Sustainable genetic improvement of goat meat and milk production in Kenya: A case of the Meru and Tharaka-Nithi Dairy and Animal Healthcare community-based Breeding Programme.

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Abstract

Livestock, particularly small stock plays an important role to small-scale resource poor livestock keepers. Their efficient utilization on small land holdings result in enhanced farm family nutrition and increased farm productivity, hence focus on their development can be one way of reducing poverty among the poor. Past goat genetic improvement programmes in Kenya were based on government research centers, hence were too expensive and unsustainable and rather irrelevant for small-scale farmers. FARM-Africa is implementing a community based goat improvement programme to improve the productivity of local goats using imported British Toggenburg. Using farmers self help groups as an entry point to the community, breeding units for the production of pure Toggenburgs and buck stations for crossbreeding local goats with Toggenburgs have been established. Farmers have formed Meru Goat Breeders Association (MGBA), through which farmers are able to supervise breeding activities. MGBA is a member of the Kenya Stud Book (KSB), which is the main livestock registering body, and for a long time small scale resource poor farmers were not active members. Through the programme the improved goat population in the project area has increased from zero in 1996, to more than ten thousand in 2002. The breeding programme, mating plans, selection criteria and the challenges to the programme is discussed. Also discussed are the impacts of the programmes and ways of sustainable way of ensuring continuity of the breeding beyond project phase funding is over.

Introduction

The need to reduce poverty among the rural poor and to produce more food to feed the ever-increasing human population in the developing countries is now more compelling than ever before (Kosura et al. 2000), For example, it is estimated that one in every three Kenyans is poor (Republic of Kenya, Poverty Reduction Strategy Paper 2001). Increases in production of food of animal origin can be achieved through adoption of more efficient and sustainable livestock husbandry practices, including use of more efficient genotypes or exploitation of non-conventional animal genetic resources. However, adoption of efficient and sustainable agricultural practices remains the single most promising options.

The greatest challenge to most governments, national and international research and development agencies is how to achieve widespread adoption of sufficient and sustainable agricultural practices in developing countries (ILRI 2000). From the demand side, it has been shown that due to the increasing global trends of human population, and economic growth coupled with increased urbanization trends, demand for livestock products will enormously increase and that such increases will have to be met, mainly, by developing countries, hence offering opportunities and therefore potential stimuli to the growth of the livestock sector in these countries (Livestock in Development 1999; Delgado et al. 1999).

However, for developing countries to benefit from export opportunities, hunger and abject poverty that currently widely prevail in these countries have to first be significantly reduced (Republic of Kenya, Poverty Reduction Strategy Paper 2001). This can be achieved by transforming the agricultural sectors of these countries into more efficient entities. Besides, supportive policy that embodies and institutionalizes the participation of the rural poor in the efforts of working their way out of poverty, including whenever possible, legal frameworks will need to be put in place.

The small-scale rural resource-poor farmers who live in the highly populated, but high-agriculturally potential regions of Africa and elsewhere, where mixed crop-livestock production systems is practiced will progressively need to adopt more efficient technologies. These include: more productive livestock genotypes, and new-crop livestock species mix, more efficient and sustainable animal healthcare delivery systems if they have to survive (Devendra et al. 1997; ILRI 2000).

It is increasingly becoming physically and bio-economically impossible to keep dairy and beef cattle in the highly populated highland areas of Kenya (Stotz 1981; Peacock 1997; Powell et al. 1998). Small animals and dairy goats in particular therefore offer alternatives to dairy cattle in such areas. Besides, goats are ideal entry points and ladders to, and for poverty reduction and economic development of the resource poor in Africa (Peacock 1999).

Several reasons make livestock (Livestock in Development 1999; Newman and Harris 1999; Mohamed et al., 2002), and dairy goats particularly attractive as potential tools for poverty reduction and improvement of family food security and livelihoods of the poor in developing countries. Although not yet quantified, results from other studies (Kotze and Schonfeldt 1996; Ivanovic et al. 2002), indicate that increased access to and consumption of milk especially that of goats would positively contribute to improved cognitive and physical development, well-being and survival of women and children. Milk in general (Newman and

Harris 1999; Mohamed et al. 2002), and goat milk in particular therefore provides the families who own such goats with better quality daily dietary intakes (Puranik 1992), hence improved health status of family members. The advantage of goats over other larger ruminant livestock species as the animal of preference as a tool and ladders for poverty reduction, and development, respectively among the poor of the poor in developing countries are listed and discussed elsewhere by Okeyo et al. (2001). In summary, these include:

