Goat Breeds Utilization and Productivity of Crossbred Goats in Eastern and Southern Ethiopia and Biophysical Model

By

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Abstract

The major objectives of this work were to assess the utilization and management condition of crossbred and indigenous goats and to develop a biophysical model for crossbred goats. A survey was made in three districts (Kombolcha, Gursum and Konso) in Eastern and Southern Ethiopia to assess the utilization of these goats. In addition, a three-year data was obtained from Haramaya University to develop the biophysical model.

Nearly 92% of the respondents prefer crossbred goats to indigenous goats. These respondents prefer crossbred goats due to the physical, productive, and reproductive features of the crossbred goats compared to the indigenous goats. However, in terms of ability to walk long distance, longevity and disease tolerance, local goats were preferred by most of the farmers than the crossbred goats. For milk and meat production crossbred goats were their first choice than local goats.

The most common method of grazing crossbred goats was tethering. About 74% of Kombolcha, 86% of Gursum and 94% of Konso district respondents feed their crossbred goats through tethering. The amount of dry matter (DM) protein supplement was the major factor affecting productivity of crossbred goats. The amount of protein supplement given to the crossbred goats affected longevity, daily milk yield and lactation length. Crossbred had higher milk yield and longer lactation length than indigenous goats but they suffered higher mortality.

In the districts an average of 3.17 family labors was used per flock. Most of the crossbred goat owners practiced controlled breeding. Goats' health care was found to be one of the most important factors that affect the productivity of crossbred goats. Increased investment (expenditure) for medical cases was found to increase the longevity of goats, milk yield and lactation length of the goats. Information generated in this study is believed to guide investment priorities for in goat-keeping families in the country.

Six models developed using a three year data. To develop these models a total of 165 crossbred goats and 257 indigenous (Somali breed) goats included in the study. To fit the models a total of 20,907 daily record of the crossbred goats are used.

- *Weight = -1.17 + 28.723*Feed Intake+ 12.619*Labor intake of each of goat*

The model shown above is used to estimate the performance of crossbred goats in the three districts and can be used to estimate the weight of a crossbred goat if the other variables are known or vice versa.

Key words: *Gursum district, Kombolcha district, Konso district, Haramaya University, crossbred goats, simulation model, indigenous goats*.

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Dedication

God, I thank you so much, you gave me lots of lessons that I could not get from school and lots of friends that helped me through.

I dedicate this thesis to my mother Mestawet Assefa and my sister Yeromnesh Nigussie.

Key to abbrevations

ARADB	Amhara Regional Agricultural Development Bureau
ASARICA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ATARC	Adami Tulu Agricultural Research Center
CSA	Central Statistical Authority - Ethiopia
CIP	International Potato Center
EIAR	Ethiopian Institute of Agricultural Research
EARO	Ethiopian Agricultural Research Organization
FAO	Food and Agricultural Organization of the United Nations
IBC	Institute of Biodiversity Conservation
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
MEDaC	Ministry of Economic Development and Cooperation

1 Introduction

Goats (*Capra hircus*) as a species have a long history of domestication and use for human consumption. Goats were domesticated from the wild version of *Capra aegarus* about 10,000-11,000 years ago, by Neolithic farmers in the Near East (Hirst, 2008). All domestic goats have 60 (30 pairs) chromosomes in each body cell (Will, 2004). Today, there are nearly 500 breeds of goats and 600-700 million of goats in the world (Hirst, 2008) living in climates ranging from high altitude mountains to deserts (Galal, 2005; Bagley, 2006).All domestic goats have 60 (30 pairs) chromosomes in each body cell (Will, 2004). According to CSA (2010), in Ethiopia alone, in the year 2009, there were about 21.96 million goats.

Goats have wide acceptance and recognition worldwide because of their multiple benefits to human. Goats have high reproductive rate (Peacock, 2005), ability to produce milk and meat (Tilahun and Goestseh, 2005). The milk and meat of goat have higher digestibility and therapeutic values (Park, 1998). Goats can inhabit a wide range of climates (Bangley, 2006), and have a huge socio-economic importance (FAO, 1999). For their small body size, goats have physical and bio-physical advantages over large ruminants. In recent years, it is increasingly becoming physically and bio-physically impossible to keep dairy and beef cattle in highly populated highlands of Ethiopia (Peacock, 1997). Dairy goats, therefore, offer alternative to dairy cattle in such areas (Mohamed *et al*., 2002)

The increasing global trends of human population coupled with increasing urbanization trends, demand for livestock products will enormously increase and that such increases will have to be met, offering opportunities and, therefore, potential stimuli to the growth of the livestock sector (Delgado *et al*., 1999). However, in order to benefit from these opportunities developing countries need to adopt more efficient technologies. These technologies include more efficient livestock genotypes, new crop-livestock species mix, and more efficient and sustainable animal health care delivery system (ILRI, 2000). The goat production systems – like all other livestock sector – need a well developed goat

production strategy which bears the current shortcomings of the production system (efficient genotype and improved husbandry).

