

# SELECTION AND BREEDING STRATEGIES FOR INCREASED PRODUCTIVITY OF GOATS IN ETHIOPIA

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## Abstract

Goats are important animals for diversifying livestock production and, thus, are an integral part of tropical agricultural systems. In Ethiopia, goats are found in all agro-ecological zones. Ethiopia has the second largest goat population in Africa (16.7 million), which constitutes about 2.7% of the 610 million goats in the world. About one-third of the goats of Ethiopia are found in the highlands. Some efforts have been made to assign Ethiopian goats to type/breed categorizations based on variables other than the functional parameters. However, for effective use of the vast genetic diversity of goats in Ethiopia in any breeding program, baseline production data is necessary, which is presently lacking. There is not an organized, structured goat breeding program in Ethiopia. For developing possible selection and breeding strategies for goat production in Ethiopia, in addition to making available the production parameters of goats, one will have to keep in mind the various agro-climatic and socio-economic aspects along with the production constraints, as they have an important bearing on the overall success of such programs. Agro-climatic zones in Ethiopia are Arid, Semi-Arid, Sub-humid, Humid, and Highland, the determining factors of these zone being climate (rainfall), elevation and the presence or absence of diseases. A breeding program for Arid and Semi-Arid zones would need to identify most promising breeds/strains/types under the prevailing system of production for genetic selection and multiplication under improved husbandry practices. Goats of the Sub-Humid zone should be selected for meat production and adaptability traits. In the Humid zone a breeding program should use goats under integrated farming systems along with other livestock and tree/cash crops. In Highlands, the breeding program on goats could be developed both for meat and milk using promising indigenous stock, improving them through selective breeding and also in crosses with exotic and(or) or promising tropical breeds.

## Introduction

Goats are often found in severely degraded areas and are thus wrongly accused of being the cause of degradation. Actually, goats are an important animal and an integral part of tropical agricultural systems. Goats are important for diversifying production, creating employment, increasing income, building capital, contributing to human nutrition and reducing risk, in addition to their quantifiable outputs of several products. Goats are found in all agro-ecological zones from hyper-arid to super-humid and over the whole range of production systems from intensive smallholder production to very extensive nomadic pastoralism (Payne and Wilson, 1999). With the realization that small ruminants in general and goats in particular are an under-used and poorly understood resource, an interest in goat production in the tropics has grown in recent years. There is need for a greater understanding of their role, capabilities and outputs that will contribute to the overall productivity of tropical farming systems.

In the mid-1990s the world population of goats was estimated at about 610 million, of which 573.4 million (94%) were in tropical and subtropical areas. Africa was home to 176.1 million goats (29% of the world's total), of which 16.7 million were in Ethiopia (2.7% of the world's goats). Ethiopia had the second largest goat population in Africa after Nigeria and the fifth

greatest in the world after India, China, Pakistan and Nigeria (FAO, 1995). Goats in Ethiopia are found in all five agro-ecological zones (Table 1). Contrary to the general assumption that goats are associated with arid and semi-arid lowlands, about one-third of the national goat population is in the agricultural highlands.

Table 1. Distribution of Ethiopian goats by agro-ecological zone (per cent)

Zone	Land area	Goat population	Human population
Arid	44.5	38.0	5.6
Semi-arid	10.1	22.0	43.4
Sub-humid	7.7	5.0	4.9
Humid		3.0	2.5
Highland	37.7	32.0	43.6

Source: Jahnke (1983)