1) Goats are easily acquired even by the poor of the poor as they require relatively modest starting capital investment
2) They can be easily tended by the weak, (old and young) and those weak victims of HIV/AIDS pandemic.
3) They can be owned by members of society that are often disadvantaged, such as women and children, hence focusing on them can held bridge gender disparities
4) They provide nutrients (protein, vitamins, minerals and energy) in quantities and qualities that are convenient and therefore effectively contribute to family's food and nutritional needs besides income generation.
5) They provide manure that can help maintain and enhance soil fertility of small family plots hence further enhance family's food security, (Onim et al. 1990).
6) Because of their small size, feeding them may easily depend on common off-farm resources and not necessarily on owned land, hence ideal for the landless members of society
7) Because it takes less to invest in a goat, projects that focus on them reach many more needy members of society

However, the above positive attributes can only be taken advantage of when more biologically efficient, and adaptable goat genotypes are kept and under sustainable feed resource management and improved husbandry practices (Winrock International 1992; FARM-Africa 1996).

In areas where the land holding/family are too small (0.5 to 1.5 acres) to support large ruminant livestock, dairy goats have become appropriate targets for research and development attention and it is on this background that the Food and Agriculture Research Management (FARM) – Africa, an international Non-Governmental Organization (NGO), in particular, has had great interest in promoting improved and sustainable goat farming as a poverty reducing strategy for the poor in Africa and Kenya specifically.

There were several past efforts that aimed at improving goat productivity through introduction of exotic improved genotypes such as the Toggenburg and Saanen for milk and Boer goat for meat production. There were also efforts to improve healthcare and nutrition but such activities were less targeted and not coordinated at farmers level. Two exotic goat genotypes were used to crossbreed the local meat goats in "upgrading" programmes. Unfortunately, past efforts by government, NGOs and International Development agencies such as FAO-UNDP to develop dairy goats in Kenya made insignificant impacts and success (Okeyo 1997). To date, more than 22 years since the initiation of such programmes in the country, there is little impact to show for them. This is clearly as illustrated by the relatively small population of improved (crossbred and pure exotic) goat genotypes (Table 1). The greatest contribution to the current total approximate population of 60,000 improved goat genotypes in Kenya, having resulted from the more recent German-GTZ and the British-FARM-Africa supported projects which started in 1992 and 1996, respectively and were based on similar farmer-participatory approaches Table 1).

The main reason for the failures of the previous projects was due to the fact that most of such projects concentrated on developing the goat rather than the people for whom the animal was being developed. The research and breeding work, in particular were mainly research-station-based, with little participation of the farmers. The result was, low survival rates of the improved genotypes (Okeyo et al. 1985), hence low number of improved genotypes within the farmers' hands and low adoption rate of the associated improved goat husbandry technology. Moreover, there were little animal health care support services, which were within farmers reach to facilitate the survival of the relatively delicate improved genotypes.

This paper presents and discusses a goat breeding programme being undertaken in Meru Districts of Central Kenyan highlands which is not only innovative in design, at least, but also sustainable structurally and organization-wise. Mention is made of some of the risks to the programmes success and steps that may be taken to minimize such risks and their effects.

The available goat genetic resources in Kenya and their distribution

The goat population in Kenya is predominantly indigenous Galla and the East Africa goats. The East African is a meat goat while Gallas in North Eastern and Eastern provinces are considered dual purpose by the local communities who keep them. Both Galla and East

African goats are concentrated in Arid and Semi-arid areas. There is a small population of improved goats (less than 1% of the National population) mainly crossbreds of exotic temperate dairy breeds with Galla and East African. The Gallas are found mainly in the lower areas and are mainly intrusions from the neighbouring Isiolo districts while the East African is found mainly in the higher areas but also in the lower parts. These goats are kept mainly for meat, although galls are also kept for milk in the Northern parts of the country (Table 1).

Table 1. National estimates and distribution of goats in Kenya by province in 1999.

