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# Community based sheep breeding programs: Tapping into indigenous knowledge

**A Haile, T Mirkena*, G Duguma*, M Wurzinger**, B Rischkowsky, M Tibbo, M Okeyo*** and J Sölkner****

*ICARDA, PO Box 5689, Addis Ababa, Ethiopia*
*a.haile@cgiar.org*
** ILRI, PO Box 5689, Addis Ababa, Ethiopia*
*** BOKU, Gregor-Mendel-Str. 33, A-1180 Vienna, Austria*
**** ILRI, PO Box 30709, Nairobi, Kenya*

## Abstract

A study was undertaken to understand local knowledge and practices of communities in animal management as a step in designing and implementation of community-based breeding programs for four local breeds (Afar, Bonga, Horro and Menz) in four sites in Ethiopia. Workshops were held with the project communities to learn their animal management practices, among others the selection of rams and ewes, ram sharing and grazing management. Breeding management skills were studied by conducting heritability and genetic correlation exercises. The most important animal traits for the different production systems were identified from a systems study. Phenotypic, production, and reproduction traits were used either in the form of drawings or verbal explanations. Pair-wise combinations of the traits were presented to the communities to express their choices via voting. For evaluating heritability, the communities were asked which trait pair is relatively more heritable than the other. For the correlation exercise, the communities were asked to estimate the magnitude (high, low, and none) of relationship between the traits in each pair.

The results indicate that farmers and pastoralists have good skills in sheep management. Although the mating system is generally uncontrolled, the farmers have a tradition of exchanging of rams. All farmers/pastoralists exercise ewe and ram selection based on phenotypic appearance and recalled pedigree. Their knowledge on heritability of traits and genetic correlations between traits more or less concurs with scientific evidence in literature. For example, qualitative traits (like colour) were judged highly heritable followed by production traits. Knowledge of correlations is used for indirect selection when the target traits are either impossible to assess on the live animal or are sex-limited. Indigenous knowledge and existing practices in the communities, developed through years of practical experience, provide an excellent basis for designing sheep breeding programs.

***Keywords:*** *breeding management, community breeding, local knowledge, sheep*

## Introduction

Although there is a general lack of sustainable strategies for genetic improvement of livestock in smallholder systems (Kosgey et al 2005; FAO 2007; Rege et al 2011), a variety of arrangements for the development and delivery of appropriate genotypes have been implemented through pilot studies (Kosgey et al 2005; Kosgey and Okeyo 2007; Peloschek 2009; Haile et al 2010, Mirkena et al 2012). Models tried for within-breed improvement programs include sire rotation or loan schemes, community-based programs (Sölkner et al 1998; Peacock 2005; Wurzinger et al 2011), and nucleus-based programs run by the public sector or linked to multipliers at community-level (Gizaw et al 2011).

Nucleus-based programs reduce the requirement for community cooperation and intensive recording in smallholder herds/flocks, which can be advantageous in some circumstances. Community-based breeding programs are most appropriate to implement in situations where livestock keepers already run their animals together, such as in communal grazing areas (Gizaw et al 2010; Gizaw et al 2011; Haile et al 2010). These situations also have potential for other community-level collective actions, such as joint procurement of services (veterinary, feeding and marketing). Programs that adopt community-based strategies need to take into account farmers' needs, views, decisions, and active participation, from inception through to implementation, and their success is based upon proper consideration of farmers' breeding objectives, infrastructure, participation, and ownership (Sölkner et al 1998; Wurzinger et al 2011). Thus, a full understanding of local knowledge and practices of communities in animal management is of paramount importance for the design and implementation of such programs. Indigenous knowledge is closely related to survival and subsistence and provides a basis for local-level decision making in natural resource management, food security, human and animal health, education, and various other community-based activities.