### Goat Types and Breeds in Ethiopia

Most tropical goats are do not appear greatly different and can be called nondescript. However, there have been several attempts to assign goats to types based on such variables as origin, utility, body size, ear shape and ear length (FARM Africa, 1996). According to Peters and Horst (1981), body size is a suitable criterion for classification since it also gives clues to potential performance. Devendra and Burns (1983) have classified tropical goats based on body size: large (> 65cm at the withers), small (51-65 cm) and dwarf (< 50 cm). Many breeds have been identified on the basis of physical, morphological and functional characteristics and more than 350 tropical breeds have been named so far. Workneh Ayalew (1992) cited 10 indigenous goat types of Ethiopia (Table 2), none of which have been established at the national level for general reference. However, it is believed that despite the indiscriminate crossing among local types and possibly also gradual and continual breed replacement for various reasons, there are fairly distinct goat populations with discernible areas of dominant distribution in different parts of the country. A comprehensive survey of goats in Ethiopia identified 14 'clusters' of breeds based almost entirely on morphological characteristics (FARM-Africa, 1996). Classification of tropical goats by function has not, so far, found a great deal of support. This is perhaps because goats indigenous to the tropics have been selected mainly for survival. Therefore, there has been little differentiation into major types related to production objective or function, and most tropical goats are used as a source of meat.

Though there are a number of goat breeds in Ethiopia, very little comparative productivity data exist. These data can provide important information on breeds that can be employed efficiently in crossbreeding programs. As indicated in Table 2, in Ethiopia Shukria has been identified as a good milk type. The Bati type was reported to be of superior skin quality. The Somali (Ogaden) is known as the best milk producer in southern and southeastern Ethiopia, while Arusi-Bale (Gishe), Adal (Afar, Danakil) and the others are meat types that may be milked rarely. Production and comparative data for these breeds could be made available for their effective use in breeding programs.

### Reproduction in Goats

#### *Males*

Data on functional parameters are scanty in Ethiopia. Payne and Wilson (1999) reviewed the reproductive and production data on tropical goats. Tropical male goats reach puberty at about 97 days, i.e., the age at which spermatozoa appear in the ejaculate, and reach sexual maturity at 132 days.

Table 2. Indigenous goat types of Ethiopia

Indigenous goat types	Area of Distribution	Description
1. Shukria	Western Eritrea	Large, desert type with long ears and legs, convex facial profile; long-haired, usually brown in colour; good milk type; Nubian type but horned.
2. Galla-Sidamo	Southern Shoa, Northern Sidamo	Medium size, light, slender body; coat occasionally long with mixed colour; males carry beard and mane; concave facial profile; rarely milked.
3. Arusi-Bale (Gishe)	Highlands of Bale, and Hararghie	Small, short-legged; short ears; both short and long haired type; hair is glossy, wavy and grey or dark in colour.
4. Somali (Ogaden, Mudugh, Boran)	Ogaden, Elkere	Medium size with long legs, adapted to dry areas; short, smooth hair with brilliant white colour; with patches of brown on shoulder and neck; ears short and never pendulous; convex facial profile; milk yield is good.
5. Adal (Afar, Danakil)	Northern Rift Valley, in Wollo and Northern Hararghie	Typically white, but some are grey, black or mixed in colour; skin and meat type; smaller to Somali goat.
6. Bati	Southeast Wollo	Known for its superior skin quality.
7. Dinka	Western Ethiopia adjacent to Dinka area of the Sudan	Medium size and stocky with long, slender legs; short coat, straight profile; short narrow ears.
8. Red Goat (Atal Cajeh)	Keren area, Eritrea	Dominant black colour, small to medium size
9. Black Goat (Atal Zallam)	Keren area, Eritrea	Dominant black colour, small to medium size
10. Southern Abyssinian	South-western Ethiopia	Medium size goat similar to the Toposa goat of the Sudan

Source: Workneh Ayalew (1992)

### *Females*

Puberty is related more closely to mature weight than to age and usually occurs at about 60-70% of adult weight, which is relatively later than in males. It is common in the tropics for goats to reach sexual maturity at 4-6 months. The duration of the oestrous cycle in goats is 18-21 days. Oestrus, which occurs throughout the year, lasts for 24-36 hours and ovulation occurs towards the end of the oestrus, which is the best time for mating. Gestation length is 145-148 days with an average of 146. Two kiddings per year are possible but seldom achieved. The

variation in age at first kidding is from as young as 7 months (conception at 2 months) to as old as 2 years. Many of the African goat breeds give birth to their first kid at 12-18 months. The kidding interval in most tropical goats varies from 180-300 days. Two births are common in goats, and larger litter sizes are not rare. Factors that influence litter size include breed, season and year of mating, nutritional status and weight of the doe. West African Dwarf goats are known for their prolificacy. Heritability estimates for litter size were  $0.35 \pm 0.05$ , which indicates that response to selection for this trait will be high.