Province	**Goat type**		**Total**
	Meat goats	**Dairy goats**	
Rift Valley	5,712,015	14,091	5,726,106
Coast	937,447	948	938,395
North Eastern	789,480	-	789,480
Eastern	1,289,146	7,732	1,296,878
Western	145,571	773	146,344
Nyanza	715,261	879	716,140
Central	234,802	32,732	267532
Nairobi	32,777	854	33,631
Total	**9,856,499**	**58,009**	**9,914,508**

Source: Annual Report, MoARD 1999

Technically it is only logical to begin by improving on the genetic resources that you already have. Second, Gibson and Cundiff (2000), in their recommendation on how to proceed under conditions similar to those in Kenya, emphasize and correctly so, that there is need to first obtain sufficient, relevant and reliable information on the available possible genotypes before formulating a breeding programme. Earlier work done by the Small Ruminants Collaborative Research Support (SR-CRSP) in Kenya clearly showed that goats could produce up to 5.5. litres with little supplementation while the East Africa produce 100mls per day (Ruvuna et al. 1988). A number of crossbreeding programme have been initiated between these indigenous breeds and the exotic dairy breeds the most comprehensive being the breeding programme of USAID sponsored Small Ruminants Collaborative Research Support (SR-CRSP). Earlier goat characterization research work revealed that within-breed selection for milk production among the indigenous goat breed in Kenya was unlikely to lead to significant genetic progress within reasonable time period (Ruvuan et al. 1988). The same work showed that that 50% or more exotic and indigenous genetic make-up would be more appropriate and ensure sufficiently improved meat and milk production potential as such a genetic combination would retain sufficiently high enough dairy, meat production potential and adaptive characteristics (Cartwright 1984; Okeyo et al. 1985; Ruvuna et al. 1988a; b; Ruvuna et al. 1992a; b; Okeyo et al. 2001). From the same set of studies and many other indigenous-knowledge-based sources, the Galla breed was shown to have greater potential for improvement for both meat and milk production under improved husbandry, including healthcare.

Breeding goals and objectives

Breeding objective refers to the trait(s) that farmers want to genetically improve in their individual animals and flocks because tin one way or another, they influence the flock returns or cost of flock production. Therefore, clear identification and statement of the breeding objectives is normally the first step in establishing any meaningful breeding programme (Groen 2000). The breeding objectives for Meru and Tharaka-Nithi Dairy Goat and Animal Healthcare Project is to improve meat and milk potential of the goat flocks, while at the same time maintaining high levels of adaptation to local feed resources, and environments in general. Through participatory workshops and discussions, farmers identified the following traits for improvement among their local goats. Milk yield, mature body size and conformation, growth rate, docility, fertility (age at first kidding, kidding interval and rate. They also wanted the high disease and heat tolerance/ resistance as well as certain coat colours to be retained in what they considered as the "ideal genetically improved goat" (Karugia 2001).

Why Toggenburg

Several exotic goats have been imported into Kenya, and indeed, in the neighboring Tanzania and Ethiopia for pure or crossbreeding. These have included Saanem, Anglo-Nubian, British and German Alpines, and the Toggenburg. These breeds have all been used for crossbreeding with various degree of success SR-CRSP used the British Toggenburg and Anglo-Nubians. Based on past crossbreeding experiments and experiences in Kenya, (Ruvuna et al 1988a ; b), involving crossing them to the indigenous goat breeds, demonstrated clearly that the Toggenburg gave better general and specific combining results when crossed to the indigenous Kenya goat breeds hence, the reason it was chosen as an improver breed in this project. It is however worth noting that German Alpine dairy breed has also been used for crossbreeding with local goat with equally good results (Mwangi et al. 1997).

It is obvious that the above desired breeding objectives can be achieved from neither the available exotic nor indigenous breeds, hence the need to combine the known attributes of these two sets of breeds in a crossbreeding programme. Borrowing from the wide experiences and analyses in dairy cattle crossbreeding work involving exotic dairy breeds and indigenous breeds, which is quite similar to dairy goats (Mc Dowell 1972; Smith 1988; Cunningham and Syrstad 1987; Madalena et al. 1990a; b) and later articulated by Payne and Hodges (1997); Gibson and Cundiff (2000), Van de Werf (2000) and Philipsson (2000), the question to be answered by the breeding project's formulation team "was ***not what breeds to cross and to what blood levels of each, but how to make sure the breeding programme, including the recording scheme was within the practical realities and scope of the local farmers and that they could sustain it beyond the project phase?"*** This is because from the many studies and reviews, especially those by Mc Dowell (1972), Cunningham and Syrstad (1987) and Madalena et al. (1990a; b), there is now a growing consensus that, in crossbreeding for dairy production for the tropics, the best performance is obtained from crosses with about 50% temperate dairy breed inheritance. However, under higher input (better feeds, better healthcare) higher grades up to 75% exotic inheritance could be accommodated. Dairy goats are quite similar to dairy cows and there is no compelling reason why similar conclusions should not be made for crossbreeding dairy goat breeds with tropical meat goats for the low input production systems in the tropics.