The International Center for Agricultural Research in the Dry Areas (ICARDA), International Livestock Research Institute (ILRI) and University of Natural Resource and Life Sciences (BOKU) in partnership with the national agricultural research systems in Ethiopia designed and implemented community-based sheep breeding programs for four sheep breeds (Afar, Bonga, Horro and Menz) representing different production systems in Ethiopia. The present study explored the indigenous knowledge of the farmers/pastoralists related to breeding as a base for designing the breeding programs. The specific objectives included: (1) to investigate the current breeding strategies in the different agro-ecologies/production systems of the project areas; and (2) to learn the breeding management skills of the participating communities and compare with scientific knowledge.

## Materials and methods

### Study areas

The sheep breeding programs were implemented in four locations representing different agro-ecologies that are habitat to four (Afar, Bonga, Horro and Menz) indigenous sheep breeds (Table 1).

**Table 1:** Characteristics of the four sites

| Breed | Habitat | Production system | Major use |
|---|---|---|---|
| Afar | Hot to warm arid plains (565–1542 m.a.s.l.) | Pastoral/agro-pastoral | Milk, meat |
| Bonga | Wet, humid (1070–3323 m.a.s.l.) | Mixed crop–livestock | Meat |
| Horro | Wet, humid (1600–2800 m.a.s.l.) | Mixed crop–livestock | Meat |
| Menz | Tepid, cool highland (1466–3563 m.a.s.l.) | Sheep–barley | Meat, wool |

At each site two communities were selected based on two aspects: (1) external aspects which included market access, guard against possible impacts by other projects, synergies with other projects and local developments occurring in relation to policies, credits, following government priorities and NGOs support; and (2) community aspects, such as sheep is priority, the community have sheep greater than or equal to 400 ewes, communal/common grazing, existing communal champion and willingness/interest to participate in the project.

### Methodological framework

Two-day workshops involving two communities were held at each site [Horro (Laku Igu and Kitlo), Bonga (Boqa and Shuta), and Afar (Bonta and Halaydegi)] on breeding strategies except for Menz where separate workshops were held for Mehal Meda and Molale sub-sites. Community members were introduced to the workshop´s agenda: current animal management practices (grazing, breeding, health, and housing managements) and envisaged animal management practices. Regarding breeding management, selection of breeding rams and ewes, use of breeding rams, culling, and recording and record keeping were amongst which focuses were given.

A checklist focusing on current grazing and breeding management, desired breeding strategies (ram selection, sharing, rotation, culling) and grazing management, genetic correlation and heritability of traits was prepared and used as a guide for discussion. Issues raised on breeding management were current and desired ram and ewe selection, ram use, culling, and mode of disposal. For genetic correlation and heritability experiments, traits that were valued important for the different production systems were identified from previous works (production system study, choice cards, own and group live animal ranking). Overall, 9 – 10 phenotypic, production, and reproduction traits were used in the form of drawings and/or verbal explanations. All possible pair-wise combinations were made and the communities were asked to express their impressions via voting. For heritability, the communities were asked which of the pairs is relatively more heritable than the other whereas for correlation exercise, they were asked for the magnitude (high, low, and none) of relationship between the pair of traits.

### Statistical analysis

Data were described using the Statistical Analysis System (SAS 2003). Spearman's coefficient of rank correlation was used as a measure of correspondence between ranks assigned to the heritability of the traits by farmers (SAS 2003).

## Results and discussion

### Indigenous breeding practices and selection

The majority of the farmers and pastoralists recognize the importance of selection and practice it with their own selection criteria. Although there are communalities in the traits that the sheep owners select at the different sites, the order of importance varies. It was found that traits like body size, appearance and/or conformation, coat color, libido and tail formation were all considered important at all sites and given due emphasis in selecting breeding rams. Body size, coat color and tail formation (size and shape) were equally important for ewes as for rams. Additionally, milk yield (for Afar), lambing interval, mothering ability, age at first lambing and twinning rate (particularly for Bonga and Horro) were also considered in selecting breeding females. Adaptive traits such as tolerance to diseases and feed shortage were given low emphasis in selecting replacement stocks in both areas.