Table 3. Comparison of population size, growth in population size, meat and milk production of goats in Ethiopia and two neighboring countries between 1975-1987.

Country	Population size (million)	Population growth rate (%)	Meat production (Kg/head)	Milk production (Thousands Metric Ton)
Ethiopia	16.7	Negligible	9	93
Kenya	7.4	4.1	11	91
Sudan	16.5	2.6	15	1544

Source: FAO (1995)

## **Production and Productivity in Goats**

### *Meat*

Goat carcasses average 12 kg in weight over most of the tropics but vary among countries and breed from 7 to 18 kg. Off-take rates (number slaughtered as a percentage of the total population) are estimated at 32% in Africa. Goat meat available per person per year in Africa is 1004 g. The protein content of goat meat is 20-22%, with a fat content of less than 3%. Goat meat is considered of adequate quality with respect to all essential amino acids, with a biological value of 60.4%. Dressing percentage varies with many factors including sex, breed, age, nutritional status and live weight. Total edible portions of the carcass are up to 70-75% and the total that is commercially valuable can be as high as 80%.

### *Milk*

The length of lactation of tropical indigenous goats is short and generally in the range of 80-200 days. Attempts to prolong lactation length usually involve crossing with exotic breeds, which has prolonged lactations by as much as 50%. However, in Ethiopia crossing of Adal with Saanen x Adal has not resulted in any increase in lactation length (84 vs 84 days), although lactation yield was increased (24 vs 31 kg). Daily yields vary from 0.25-2.00 kg/day. In addition to genetic effects, a major environmental factor influencing daily yield is size of the litter, which can be as much as 50% higher for dams suckling twins than for those suckling singles as shown for both Boer and Red Sokoto goats in Africa. In Africa, lactation yield varies from 24 (Adal in Ethiopia) to 480 kg (Alpine in Burundi). Age of dam has a strong influence on total yield, especially in Ethiopia where 7-year-old females produced 50% more milk than those 2 yr of age. Breed effects on the percentage of milk fat in tropical goats are considerable, ranging from 2.9% in the Adal to 8.3% in mid-lactation for the West African Dwarf. In Red Sokoto goats of Nigeria, suckling twins had significantly higher milk fat content (5.03%) than those suckling singles (4.37%), even though fat percentage typically decreases with increasing yield.

In Ethiopia productivity of local goats is very low, as indicated by the comparative study carried out for Ethiopia and two neighbouring countries between 1975-87 (Table 3). Among the very limited efforts to improve local goat productivity in Ethiopia, the one by FARM Africa, in collaboration with different governmental and non-governmental organizations, is worth mentioning. The project has used local Somali goats that are valued for milk production (Neugebauer et al., 1991). Local Somali goats have been crossed with the exotic Anglo-Nubian breed, which is known for high milk production, with the aim to improve meat and milk production of local Somali goats and thereby raise the living standard of rural people. Accordingly, crossbreeds have been distributed to poor rural families in the highlands of Ethiopia (Peacock et al., 1991).

### *Skins and Fiber*

Skins are an important but often neglected byproduct of goat production. In Ethiopia, goat skin makes an important contribution to exports. In 1983 some 1.8 million goat skins and 3.3 million sheep skins earned revenues equivalent to 9.2% of all agricultural exports and 29.5% of agricultural exports excluding coffee. In Africa a move from exporting raw skins to partially manufactured products is exemplified by efforts in Ethiopia over the 10-year period of 1978-87. Quality skins are produced from the Red Sokoto breed in Nigeria and Niger and from the Mubende breed in Uganda. The average dry weight of Red Sokoto skins is 420 g and the useful area for tanning is from 0.28 to 0.65 m<sup>2</sup>.