Breeding Strategy.

To exploit immediate heterotic gains in milk and meat potential by importing males and females of an established and pedigree recorded dairy breed, the British Toggenburgs. Male Toggenburgs were, and mated to a more adapted indigenous goat breeds as well as to pure Toggenburg does. On reaching sexual maturity, the resultant females (F_1s and pure Toggenburgs) were further mated to unrelated pure Toggenburg males, while the F_1 males are all castrated, while the young pure Toggenburg billies are reared together in a buck rearing center. This exercise was carried out in two different ways:

1. The establishment of a breeding unit for pure Toggenburgs, with the main objective to produce pure Toggenburg for expansion into new groups and also replace the aging buck at the buck station. This is done by the community and its important since one of the constraints has been source of breeding materials. Each breeder unit is established with four does and one buck, all of which pure Toggenburgs. Forty-seven

of such breeder units have been established and together have produced over 500 pure Toggenburgs since 1996 (see Table 2.)

Table 2. Toggenburg population and sample crossbred population in the project area

	Pure Toggenburgs		F1 (TogxLocal)		Three-quarter Toggenburg (3/4T 1/4Local)	
Year	Number Born	Number Dead	Number born	Number dead	Number born	Number dead
1995	37	-		-	-	-
1996	37	-		-	-	-
1997	116	-	7	-	1	-
1998	83	5	69	-	4	-
1999	92	6	167	-	17	-
2000	102	11	308	5	121	1
2001	93	7	325	6	198	2
2002 July	47	7	40	1	26	0
Total	**607**	**36**	**916**	**12**	**367**	**3**

2. The establishment of buck stations mainly for crossbreeding Toggenburgs with local goats. In just under 4 years, the number of crossbred kids has more than doubled (Table 3). Seventy-nine of such buck stations have been started and together have recorded over 15 thousand services, which resulted in 13,604 births of various crossbred kid genotypes . For each service farmers pay between Kshs.30 and 50. Given that by 1996 when the project began, there were only approximately 40, 000 improved dairy goats in the country, most of which were the result of very recent efforts of a German government funded project with similar approach, the impact of this particular project is remarkable.

Table 3. Number of buck services and crossbred goat population in the project area-1996-2002.

