 07/98 (n=171)	Final stock 06/98 (n=158)
F1	31.0	21.5
F2	31.6	30.4
F3	9.1	9.5
75% AN cross	1.8	6.3
25% upgrade	21.1	19.0
12.5% upgrade	1.2	1.9
25% self cross	0.0	0.6
62.5% backcross	0.0	0.6
25% backcross	1.8	8.2
12.5% backcross	1.2	1.3
6.25% backcross	0.6	0.6

Rapid turnover of breeding goats and small flock sizes

The number of days goats stayed in study flocks over the study period ranged from 2 to 365 days, with an overall mean of 212 days. About 30% of those goats present at the beginning of the observation period were disposed of or lost during the observation period. In general crossbred goats stayed 42 days longer than indigenous goats, females stayed 48 days longer than males, and home-bred goats stayed 27 days longer than purchased/introduced goats. At the district level, goats in Kombolcha stayed longer than those in Gursum (Table 4). Such a high turn over of goats puts a restriction on opportunities for selective breeding and the maintenance of superior breeding animals, a necessary condition for organizing any crossbreeding programme.

Table 4: The number of days goats stayed in study flocks during the observation period of 365 days – means (standard errors)

	Categories	N	Komolcha	Gursum	Total
Breed group	Indigenous	537	227.1 (12.1)	189.3 (6.3)	198.0 (5.6)
	Crossbred	275	252.4 (10.2)	228.0 (10.8)	240.1 (7.5)
Sex	Females	506	251.6 (9.9)	219.6 (7.1)	230.4 (5.8)
	Males	306	219.1 (12.8)	166.9 (8.3)	182.3 (7.1)
Source of goat	Home-bred	543	250.8 (9.1)	207.6 (6.4)	219.8 (5.3)
	Purchased/Transferred	269	222.7 (14.4)	180.4 (10.4)	193.5 (8.5)

The small flock sizes and associated variabilities (Table 5) partly explain the rapid turnover of goats. Furthermore, examination of the overall off-take (outflow) reveals that about two-thirds of the sales, slaughter and transfer cases were prompted by short-term objectives of meeting subsistence needs,
i.e. forced outflows (Table 6).

These flock dynamics patterns suggest that the short-term objectives of the farmers override longer-term benefits (for themselves and the community), and hence farmers' decision-making behaviour does not favour the keeping and selection of high performance breeding males just for the purpose of breeding But this does not mean that indigenous goats do not respond to improvements in the level of management. As a related study on comparison of the overall aggregate benefits from the same study flocks has shown, the indigenous goats do respond to improvements in level of management, leading to higher realised net benefits to their owners per unit of land and labour used; the increments in overall benefits came from horizontal (multiplication) rather than vertical (intensification) improvements, by keeping more goats for the land and labour available through a combination of reduced goat losses, more kids born, higher off-take and a bigger stock of goats (Workneh et al., 2002).

Table 5: Variation of changes in the annualised sizes of study flocks by study group.

Descriptors	Improved management		Traditional management	Total
	Flocks with crossbred goats	Flocks with only indigenous goats	Control	
Number of flocks	90	31	37	158
Annualised average flock				
Mean	3.16	2.90	2.61	2.98
Minimum	0.36	0.07	0.22	0.07
Maximum	9.02	7.68	6.75	9.02
Standard deviation	1.96	1.59	1.61	1.83
Total inflow:				
Mean	0.81	1.35	0.97	0.96
Minimum	0	0	0	0
Maximum	5	5	10	10
Standard deviation	1.26	1.66	1.86	1.51
Total outflow:				
Mean	1.98	2.55	1.73	2.03
Minimum	0	0	0	0
Maximum	7	8	7	8
Standard deviation	1.68	2.08	1.59	1.76

Table 6. Estimated value (Birr) of average total and forced goat outflow by study group.

Descriptors	Cross/Improved	Mixed/Improved	Indigenous/Improved	Indigenous/Traditional
Number of flocks	28	62	31	37
Value of total outflow (Birr)	75.66	180.66	156.30	102.23
Value of forced outflow (Birr)	55.76	109.88	112.53	63.10
In per cent of total outflow	73.7	60.8	72.0	60.0

Discussion

Apart from the influence of farmers' behavior on the maintenance of F1 breeding males, the reason for the declining trends of crossbreeding lies in the weak supply of improved stock (F1 goats and Anglo-Nubian bucks). It was assumed that local institutions, which had been collaborating with the DGDP throughout its implementation, would take over the task of distributing improved stock to the villages. However, both the extension services and private commercial farms were unable to deliver adequate numbers of improved stock. In fact, even the opportunity of utilizing group revolving funds for the procurement of crossbred breeding males from the nearby commercial producers was lost.