Mating was generally uncontrolled in Horro and Menz. Bonga farmers practice controlled breeding from cropping up to harvesting time as flocks are kept separately tethered on private lands and either ewes in heat are taken to the ram for mating or rams are brought to the flocks of households with no breeding ram. Afar pastoralists cull unwanted male animals early by castrating or selling. They restrict sheep breeding to specific seasons by tying the tip of sheath to the base of the scrotum. Besides, lactating ewes are not allowed to breed until they wean their lamb(s) at about three months of age. Also, lambs are not allowed to suckle beyond three months. Generally breeding rams are selected from the flock and those households who do not have rams with desired characteristics use rams from others.

There are three ways to access rams among Afar community: the most common form is at grazing areas where flocks of related households (that usually settle in close proximity) graze together, rams could be borrowed and brought to the flock even from distant areas or ewes in heat may be taken to rams. Breeding ram usually serves for three seasons (years) before being replaced. The paradox in communities who do not exercise control over breeding is that almost all are aware of the potential problems associated with uncontrolled breeding and indicated their desire to eliminate mediocre rams and use large sized rams for breeding.

Regarding use of breeding rams, in Menz, it was mentioned that households with rams allow only their relatives, neighbors, and intimate friends to use them for breeding while others experience problems of accessing selected or superior rams. However, in the other communities (Afar, Bonga and Horro) ram sharing is common. It is usually the close neighbors having several social ties that borrow breeding rams from each other. The social network plays major role in sharing of breeding rams and this needs to be given special emphasis in organizing of ram use groups as community-based breeding programs usually involve communal ram use through different arrangements including ram groups. In Afar, ram is considered as property of a given clan. They indicated that denying others to use

breeding rams is culturally prohibited. Such norms facilitate use of only selected breeding rams in common. However, communal use of rams is challenged by migration pattern in which individual households sometimes migrate separately in search of feed. When there is communal grazing areas, ram sharing is not an issue because rams normally mount ewes in heat during grazing.

Communal ownership of male breeding animals has also been reported elsewhere. In Rajasthan, the village bull is traditionally selected and maintained by the community as a whole (Köhler-Rollefson 1997). Villagers pool their resources to purchase a bull from a reputed breeder, share the upkeep by providing a fixed amount of grain and green fodder per household, employ a keeper, and make a joint decision on when and how to dispose of the animal (usually after three to four years) to avoid inbreeding. Among Raika camel breeders, there is an obligation for the proprietor of a good quality male camel to share its services with owners of other female camels. It is virtually impossible to turn down requests from other members of the community, even if it means that the male will be overburdened.

Generally, there is shortage of breeding rams in Horro and Bonga areas. There are various reasons for this. Several households prefer to sell male lambs early for immediate cash income, fear of theft and predation. It is understood that mature rams are unmanageable and wander for mating. Such rams are usually stolen or eaten by wild predators. This essentially means that fast growing lambs will be sold early and this results in negative selection. Mediocre lambs therefore remain in the flock for mating. Mechanisms for retaining fast growing rams should be designed to avoid negative selection. Due to Lack of breeding rams ewes remain open and there are few lambs born compared to the actual potential. In areas where resources (particularly feed) are not constraints, availing breeding rams could result in more births and this could make significant contribution to improvement in livelihood of communities. Rams start service usually around the age of one year. In Afar they are usually kept until comparatively old age. However, in other areas they use the rams for two years after which the rams are castrated and fattened for sale and this practice also helps to control inbreeding.

**Animal identification and recording**

Livestock identification and recording are crucial for genetic improvement. In the absence of these, it is difficult to trace pedigree and design appropriate breeding strategies. Sheep are traditionally recognized as being the progeny of a given family through maternal line. In most of the cases, the color of the dam is used for identification and recalling the pedigree. There is no recorded information; rather it is based on memory in all sites.