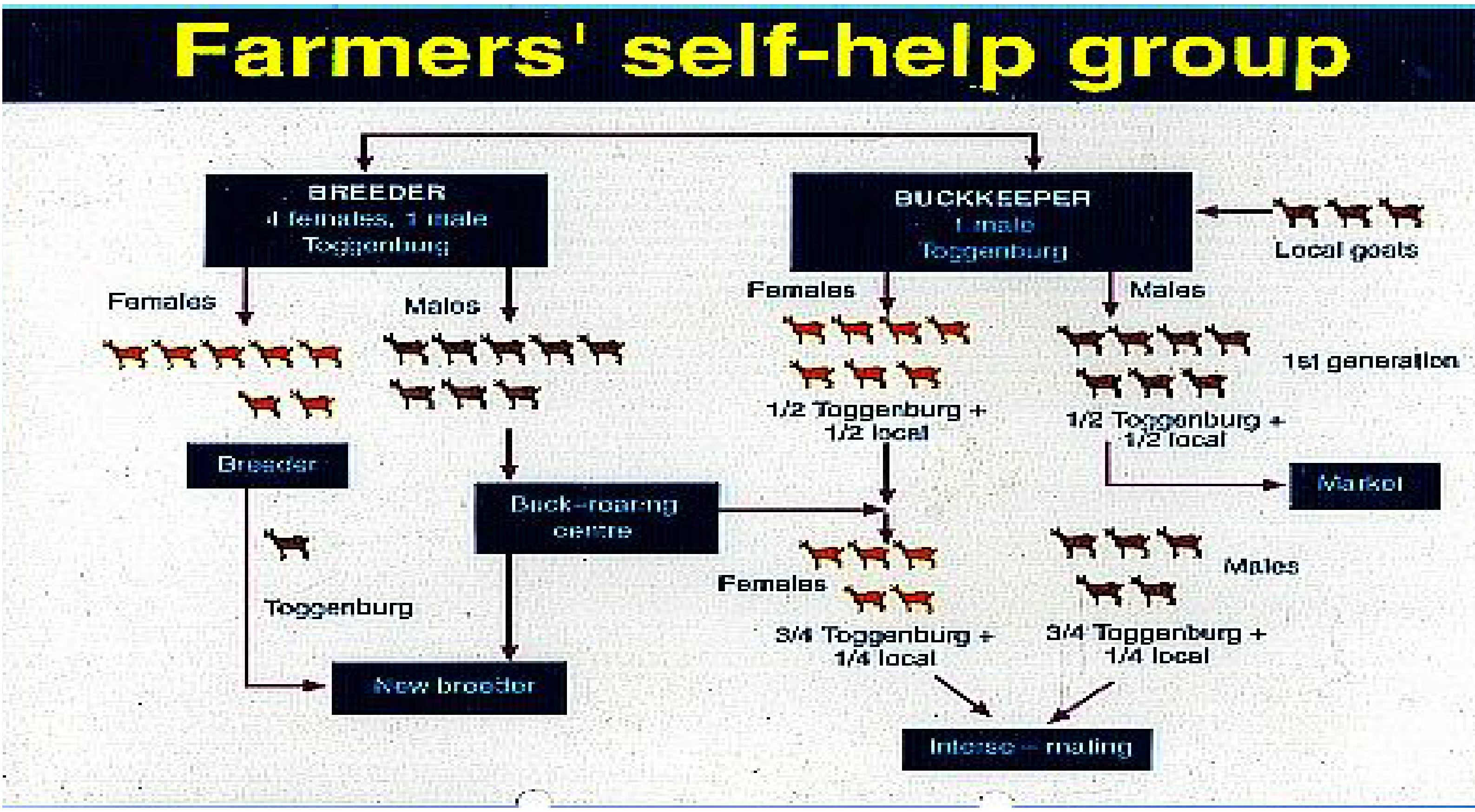
Year	Buck services	Buck stations	Kids born	Annual % change in kids born
1997	819	22	696	
1998	1946	34	1654	237
1999	3307	44	2810	169
2000	4074	48	3463	123
2001	5860	54	4981	143
Total	16,006	62	13,604	

Mating plan and breeding organization

The mating plan and organizational structure are illustrated in Figure 1and 2, respectively.

The mating plan

The detailed mating plan is presented below (Figure1).



The organizational structure

Farmers Self-Help groups have been used as the entry point. The group members are mainly the poorer members of the community who have identified themselves with a common course (goat rearing). The groups are registered with the governments department of culture and social services. Each group selects two members; one becomes the breeder while the other is the buck keeper. Each group has a committee that oversees the activities related to goat improvement including monitoring activities, organizing shows and auctions. The groups come under one umbrella organization known as the Meru Goat Breeders Association (MGBA). MGBA is a fully registered local breed association that draws its membership from registered farmer goat groups mainly from Meru Central and South districts. It has formulated its own by-laws to which all the members must abide. The organizational structure of the breeding programme, including the functions of each component is presented in Figure 2, while the main activities and functions of MGBA are shown in Table 4.