Livestock development policies in developing countries including Ethiopia mainly focus on importing high yielding exotic breeds and crossing them with indigenous goats, which is considered 'cheap' (Workneh, 2000; IBC, 2004) and short-cut way to improve the local goats. By definition, crossbreeding combines merit traits of two breeds so that the progeny will have better performance than either parent in the area. However, there are also other methods such as selection within breeds and crossbreeding between breeds to improve the productivity of local goats (Banerjee et al., 2000). Crossbreeding should be done after having sufficient (phenotypic and genotypic) knowledge about the parent breeds which are going to be crossed. However, the genetic potential of Ethiopian goats for meat and milk production and resistance to disease or parasites has not yet been quantified (Animut *et al.*, 2000). Furthermore, introduction of a new genotype should consider the demand of the livestock keepers and the prevailing environmental conditions.

There have been some attempts made in Ethiopia to improve the performance of local goats by upgrading the exotic genetic blood levels. One of these attempts was done by FARM Africa through its Dairy Goat Development Project (DGDP). The objective of the DGDP was to promote dairy goat farming in view of improving the socio-economic and nutritional status of poor women and their children through higher yield of milk and faster growth rates (Teffera, 2000). DGDP was first launched in September 1988 in the high- and mid-altitude areas of the country. It operated in Eastern Hararghe and Southern region (now SNNPR) covering a total of 7 districts. The seven districts where DGDP operated were Gursum, Kombolcha, Deder (in eastern Hararghe) and Kindo Koisha, Dallocha, Konso, and Bolosore (in SNNPR). It was functional for 9 years in all the districts until it was phased out in June 1997 (Teffera, 2000).

Following this crossbreeding attempt some studies have been made to assess the benefits of the crossbreeding program. Out of these studies some concluded that crossbred goats don't perform better than indigenous goats if both groups are kept in similar management

levels (Workneh, 2000, Workneh *et al.,* 2001). Opposite to this view, other studies commented that the DGDP was much more helpful for the farmer, particularly by improving the health and nutritional deficiency problems of women and children (Workneh *et al.*, 1999; Zewdu and Peacock, 2000), increase in meat and milk outputs and per capita income of goat owners (Awgichew *et al*., 1988; Wagayehu and Habtemariam, 1994; Kassa *et al*., 1995). Wagayehu and Habtemariam (1994), however, emphasized that the long-term success of a goat improvement strategy based on crossbreeding with exotic breeds remains unproven.

Though the conclusion that crossbreds did not generate higher net benefits than indigenous goats in improved management seems to dominate, still goat crossbreeding is underway which necessitated designing of studies on the need and capacity of the farmers to handle 'upgraded' goats. This study provides a ground for future breeding strategies and studies by setting the characters of goats that are needed by the farmers. Moreover, it has documented the perception of the farmers towards crossbreed (Anglo-Nubian X Hararghe Highland/Konso) and local (Hararghe highland or Konso) goats. The indigenous goat breeds widely found in Konso district are Woyto-Guji which are also known by the names Woyto, Guji, Konso. While, the goat breeds common in Gursum and Kombolcha are Hararghe Highland goats.

The thesis also reports on farmer's choice between crossbreed and local goats. Finally, this work developed a simple simulated model using crossbreed goats in a farm, which allows one to estimate what bio-physical benefit a farmer can generate from these crossbreed goats assuming that s/he knows the amount of some inputs s/he gives to the goats.

2 Literature Review

2.1 Goats of Ethiopia

According to CSA (2010) there are about 21.96 million goats in Ethiopia. In Ethiopia, goats are raised mainly for three purposes: about 3% of adult goats are kept for milk, about 3.36% for meat, about 46.3% for breeding, and the rest are raised for all the above three and other purposes (CSA, 2008).