In Afar, female animals are assigned a specific name depending on physical appearance and behavior except for does where name is given based on color type alone. Pedigree is counted through the maternal line and they claimed to be able to tell the genealogy of a specific animal up to seven generations. Sire line is not considered in pedigree counting but the sire of a given lamb is mostly known by the owner because of the regular herding. In case mating is during the night, the Afar community traces back the sire based on color and overall phenotypic appearance of the newly born lamb.

Traditional animal identification among the Afar community is clan and household based. A specific symbol is given to each clan and every individual belonging to a given clan must apply the symbol to all animals to safeguard against theft and loss due to wandering away of the herd during grazing. The symbol is applied to sheep in two forms: branding and ear notching. Because of this, the community rejected applying ear tags to their animals for our community-based breeding programs. Initially they suggested applying numbers in the form of branding or ear notching without affecting their own clan symbols. They agreed to keep written records either on their own or through the help of development workers. We felt branding is difficult to manage and ear notching is impossible to apply due to ear shape and therefore we initiated repeated consultations with the clan leaders and the community and finally consensus was reached to use ear tags.

The type of data and frequency of collection need to be decided upon in close consultations with the community and it has to be based on the agreed breeding objectives and selection traits. The simpler it is kept, the better it is and the higher is the probability of its sustainability. First, focus should be on the few (3-4) key traits only, with additional traits added when necessary and as experience accumulates.

**Grazing management**

The major feed resources in the study area include natural pasture (range in Afar), crop aftermath, fallow land, crop residues, hay and cultivated forages. Feed availability (in quality and quantity) is the major challenge in all systems except Bonga, the magnitude of the challenge is variable, though. The shortage is particularly severe during the dry season. Farmers employ different mechanisms to support their sheep during feed shortage, including providing supplementary feed (crop residues, local beer by-product, hay and cultivated forages), a small proportion reported they provide purchased feed and some farmers in Menz even indicated they reduce their flock size. For pastoralists in Afar area, flock mobility was the main coping mechanism during feed shortage. This could have consequences on gene flow. This also challenges communal use of selected rams. This is so because flocks in the same neighborhood may not necessarily migrate together. To alleviate the existing feed shortage there is need to look in to efficient utilization of the existing resources which could include hay making and conservation of crop residues. Introduction of improved forages in to the existing system is also an option. These exercises would create a more sedentary livelihood which may make community-based breeding a feasible option.

There are two types of grazing lands in Horro and Menz: private and communal. It was mentioned that both private and communal grazing lands are limited in size. The number of households using a given plot of communal grazing area differs from village to village. The access right to a given grazing area is determined both by government bodies and respective community members. Breeding management differs between the two grazing lands.

*Private*

Every household has his own grazing land though the size may vary from household to household. It is relatively better managed and some development activities may be carried on it as compared to the communal one. Because it gets rest during the rainy season, it is from this plot of land that farmers harvest grasses and prepare hay for later use in the dry season. It is also protected from erosion by preparing dike and terrace. Moreover, it is protected from overgrazing as compared to the communal one. It is used for grazing early in

the morning and in the afternoon. The size of private grazing area ranges from 18 x 50 m to 30 x 50 m per household. It is commonly used for milking cows and oxen (example in Horro). Sheep and horses do not have access to such type of land indicating that sheep have been ignored even though they are considered to be the most important species for immediate income generation in the area. Some participants confessed that the less attention given to sheep was due to lack of awareness.

*Communal*

The number of households accessing a given communal grazing area varies from village to village ranging from 5 to 20 households. It is where every species of livestock are kept during the day. The communal grazing areas generally serve as holding area. It is solely utilized during rainy season (from June to August). No kind of protection and development are carried out on it. It was emphasized that animal fight, diseases transmission, uncontrolled mating (breeding), overgrazing due to competition, and lack of responsibilities are some of the major problems in wise utilization of the communal grazing lands. Currently, the sizes of most communal grazing areas are shrinking due to several reasons including lack of legal protection, encroachment by households who have crop land adjacent to the grazing land and afforestation of the degraded communal grazing lands by government.