Figure 2: The breeding organization

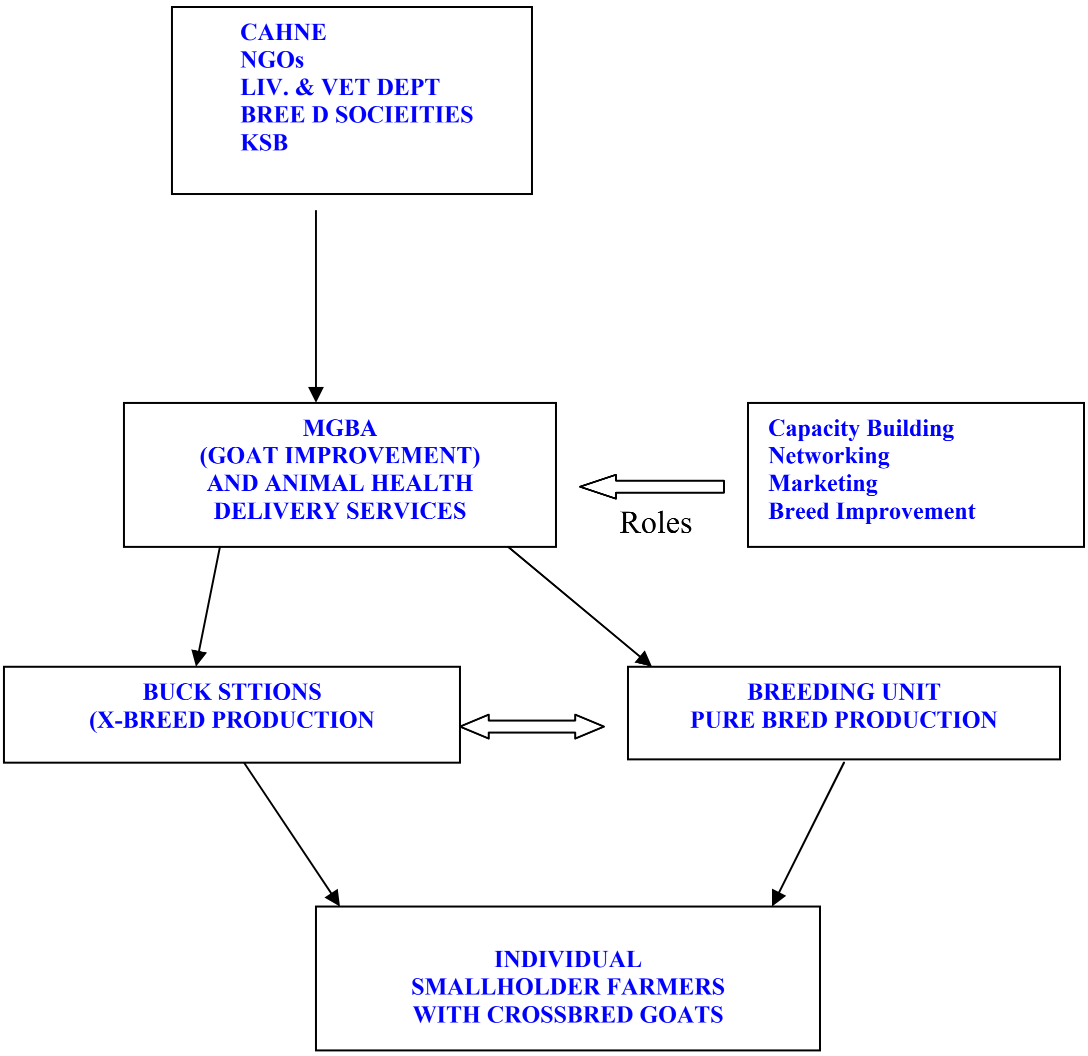


Table 4. Functions and activities of Meru Goat Breeders Association

Functions	Activities
Maintenance of breed improvement services	Performance recording Setting breed standards Supply of breed information Judging and inspection Registration with the Stud Book
Marketing	Identification of marketing outlet Organizing shows, field days and auctions Publicity and advertising
Training	Training officials/managers of MGBA on breed inspection and judging

Recording scheme and selection criteria

Recording scheme

It is only through accurate performance and pedigree recording that the relative genetic worth (breeding values) of each animal can be predicted and knowledge-based selection programme can be undertaken, and consistent ,and desired genetic progress made in the growth, fitness and milk production made. If no or inadequate recording is done, then no monitoring of herd performance and indeed, genetic evaluation can be undertaken. However inaccurate records are worthless. Likewise, records, however accurate they are worthless if they are not usedas aids in decision making e.g. during culling, selection and setting of sale prices etc.

In the mean time, manual recording and data storage is the being maintained at farm level, while the project office is centrally storing the same data in electronic form. The central data-base is accessible to the members through MGBA and it is planned that when the project ends, MGBA will maintain the central electronic data-base.

Some important records that farmers must keep include;

1. Individual animal records on reproductive, growth and health (mortality & morbidity) performance.
2. Herd events e.g. vaccinations, weaning dates.
3. Pedigree records.

For smallholder farmers, most of whom are illiterate, the emphasis is to keep the recording system as simple as is practically possible so as to make it sustainable. The literate members of the family (e.g. children in school) are taught how to keep daily farm records. These are further checked regularly by one of the trained group members or the local extension staff. Regular livestock exhibitions are held by several farmer groups during which the use of the records are demonstrated, with regard to selection, culling and determination of the prices of breeding stock. This way, farmers are made to appreciate the importance and value of accurate record keeping.