### **Genetic Modification by Selection and Breeding**

The methods used for genetic modification in goats are selection within breeds or types and crossbreeding. Selection within indigenous breeds or types is necessary to understand their potential. Only after the process of selection is completed and the need for further improvement justified should crossbreeding be undertaken. Before selection, knowledge of the heritability, repeatability and genetic and phenotypic correlation among traits is essential in deciding whether or not a particular trait(s) should be included in the selection criteria and in the breeding objectives.

In addition to meat, milk and skin are the major products of goat production. There have been some attempts to improve these traits in indigenous goats by outcrossing to temperate breeds for milk, meat or fiber production. These special types are being increasingly used in modern intensive and semi-intensive systems and in traditional and improved traditional systems. Projects of this kind have often shown some success when there was external support and in cases where artificial conditions have been created for the pure exotics and for backcrosses beyond the F1 generation. For example, the Saanen is particularly vulnerable to problems if it is not provided with shade. The improved European breeds used are the Alpine, Anglo-Nubian, Saanen and Toggenburg. In general, the Anglo-Nubian is widely distributed and performs well both as a purebred and a crossbred for meat as well as milk. There are even possibilities for improving milk or meat production by the use of some tropical breeds such as the Jamnapari and Beetal of India, the Boran or Galla of northern Kenya or the Boer of southern Africa. While the Jamnapari is capable of producing 1.3-3.0 kg of milk daily, females of the outstanding Boer meat got breed can weigh as much as 75 kg and mature castrates weigh 100 kg without supplementary feeding.

One of the major constraints to increased milk output in goats is that purebred imported exotics or crossbreeds of exotics with locals are not adequately adapted to tropical management and often

do not survive. In this regard, experiments in Kenya were carried out under a Kenyan traditional mixed farming system with use of two local breeds (Small East African and Galla) and two established milk producing breeds (Toggenberg and Anglo-Nubian). Simple two-way crossbreeds produced more milk than local unimproved goats but required constant management skills superior to those generally available in Africa, as well as higher levels of nutrition. Composite or synthetic breeds lose less heterosis due to recombination during stabilization compared with crossbreeds and are more responsive to selection.

### **Possible Selection and Breeding Strategies for Goat Production in Ethiopia**

While Adeniji (1985) had his views on livestock breeding in Africa, Kiwuwa (1992) discussed breeding strategies for small ruminant productivity in Africa. There is as such no goat breeding program in Ethiopia. The breeding of goats has been left to continue as it has always been done, traditionally. Although there has been some effort by international organizations along with the national institutions to improve production and productivity of goats in Ethiopia, there needs to be a concerted effort to formulate and implement a clear program and strategy for goat production in view of its importance to the national economy. While considerable efforts are needed to increase productivity of goats in Ethiopia through the development of an efficient selection and breeding program along with improved animal husbandry practices, one has to keep in mind the country's agro-climatic and socio-economic aspects along with the various production constraints before formulating such strategies because these factors have an important bearing on the overall success of such programs.

#### *Agro-climatic aspects*

Ethiopia has a total land area of about 122 million hectares. Of these, about 65 million hectares are pastures and 18 million hectares are crop areas. The grazing area is distributed between the highlands (22-23 million hectares) and the lowlands (43-44 million hectares). The highlands are populated by 90% of the total population and here almost all the crops are produced and about 70% of the livestock population is found. The hot dry lowlands are mainly populated by nomadic pastoralists (Brannang and Persson, 1990). Out of the estimated 140 million Ethiopian livestock population, there were about 16.7 million goats that constitute 24.7% of the total livestock population of the country in 1995 (FAO, 1995). Along with camels, goats are the main livestock species kept by nomadic pastoralists in the lowlands, with about 68% of the goat population. For the pastoralists in the lowlands, the goats are the backbone of their lives (Brannang and Persson, 1990).