Communal grazing areas are very common in Horro and Menz and thus mating usually takes place in these areas. Therefore, to be successful in community-based breeding programs, unselected, mediocre rams should be castrated through agreement of the community sharing the grazing areas. In Bonga, sheep are commonly tethered on private fallow lands and ridges of cropland from cropping up to harvesting seasons (July to February). There is no communal grazing land in this area and hence households have access only to their own plots of land. Sheep are left free to roam from February to June after harvesting season; however, they are looked after by the family members to avoid predator attack and theft. During this season, they forage mainly on crop fields. Sheep of neighboring households mix and graze together immediately after harvesting until cropping. The implication of this is that there is a combination of controlled mating in cropping season and free mating after crop harvest as rams usually run with ewes during communal grazing. In such settings, when community-based breeding structures are established, ewes in heat could either come to the community selected rams or the ram could visit the ewes in their barn based on agreed modalities. This ensures accurate capture of the sire line.

In Afar, there is no any form of private grazing land in communities participating in this project though their livelihood is entirely based on livestock production. The prevailing production system is pastoral/agro-pastoral that is mainly dependent on communal grazing lands. There is no fixed place owned by a given community members. Temporary settlement is clan based but access to grazing land is open to any clan within Afar as there is no conflict among them on resource use especially grazing lands. The migration route of the communities in search of feed is to relatively upland areas like Halaydegi during the wet season and to the Awash basin (bottomland) during the dry seasons. These movements make it community-based breeding difficult as follow-up and recording is challenging. Therefore, design of breeding schemes should consider this. Mechanisms to record when they come back to their home base could be considered.

**Table 2:** Summary of sheep management practices in the project sites

| Parameter | Afar | Bonga | Horro | Menz |
|---|---|---|---|---|
| Ram sharing | Common | Common | Common | Depends on social ties |
| Grazing practice | Communal | Controlled during cropping season | Communal | Communal |
| Private grazing | Not available | Very common | Available | Available |
| Mating practice | Seasonally controlled | Seasonally controlled | Uncontrolled | Uncontrolled |
| Ram availability | Available | There is shortage | Critical shortage | Available |
| Animal identification | Traditional, challenging | Initially challenging | Not a problem | Not a problem |
| Recording | Challenging | Possible | Possible | Possible |

**Knowledge of heritability of a trait**

Obviously heritability is an important factor for determining how much genetic improvement can be made in any trait. Indigenous knowledge about the heritability of a trait would help the communities to understand which selection strategies lead to higher breeding progress. The results of farmers/pastoralists' knowledge about heritability of traits are not consistent among the sites. However, common understandings were established for some of the traits regardless of the sites. For example, qualitative traits (like colour) were judged highly heritable followed by production traits at three sites. However, in Menz, colour was ranked $6^{th}$ in Mehal Meda and $4^{th}$ in Molale, which might be associated with the diverse colour observed for this breed, as during uncontrolled mating any of the mixture could be produced unlike in Horro and Bonga where the breeds have typical colour patterns.