2.1.1 Goats genetic resources in Ethiopia

Ethiopia has long been recognized as a source of genetic diversity in plants and animals. It served as a gate way of genetic material from Asia to Africa, receiving goats from the north sometime between 2000 and 3000 BC (Mason, 1984). Since then, the goats have spread all over the country and made their differentiation into different types through human and natural selection. In the tropics many breeds have been identified on the bases of physical, morphological and functional characteristics and more than 350 tropical breeds have been named so far (Banerje *et al.*, 2000). Using the above characteristics, goats in Ethiopia are divided into 13 distinct major breeds and four additional sub-types (FARM-Africa, 1996_a).

Workneh (1992) has made emphasis on functional traits in addition to the morphological characteristics and cited 10 indigenous goat types though not established as a reference at the national level. While phenotypic characterization is an essential, initial step in breed identification, little further effort has been made towards an in-depth genetic characterization of indigenous goat breeds (Yosef, 2007). According to the same author, a lack of information on genetic resource may lead to the underutilization, replacement and dilution through crossbreeding of local goat breeds, despite their local adaptation to environmental constraints.

Tesfaye (2004) has classified indigenous goat breeds of Ethiopia using genetic DNA markers into 8 distinct genetic entities. In this study 11 indigenous goat populations/ types of Ethiopia and nine reference breeds (four from other African countries viz. two from Kenya, one from Guinea Bissau and one from Botswana), and five from non-

African countries (one breed from Turkey, Egypt, Italy, Mongoliya and Sudi Arabia each) wear included. Genetic diversity of the goats was assessed by using Microsatellites. In the study, DNA was extracted either from peripheral blood lymphocytes (PBL) or FTA® blood cards (whatman® Bioscience) and 15 microsatellite loci (BM1818, BMS1494, ILSTS05, ILSTS11, IlSTS44, ILSTS87, INRA05, INRA63, NRA132, MAF35, MAF65, MAF209, OarAE129, OarFCB304, and SRCRSP03) were used.

After amplification with PCR on Gene AMP®PCR system 9700 (Applied Biosystem) thermocycler electrophoresis on a 4.25% denaturing polyacrylamide gel using a 377 ABI automatic DNA sequencer (ABI PRISM 377, Applied Biosystems) a number of analysis were performed using allelic variation obtained at 15 microsatellite loci. Allele frequencies at each locus were calculated for each population.

Tesfaye (2004) found that out of the 15 loci, there was no locus that deviated from HWE for all the populations and also no population was observed to deviate from HWE for all the loci. The mean observed hetrozygosity (HO) and Expected heterozygosity (HE) for Ethiopian goats was 0.551+0.015 and 0.576+0.015, respectively, across all loci and all population.

Finally the author concluded that the previous grouping of Ethiopian goat populations into 11 can be regrouped as eight distinct genetic entities: Arsi-Bale, Gumez, Keffa, Woyto-Guji, Abergalle, Afar, Highland goats. Therefore within breed selection should be conducted to improve these eight breeds and lines with different characters should be established to conserve the genetic diversity in the future.

2.1.2 Habitats of goats

The habitats of the indigenous goat breeds in the tropics in general and in Ethiopia in particular extend from the arid lowlands to the humid highlands (Workneh, 1992; Peacock, 2005) covering even the extreme tsetse infested areas of the country (Workneh, 1992).

The goats are mainly kept under smallholder mixed farming system in the highlands and pastoral and agro-pastoral production system in the lowlands (Workneh, 1992). No

commercial scale intensive goat production system has yet been reported (Mengistu, 2007). In the mixed crop-livestock and agro-pastoral farming systems, goat production is based on grazing, sometimes supplemented with crop residues, and the animals are penned at night. In the pastoral system (arid and semi-arid regions), goats are raised often under extreme harsh conditions on marginal rangelands during the day with almost no supplementation and return to thorny enclosure at night (FARM-Africa, 1996_a). In arid and semi-arid regions of Ethiopia, goats are more populated than other livestock (CSA, 2008) and are the most important animals for milk next to camel (Baars, 2000). It was also reported that goats are the most common animals sold by pastoral households for immediate cash income, and slaughtered at home to be consumed by family (FARM-Africa, 1996; Baars, 2000).

According to Solomon *et al.* (2003) Ethiopian sheep and goat production system can be classified into three major and two minor systems. The three major production systems are: highland sheep–barley system, mixed crop–livestock system, pastoral and agro-pastoral production systems. Other two production systems that are not currently practiced widely but have a future are: ranching and urban and peri-urban (landless) sheep and goat production systems. According to the same author both highland and arid and semi-arid ranching can be undertaken in Ethiopia while urban and peri-urban sheep and goat production systems in Ethiopia are practiced within and at the periphery of cities (Solomon *et al.*, 2003).