#### *Socio-economic aspects*

It should be kept in mind that the raising of goats in Ethiopia is not market oriented, but rather goats are used within the framework of the subsistence farming system as producers of meat, milk, hides, etc. They also provide a kind of financial security and even wealth for many people and are not likely to be sold. These attitudes have to be understood and seen in their context while formulating breeding strategies.

### **Constraints**

So far as the constraints of production in Ethiopia are concerned, grazing lands are currently heavily populated and there have been no efforts to limit numbers; hence, pastures are overstocked and overgrazed. Consequently, they are often invaded by inferior grass

species. Also, with continuous grazing parasites become a serious problem, especially for the young stock. During the dry season the grazing resources are soon exhausted, and animals are not even be able to maintain body weight. The rather scarce amounts of crop residues are not enough and priority is given to draught animals. The heavy burden of different diseases among livestock results in substantial losses. The traditional marketing system is not very well developed. Long trekking of animals to the numerous small market places with sparse feeding results in severe losses in weight. Other major constraints are shortages of infrastructure and suitable transportation.

Nevertheless, with the present knowledge of planned breeding programs, forage production practices, improved animal husbandry techniques and extension capabilities, much can be done to improve production and productivity of goats in Ethiopia. Based on the type of the goat population and the production environment in Ethiopia, possible selection and breeding strategies are addressed below.

### *Ecological Zones and Breeding Programs*

Depending on climate, elevation and presence or absence of livestock diseases, Ethiopia is divided into five agro-ecological zones: Arid, Semi-arid, Sub-humid, Humid and Highland.

#### *Arid Zone*

The rainfall in this zone is 100-400 mm/yr. The effect of rainfall distribution and intensity dictates the basic pattern of livestock production, which is Nomadism, an extensive form of production. Stockmen in these zones move their herds and flocks over extensive areas in search of water and grazing. The movement in this system of production is neither at regular intervals nor mindful of political boundaries (Adeniji, 1985). The herd increases in a good year and when there is an outbreak of disease or drought numbers are reduced unless avoided through movement. Therefore, the environment is unfavorable for livestock production. However, the livestock that have lived in this ecozone have become highly adapted through natural selection, which has been mainly for survival. The breeding program for this zone should identify the most promising breeds, strains or types under the prevailing system of production available for genetic selection and thereafter multiply the stock under improved husbandry practices. To accomplish this task, different methods such as revegetation, provision of water through construction of dams and digging bore holes, control of nomadism by confining them to defined boundaries, provision of alternative forms of employment and implementation of effective disease control measures need to be adapted. The greatest impediment of these activities is the shortage of funds.

#### *Semi-Arid Zone*

The rainfall in this zone is 400-800 mm/yr. This zone is the major livestock producing area and the problems encountered are similar to those of the arid zone. The rainfall distribution allows for a relatively long growing season that can effectively accommodate both the extensive and semi-intensive form of production, i.e., pastoralism and ranching, respectively. The breeding program suggested for this ecozone is similar to that of the arid zone. Also, comparative evaluation of the different indigenous goat breeds/types under the prevailing system should be carried out mainly for meat production traits. This zone may have relatively less adaptability problems for the high producing exotic breeds. Therefore, exotic breeds that are relatively less adaptable can also be introduced in this ecozone for crossing purposes.

### *Sub-Humid Zone*

The rainfall in this zone is 800-1400 mm/yr. The rainfall distribution is such that this area is suitable for crop production. Therefore, livestock production is of secondary economic importance and competes with or supports crop production. The breeding program suggested is the use of indigenous breeds/types of goats for meat production. Goats should also be selected for fitness, adaptation to the environment, growth and prolificacy. With improved environmental conditions one can use improved indigenous tropical breeds for meat production. Exotic breeds are unsuitable for this environment because of high temperature and humidity. Therefore, crossbreeds could be developed for meat and milk, which will lead into development of performance testing schemes.