The correlation coefficients between the ranks made about heritability of traits for the different sites ranged from -0.50 (between Bonga and Mehal Meda, Menz) to 0.75 (between Horro and literature) (Table 3). Unlike Bonga and Horro where crop/livestock systems dominate, for Afar and Menz, livestock (sheep in Menz) are the basis of their living and hence they have more association with their livestock and consequently it is assumed rich indigenous knowledge exists. However, the rank correlations between perceptions of Afar and Menz community about heritability of traits with literature are low and negative. Correlations of Afar and Menz with Bonga and Horro were also low and in some cases negative. This is unexpected but could point to the need for detailed consultation with the community, as it seems that in Afar and Menz, economically important traits were judged more heritable. One possible explanation could be that intensive external development interventions in Afar and Menz could have weakened the indigenous knowledge base and caused some confusion compared to the Bonga and Horro where there has been comparatively less 'interference'. There is also need to find out if other factors such as level of literacy, gender and others have influenced the indigenous knowledge. For example, the indigenous ecological knowledge of men and women pastoralists in Boran, Ethiopia, was found comparable (Gemedo et al 2006). Although men were more knowledgeable of the forage value of woody plants, women were more knowledgeable of herbaceous species, demonstrating the complementarities of the indigenous ecological knowledge of both gender groups.

The importance of indigenous knowledge in animal breeding has been documented. In recent report (Gizaw et al 2011) where congruence between selection on breeding values and farmers' selection criteria in sheep breeding under conventional nucleus breeding schemes was studied, it was indicated that conventional selection criteria based solely on EBV for production traits do not address farmers' trait

preferences fully, but only partially. These results, therefore, indicate the need to consider indigenous knowledge of farmers/ pastoralists when designing and implementing improvement strategies in the community.

**Table 3:** Ranks for heritability of traits as perceived by different communities and literature report

| | Afar | Bonga | Horro | Menz-Mehal Meda | Menz-Molale | Literature |
|---|---|---|---|---|---|---|
| Body Size | 2 | 7 | 3 | 1 | 3 | 2 |
| Tail Type | 9 | 5 | 6 | 2 | 6 | 4 |
| Mothering Ability | 5 | 4 | 3 | 2 | 2 | 6 |
| Twinning Rate | 8 | 7 | 2 | 7 | 9 | 7 |
| Lambing Interval | 6 | 3 | 7 | 3 | 8 | 8 |
| Lamb Survival | 1 | 5 | 7 | 4 | 6 | 10 |
| Conformation | 6 | 2 | 3 | 5 | 4 | 2 |
| Color | 3 | 1 | 1 | 6 | 4 | 1 |
| Disease Resistance | 3 | 9 | 7 | 1 | 1 | 9 |
| Milk yield | 9 | | | | | 5 |

**Table 4:** Spearman's Rank Correlations for perceived heritability ranks between different sites

| Site | Bonga | Horro | Menz-Mehal Meda | Menz-Molale | Literature |
|---|---|---|---|---|---|
| Afar | -0.13 | -0.17 | 0.28 | 0.48 | -0.22 |
| Bonga | | 0.31 | -0.50 | -0.15 | 0.42 |
| Horro | | | -0.52 | -0.03 | 0.75** |
| Menz-Mehal Meda | | | | 0.65 | -0.23 |
| Menz-Molale | | | | | 0.18 |

**p<0.01

**Indigenous knowledge about correlation between traits**

Tables 5 through 7 indicate results of correlation exercise between traits identified by the communities in systems study. Although the results are not fully consistent among the sites, some general trends could be derived. Body size had high correlation with tail type for all communities. Similarly, body size had high correlation with conformation in all communities except for Molale in Menz. The communities feel that color has low or mostly no correlation with the other traits except for milk yield in Afar in which case the pastoralists indicated red coat colored ewes as good milkers compared to others. Such beliefs need to be scientifically substantiated, but during our consultation no evidences were produced by the community. Additionally, for Afar pastoralists, disease resistance doesn't have correlation with most of the traits except for milk yield and lamb survival. Milk yield was thought to be highly correlated with all traits.

The interesting nature of the results in the correlation exercise relate to the farmers/pastoralists deep knowledge of the association between traits to the extent of describing them as 'low' and 'none'. The results also more or less concur with scientific literature reports (Safari and Fogarty 2003). Knowledge of correlations is used for indirect selection when the target traits are either impossible to assess on the live animal or are sex-limited. Indigenous knowledge and existing practices in the communities, developed through years of practical experience, provide an excellent basis for the selection of combination of traits.