2.2 Uses of goats

In Ethiopia, the agricultural sector accounts for about 44.1% of the total gross domestic product (GDP) of the year 2007/08 while the livestock sub-sector accounts for about 11.8% of the GDP and about 26.5% of the agricultural GDP (MoFED, 2009). Livestock related exports accounts for ~15% of the total export revenue of the country, third in importance after coffee and khat (*Catha edulis*) (MEDaC, 2000). At the national level, sheep and goats account for about 90% of the live animal and meat export and 92% of skin and hide export trade value (Andrew, 2003). It has been demonstrated that goat meat accounts for ~26% of Ethiopia's total red meat consumption per capita (ILCA, 1991).

In many tropical countries, goats make a valuable contribution to the poor in rural areas. This is mainly due to their efficiency in terms of meat and milk production (Tilahun and Goestseh, 2005), low cost of maintenance, a great adaptive feature to the harsh environment (Silanikonve, 2000) and their inherent sustainability for small-scale production (Silankonve, 2000; Peacock, 2005; Degen, 2007).

Goats also have socio-economic importance in developing countries like Ethiopia. Goat production helps to meet local meat demands, keeps foreign currency from being spent on importing meat and increase hard currency reserves through exports of goat meat and skins (FAO, 1999). Goat production provides employment for rural families, especially for women and children (Lebbie, 2004). They can be sold to attain immediate cash assets for poor goat holders, helping them to improve livestock and crop farming and financing social events (Workneh, 2000; Morand-Fehr *et al.*, 2004). Especially during droughts when crops fail, goats, due to their adaptation capabilities, coupled with their high reproduction rate and short generation interval, goats enable their owners to recover quickly and economically (Lebbie, 2004; Peacock, 2005). The value of goats for the use of the vast areas of natural grasslands, regions where crop production is yet impracticable, should not be overlooked (Lebbie, 2004).

Goats have ecological benefits and allow efficient utilization of natural resources. They are complementary to other species with regard to forage resources consumed and the height at which the forage is found (Table 1). A mixture of species on semi-arid rangelands, for example, make it possible to reduce the stocking rate of 26 hectares per tropical livestock unit (a TLU is equivalent to 250 kilograms live body weight) for cattle alone to 13 hectares per TLU when cattle and goats are reared together and to 10 hectares per TLU when camels are included (Schwartz, 1983).

Table 1. Contribution of different fodder sources (percent) to the diet of domestic herbivores in Kenya

Species	*Field layer*	*Dwarf shrubs*	*Browse layer*
Camels	3	56	34
Cattle	96	4	0
Goats	38	21	18
Sheep	58	25	2
Donkeys	71	22	0

Source: Schwartz & Said (1986).

Though goats have a lot of benefits and capacity to live in diversified climate, they are not widely distributed throughout. Salco and Abul (2007) found that the high socio-economic and cultural status accorded to cattle by livestock farmers makes the livestock industry to be continuously monopolized by beef production. Little attention given to goat is also another factor for inefficient use of the animals (Animut *et al.,* 2000; Aschalew *et al.*, 2000). The absence of commercial goat farm in the country (Mengistu, 2007) could also simply show how much this animal is underutilized.

2.3 Genetic improvement of goats

The basic unit of inheritance is called a gene which is located at same site in the chromosome. All domestic goats have 60 (30 pairs) chromosomes in each body cell (Will, 2004). The methods used to make genetic modification to local goats are selection within breeds and crossbreeding between breeds (Banerjee et al., 2000). In reverse to selection and crossbreeding, inbreeding (breeding between relatives) has a negative impact on the genetic improvement of goats. A breed is a group of similar animals within a species. In the context of developing regions, the term breed has been defined as any recognizable interbreeding populations, groups or regional stocks in a livestock species (www.biology-online.org).

2.3.1 Crossbreding

Crossbreeding is the act or process of producing offspring by mating purebred individuals of different breeds, varieties or species. Crossbreeding is usually done with the intent of producing offspring that share the traits of both parent lineages, especially if the traits are beneficial. However, an irresponsible crossbreeding can also produce animals of inferior quality or weaken purebred gene pool (www.biology-online.org). When new offspring (zygotes) are formed by the joining of a male gamete and a female gamete, they have the normal number of genes and chromosomes for that species. Half the chromosomes will be contributed by the sire and half from the gamete contributed by the dam. Determination of which sperm will join with which egg, is a random process. Nearly all gametes have an equal chance of contributing to a zygote. There is a significant amount of randomness in what goes on with meat and milk goat, and other livestock, inheritance. It is also vitally important to the success of artificial selection. Nonetheless it does create problems for breeding improved goats because it reduces our ability to control the outcomes of matings (Will, 2004).