### *Humid Zone*

The rainfall in the humid zone is above 1400 mm/yr. As in the sub-humid zone, livestock production is of secondary importance. The area is infested with tsetse flies, and trypanotolerant goats indigenous to this zone can thrive. The breeding program suggested is the development of integrated farming system of goats and other livestock and tree/cash crops. A comparative evaluation of goat types adapted to this ecozone and genetic improvement through selection and establishment of nucleus herds on commercial, private and government production centers are also suggested.

### *Highland Zone*

The highland zone in Ethiopia, defined as areas above 1500 m, occupies about 38% of the total land mass of the country, with rainfall usually more than 600 mm/yr. This ecozone is suitable for all forms of livestock production and consequently carries the highest concentration of livestock per unit area in the country. It is in this ecozone that large scale mixed farms are found. When the environment is unfavorable as a result of poor pasture development and inadequate feed supply, the breeding program could be developed for meat production using best known meat breeds/types. Indigenous meat type breeds in the area need to be selected for meat characteristics on the basis of their phenotypes, either through individual or family selection. Crossbreeding local breeds with others known to be well adapted to the region and possessing favorable meat or milk production traits can also be conducted at the experimental level to ascertain appropriate levels of heterosis. Examples of breeds that deserve consideration for crossing include the Boer of southern Africa, Jamnapari and Beetal of India and Boran (Galla) of northern Kenya.

When the environment has been modified as a result of provision of adequate feed, well established pastures, adequate marketing facilities particularly for milk, the breeding program should be for dairy goat milk production using exotic breeds, either crossbreeding or upgrading indigenous breeds with exotics particularly in areas with high human pressure. For this purpose local Somali goats, which have reasonably good milk production, can be crossed with the Anglo-Nubian breed to produce F1 as has been done by FARM Africa. In areas where there is sufficient feed and pastures, animal husbandry practices are improved, marketing facilities are adequate, demand for milk is high and private entrepreneurship is forthcoming, one can employ a grading up program. Formation of composite or synthetic breeds could also be conducted, since they lose less heterosis due to recombination during stabilization than do simpler crossbreeds and are more responsive to selection for maintaining or increasing production.

### **Conclusion**

The estimated number of goats in Ethiopia of 17.5 million is the second largest in Africa. Along with camels, goats are the main livestock species kept by nomadic pastoralists in the lowlands of the country. They are also an integral part in the highland agricultural farming systems, playing complementary roles with other species of livestock. In fact, goats in Ethiopia are found in all the agro-ecological zones and contrary to the general assumption that goats are associated with arid and semi-arid lowlands, about one-third of the national goat population is found in the agricultural highlands. It is believed that despite the indiscriminate crossing between local types and possibly also gradual breed replacement for various reasons that has been occurring for many years, there exists distinct goat populations and vast genetic diversity that could be exploited through judicious planning of selection and breeding strategies for each ecozone for increased goat production in Ethiopia.

However, for effective use of the vast genetic diversity of goats in Ethiopia in any breeding program, comparative productivity data are needed and presently unavailable. There is as such no goat breeding program in Ethiopia. For evolving possible selection and breeding strategies for goat production in Ethiopia, in addition to making available the production parameters on goats, one will have to keep in mind the various agro-climatic and socio-economic aspects along with the production constraints, as they have an important bearing on the overall success of such programs. Agro-climatic zones in Ethiopia are Arid, Semi-Arid, Sub-humid, Humid, and Highland, the determining factors of these zones being climate (rainfall), elevation and presence or absence of diseases. The breeding program for Arid and Semi-Arid zones should identify the most promising breeds/strains/types under the prevailing system of production for genetic selection and their multiplication under improved husbandry practices. Goats of the Sub-Humid zone should be selected for meat production and adaptability traits. In the Humid zone the breeding program should use goats under an integrated farming system along with other livestock and tree/cash crops. In Highlands, the breeding program on goats could be developed both for meat and milk using promising indigenous stock, improving them through selective breeding and also via crossing with exotic and(or) promising tropical breeds.

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