Lack of effective control of the breeding process, and the difficulty of stabilizing the exotic blood level in the crossbreds are the major operational limitations of crossbreeding programmes. These difficulties have also been common experiences in many dairy cattle crossbreeding programmes. In their extensive review of crossbreeding programmes of the *Bos indicus* with *Bos taurus* in the tropics, Cunningham and Syrstad (1987) have concluded that the continuous production of F1 crosses is either operationally difficult to set up or economically difficult to justify even for the more important dairy cattle industry. Although the evidence indicates that heterosis realised from crossbreeding is higher in poor than in good environments, the breeding programmes in developing countries are generally constrained by both physical and social environments, lack of records of performance, ill defined breeding objectives, and small population sizes (Bondoc *et al.*, 1989).

To develop a new gene pool, and gradually a new breed, through crossbreeding as tested by the DGDP, the emphasis should be on producing the breeding males through nominated matings and then selecting the best for extensive use (Cunnigham and Syrstad, 1987; Taneja, 1999). This requires measurement of individual performance, evaluation of animals, choice of breeding stock and organization of their use. But judging by the experiences of managing the crossbreeding station in the study area and its working link with the pilot villages, organizing such a systematic selection of breeding males, distributing them to the villages and monitoring their performance is difficult to manage without firm institutional support. Although the preliminary forms of animal breeding in the form of culling of inferior animals and selective mating by the farmers are theoretically possible, systematic performance recording as part of a genetic improvement process has yet to be demonstrated and institutionalised. However, the limitations are logistical rather than technical. The recording exercise needs to be cost effective and sustainable.

Furthermore, although crossbreeding is often regarded as an alternative to selection, any crossbreeding exercise inherently requires a supporting selection programme, either in the parental pure breeds, or in the resulting crossbred offspring (Cunningham and Syrstad, 1987; Pagot, 1992). Ironically, these technical constraints of operating long-term breeding programmes are the very reasons for the general recourse taken to the introduction of blood from breeds already selected in developed countries. Introduction of high producing exotic breeds has been carried out since the nineteenth century by importation of male breeding stock, and more recently by semen. Experience shows that an essential condition for the success of a crossbreeding programme is the presence of an integrated selection programme in the pure indigenous breed (Pagot, 1992), which even provides for the basis of long-term improvement of the indigenous genetic resource itself.

There is no doubt that crossbreeding programmes involve capital-intensive interventions in the form of importing exotic breeds, provision of improved husbandry practices (e.g. health care) and technical supervision. Too often these genuine desires of basic development assistance are dependent on critical foreign donations and credit. However, these resources have rarely been directed to supporting the low-input traditional production systems. Therefore, the opportunity costs of introducing, promoting and supporting crossbreeding programmes should be critically re-examined. For instance, would it be more cost-effective to invest the same resources (foreign capital, trained man power and time) in the investigation of the biology, economics and sustainability of the traditional production systems? The indigenous goats maintained under the same improved management as the crossbreds were observed to have responded strongly to improvements in feeding and basic health care, so that there was no difference in the unit net benefits between the two genotypes (Workneh, et al, 2002). The larger body weight of the crossbreds can mean that fewer but larger crossbred goats could generate the same aggregate benefits per unit of inputs, but this possibility is constrained by practicalities of maintaining an effective crossbreeding programme.

The conclusion is that the introduction of supposedly more productive exotic breeds for purposes of crossbreeding does not necessarily lead to genetic improvement of the subsistent mode of smallholder production. Neopane (2000) also reported that crossbreeding of local goats with introduced breeds was not successful in increasing productivity in the hill goats of Nepal; after 14 years of trial with crossbreeding, decision was taken to set up selection within the local breeds in an open nucleus scheme as a more viable tool for making genetic improvement in these goats. Similarly, Chiche *et al*., (2000) reported that 20 years of promotion of a commercial dairy industry in Morocco, based on imported European goat breeds, could not lead to transformation of the traditional mountain and steppe goat husbandry. The local breed proved a better option to survive and produce in the low-input management environment, and to satisfy the needs of the poor villagers as well as those of the small local markets.

The question remains, would it be possible to bring about similar improvements in productivity without the incentive of introducing the crossbreds? What would it take to initiate sustainable improvement of the traditional low-input management regimes of smallholder farmers? The improvements in livestock production (or increase per animal) will have to be made within the constraints of the available feed resources, prevailing disease challenges and marketing difficulties. The smallholder production system tends to follow such production strategies that are risk-averse and use low external inputs. Under these circumstances indigenous animals provide more realistic and sustainable options of improvement of livestock production. Because farmers are increasingly using their animals to meet their short-term subsistence needs, to the extent that the scope for long-term livestock development is limited, a direct way of helping them is to assist in meeting the immediate consumption needs through micro-financing schemes (Zeller, 1999), which provides for reduced turn over of animals, and hence the opportunity for longer term improvement. Existing indigenous institutions for informal financing and insurance services may provide the basis for these micro-financing schemes. Marketing of livestock and livestock products is another avenue for longer-term improvement. The largely subsistence mode of production needs to be gradually transformed into one that is market-oriented, which then can generate the economic incentives for investment on indigenous animals. Significant improvements in subsistence goat production could be achieved through reduction of losses (mortality, morbidity, loss) and wastages (poor reproduction, slow growth, high maintenance costs from replacement flock, morbidity and associated suboptimal production) in the production process.

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