**Table 5:** Views of communities on genetic correlations among different production and reproduction traits for Molale (above diagonal) and Mehal meda (below diagonal) in Menz

| | Body Size | Tail Type | Mothering Ability | Twining Rate | Lambing Interval | Lamb Survival | Conformation | Color | Disease Resistance |
|---|---|---|---|---|---|---|---|---|---|
| Body Size | | High | Low | Low | Low | Low | Low | Low | High |
| Tail Type | High | | High | Low | Low | Low | High | Low | High |
| Mothering Ability | Low | High | | High | High | High | High | Low | High |
| Twining Rate | Low | Low | High | | High | High | Low | Low | High |
| Lambing Interval | Low | Low | High | High | | High | Low | Low | Low |
| Lamb Survival | Low | Low | High | Low | High | | High | Low | High |
| Conformation | High | High | High | High | High | High | | High | Low |
| Color | Low | Low | Low | Low | Low | High | High | | Low |
| Disease Resistance | Low | High | High | Low | Low | Low | Low | Low | |

**Table 6:** Views of communities on genetic correlations among different production and reproduction traits in Horro (above diagonal) and Bonga (below diagonal)

| | Body Size | Tail Type | Mothering Ability | Twining Rate | Lambingm Interval | Lamb Survival | Conformation | Color | Disease Resistance |
|---|---|---|---|---|---|---|---|---|---|
| Body Size | | High | High | High | Low | Low | High | Low | High |
| Tail Type | High | | Low | High | Low | Low | High | Low | High |
| Mothering | Low | High | | Low | High | High | Low | None | High |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Ability | | | | | | | | | |
| Twining Rate | Low | High | Low | | High | Low | Low | None | Low |
| Lambing Interval | Low | Low | High | None | | Low | Low | None | Low |
| Lamb Survival | Low | High | High | High | High | | Low | Low | Low |
| Conformation | High | High | High | High | High | High | | High | High |
| Color | Low | Low | None | None | None | High | High | | Low |
| Disease Resistance | None | None | None | None | Low | None | None | None | |

**Table 7:** Views of communities on genetic correlations among different production and reproduction traits in Afar

| | Milk yield | Body Size | Tail Type | Mothering Ability | Twining Rate | Lambing Interval | Lamb Survival | Conformation | Color | Disease Resistance |
|---|---|---|---|---|---|---|---|---|---|---|
| Milk yield | | High | High | High | High | High | High | High | High | High |
| Body Size | | | High | None | None | High | High | High | Low | None |
| Tail Type | | | | None | None | None | None | High | None | None |
| Mothering Ability | | | | | None | High | High | None | None | None |
| Twining Rate | | | | | | Low | High | None | None | None |
| Lambing Interval | | | | | | | Low | Low | None | Low |
| Lamb Survival | | | | | | | | None | None | High |
| Conformation | | | | | | | | | High | None |
| Color | | | | | | | | | | None |
| Disease Resistance | | | | | | | | | | |

## Conclusions

- The four project sites represent different agro-ecological conditions, and preferences for traits, breeding and grazing managements varied accordingly. This confirms that community-based management of animal genetic resources should take into account the peculiar nature of each production circumstances and the community. The farmers/pastoralists have accumulated traditional knowledge in animal management. Therefore, the role of scientists should be catalytic and needs to focus on integrating scientific knowledge and methods with the traditional management to help them in their decision making and ultimately achieving their breeding goals. Ideally, both types of knowledge are complementary and have to be integrated and used together for improved livestock production. This is easier when both types of knowledge are congruent, which was not always the case as evident in this study. Understanding traditional knowledge on selection of sheep, ram sharing and management, and community views on some genetic parameters (heritability and correlation) is determinant for design of breed improvement program at the community level.

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