Reproductive efficiency is one of the most important factors to consider in any commercial livestock production. However, because such traits are not directly observed or do not have immediate observable impacts, they usually escape inexperienced farmer's attentions. To address these, MGBA member farmers are trained during participatory sessions on how to derive and deduce reproductive efficiency components such as; length of oestrus cycle, service per conception, kidding intervals and their irrelevance to overall flock/herd productivity. This way, the practical role of MGBA, to members is enhanced.

Limitations of farmers village level recording scheme

The following are some of the limiting factors to village-based recording schemes:

- Limited experience and knowledge of, and experience as to of benefits of recording
- Small herd sizes
- Inadequate understanding and perception of the complex and long term nature of genetic improvement programs by farmers.
- Unavailability of facilities for data and analysis and qualified support personnel to accurately interpret the data and results of their anlyses.
- Limited scope of the MGBA memberships in the collection of data and coordination of recording schemes and utilization of the data.
- limited number of recording personnel
- Lack of incentives for farmers who record their livestock, due to inappropriate livestock marketing policies, especially lack of quality-based livestock and livestock product pricing system

Small scale farmers need to be trained and facilitated through training and continuous technical advisory support or guidance to keep and use their own farm records. To ensure sustained record keeping, the records must be kept simple and a proper flow of information to and from extension, researchers etc. maintained.

In return, farmers should be adequately rewarded for keeping accurate pedigree and performance records. Animals which are registered with the Kenya studbook should always attract higher market prices. Prices of animals that are being sold for slaughter should be based on weight for age, with premiums paid for young but well conditioned animals. On the other hand, young breeding stock should be sold on the basis of their predicted breeding values, which itself must be accurately computed, hence guaranteeing attractive prices for well managed and bred stock. Also, goat meat should be graded, and retail prices should reflect the quality of the carcass unlike the current practice where cut or carcass weight and not quality that matters.

Selection criteria

All the farmers who are members of the MGBA keep records on growth and milk production. At the beginning of the programme, the emphasis was on milk production. But as the farmers began to milk the does and sell the castrated crossbred males and young doelings, the emphasis has shifted to duality of purpose (i.e. meat and milk). The crossbreds have therefore been very popular because of their high growth rates and milk production. The average yearling weight of the crossbreds is 40 and 30 kg for males and g females, respectively, while the mean daily milk production of F_1 females in their first and 2nd parities is 2.6 litres.

There is a need to establish a network of breeding expertise (universities, research institutes, private companies and professional) in a well coordinated and collaborative manner for organized and sustainable genetic improvement programmes. This perhaps is the only way the farmers can be assisted to collectively benefit from the various existing pool of expertise in a non-biased way.

Breeding technologies

One of the technologies that could be used in propagating the improved goats is artificial insemination (AI). However, recent results from AI trials undertaken by the Dairy Goat Association of Kenya indicate that this technology is presently economical, as farmers would have to pay Ksh 500 (US$ 6.4) per insemination, which is very expensive. However, semen from a few genetically proven top quality bucks is being collected and preserved for future and strategic use.

Impact of the project

The impact of the project can be measurably demonstrated by the tremendous increase in the number of crossbred goats that have been raised (Table 5a and b), and sold at higher profit margins compared to that of the local goats over the project period, the higher salable meat and harvestable milk production per female goat available to the farm families (Table 5c), as well as the improved survival rate of the improved genotypes (Table 5a). The latter point is indicative of the achievement of improved/ enhanced capacity of the local farmers to successful care for the improved genotypes, unlike the case of the past failed projects (Okeyo 1997). This in turn is a good sign showing that the programme would most likely be sustainable beyond the current project life.

Population and productivity of improved stock over the years

The population and production levels of the improved goats in the farms that are monitored by the project team is given in Tables 5a, 5b and 5c. The figures (increases in animal numbers, productivity) translate directly into improved welfares of the farmers through improved nutrition, cash earnings and resource, mainly soil management. For example, for a 3 doe unit, with 2 of the does, each producing 2.5 litres of milk each day at any one given time for 175 days, and assuming that half of it is sold, then such a family if it is composed of 3 young children has more than adequate daily protein intake, and additional daily cash income amounting to US$ 0.66 from the goat enterprise alone.

Table 5a: Number of improved goats born and their survival rates (%) to weaning by genotype and year from 1996 to 2002 in the farms being monitored in project area.

Year	Pure Toggenburg		F_1 (Toggenburg x Local)		¾Toggeneburg/ ¼Local	
	No. Born	% Weaned	No. Born	% weaned	No. Born	% weaned
1996	37	100			-	
1997	106	91	7	-	1	
1998	83	94	69	95	4	
1999	92	90	167	90	17	90
2000	102	92	308	97	121	96
2001	93	88.5	325	98	198	94
2002	23		40		26	0
Total	536		916		367	

Table 5b: Improved goat population by genotype and year, and percentage change (in bracket) from 1996 to 2002 in the farms being monitored in project area

Year	Pure Toggenburg		F_1 (Toggenburg x Local)		¾Toggeneburg- ¼Local	
	Females	Males	Females	Males	Females	Males
1996	22	18	-	-	-	-
1997	53	63	7	-	1	-
1998	45	38	65	4	3	1
1999	42	50	146	21	11	6
2000	49	50	225	83	68	53
2001	52	41	174	151	104	94
2002	23	24	246	18	18	8
Total	306	301	633	283	205	162
Grand Total	607		916		367	

Table 5d: Average (±se) yearling weight (kg), daily milk yield (kg) and lactation length (days) of goats by genotype and year from 1996 to 2002 in the project area.

Genotype	Number over 1 year& over	Yearling weight (kg)		Milk yield (kg/day)	Lactation length (days)
		Male	Female		
Pure Toggenburg	560	42 ( )	38 ( )	3.20 ( )	176 ( )
F_1 (Toggenburg x Local)	874	40 ( )	34 ( )	2.57 ( )	136 ( )
¾Toggeneburg/ ¼Local	341	-	187 ( )	-	-

Challenges to the breeding programme

From the forgoing results and discussions, it is obvious that the breeding programme has indeed made tremendous impact on the target farmers as well as other elsewhere, who have been able to purchase improved breeding stock from the project farmers. However, the greatest challenge and question being asked is " How can these smallholder farmers maintain the desired level of crossbred populations in a sustainable way?" It is obvious that, only very few farmers can economically and therefore viably keep pure Toggenburgs, while the majority are comfortable with ½ Toggenburg - ½ Local or ¾ Toggenburg-¼ Local. But in order to sustain such genetic composition, the farmers need to not only all pool their resources together, but to also to adopt similar mating plans, breeding objectives and selection criteria. To do this, they need continued technical support form local extension staff, universities and research institutions. If such support is appropriately provided, then a new synthetic dual purpose goat breed is in the making.

It is also obvious that the relatively small populations of founders (62 females and 68 males) of which 26 animals were genetically unrelated, the genetic base of the resultant crossbred population, especially the ¾ Togg-¼ Local, is bound to be somehow narrow. Hence there is need to import other unrelated Pure Toggenburg bucks to be mated to the ½ Togg- ½ Local crossbred females to produce the ¾ Togg-¼ Local in large enough numbers to allow for subsequent *inter-se* mating, selection, and progressive formation of a synthetic breed whose composition is ¾ Togg-¼ Local.

However, deducing from the existing large body of evidence from results and discussions of crossbreeding of exotic dairy and zebu cattle (Mc Dowell 1972; Smith 1988; Cunningham and Syrstad 1987; Madalena et al. 1990a; b; Payne and Hodges 1997), it would appear that ½ Togg- ½ Local would be the ideal genetic composition from which the synthetic breed should be derived. Where as the current mating plan does allow for stabilization of the F_1s into a synthetic population, it is not easy to convince the farmers that they are much better off with the F_1s than with the ¾ Togg-¼ Local because of their limited scope in understanding the full phenomenon of genotype by environment interaction.

The other challenge is how to replicate this programme among the other farmers elsewhere, in Kenya and the region, so as to allow for continued exchange of proven breeding stock between such groups without compromising on genetic quality. This way, inbreeding levels in the subsequent generations would be greatly reduced, at least, in principle. To do this, pedigree and performance recording by such farmers and genetic evaluation of such stock should be a priority. Also, breeding programmes, by their very nature, being long-term, understanding among investors, need to be solicited, so that financial and technical support from donors are given for longer periods that is the case with other projects.

Conclusions

Small-scale resource poor farmers can operate a successful and therefore sustainable community based goat genetic improvement programme, with appropriately designed technical support services at affordable costs. Such programmes have the potential of improving their well-being of the poor farmers through many ways (improved family nutrition, increased soil fertility and crop yields, increased cash earnings from sale of improved and more productive stock), hence reducing poverty. However the technical challenges must be adequately addressed for the programmes to succeed.

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