The two general categories of gene action (expression of genes in a phenotype) are additive and non-additive. Non-additive gene action is the expression of most simply-inherited traits — those that are easily observed. Additive or independent gene action generally occurs when traits are influenced by many pairs of genes (polygenic) and each gene has small but additive effects that accumulate. Years of breeding research has indicated that most of the performance traits of economic importance are governed by additive gene action (Dabholkar, 1992).

Simply-inherited traits are affected by only a few genes. Only a single locus or at most, a few loci are involved in their expression. They tend to be categorical in nature and affected very little by environmental factors. While, polygenic traits are affected by many genes, and no single gene is thought to have an overriding influence. Examples include growth rate, feed efficiency, and ribeye area of the carcass. Phenotypes for polygenic traits are usually described by numbers, and are quantitative or continuous in their expression rather than categorical, and are clearly affected by environmental factors to

varying degrees. Be aware that there can be some crossover between the secondary characteristics of simply-inherited and polygenic traits. Size is an example wherein mature size is clearly polygenic but some dwarf body types are simply-inherited and controlled by a major gene as well (Dabholkar, 1992).

2.3.2 Selection

The other means of genetic improvement is through selection. From a population genetics standpoint, the effect of selection is to increase the gene frequency of favorable alleles. As a result, offspring in the next generation should have, on average, better sets of genes than the current generation.

2.3.3 Inbreeding

Inbreeding is generally undesirable for the improvement of many traits because of the effects of homozygosity in allowing the expression of undesirable genes, resulting in inbreeding depression. This is usually greatest for characters associated with natural fitness such as viability and reproductive ability (Nicholas 1987). A general conclusion is that inbreeding should be avoided.

2.4 Conservation of genetic resources

In developing countries, animal genetic resources (AnGR) are being eroded through rapid transformation of agricultural systems. One of the major causes to the loss of indigenous breeds of farm AnGR is indiscriminate use of exotic genetic resources. According to FAO (1999), about 30% of the world's farm animal breeds are subjected to the risk of extinction. In Ethiopia, local communities still remain custodian of the diversified farm AnGR and the indigenous knowledge associated with it.

Conservation of local breeds of farm AnGR is part of animal husbandry and should, ideally, be based on complete information on distribution, structures, trends, productive and adaptive performances of populations of the existing breeds (Solomon, *et al.*, 2008). Although much information is lacking, conservation of farm AnGR in the Ethiopian perspective should be viewed from the rational utilization and protection of existing genotypes from genetic erosion (IBC, 2004). Unfortunately, no conservation activities of

farm AnGR have so far been practiced in the country, except for limited activities that are meant to maintain pure stocks of three cattle and one sheep breeds. Breeds of farm AnGR so maintained are Borena cattle breed at Did Tuyura Ranch, Horro cattle breed at Horro Ranch, Fogera cattle breed at Metekel Ranch and Adet Agricultural Research Centre, and Menz sheep breed at Amed Guya Research Centre (IBC, 2004).

A number of organizations attempted to evaluate performances of some farm AnGR at different times. Attempts by the former Ministry of Agriculture (MoA) in 1975 were one of the few pioneering efforts made to classify the indigenous sheep, goat and cattle breeds into specific groups (IBC, 2004). Based on the tail form and quality of the hair, 20 sheep breeds were classified into four broad categories as Hairy Thin Tailed, Woolen Thin Tailed, Fat Tailed and Fat Rumped. Goats were classified into five major groups as Nubian, Highland, Afar, Somali and Long Tailed goat Gishe (IBC, 2004).

The other nationwide baseline survey was conducted on goats by FARM Africa in collaboration with the former MoA and the then Alemaya University of Agriculture (Ruda, 1993; Workneh *et al.*, 1994; Alemayehu, 1994).

The Oromia Agricultural Research Institute (Bako and Adami Tulu) is currently undertaking phenotypic characterization on sheep and goats. The Amhara Region Agricultural Research Institute (ARARI) has undertaken phenotypic characterization of sheep breeds of the region in 2001 (ARADB, 2001). Similarly, Tigray Regional Agricultural and Natural Resources Development Bureau (1997) conducted a survey on livestock breeds of the region in 1997. The Oromia Agricultural Development Bureau in collaboration with ILRI (ILRI, 2004) also conducted a comprehensive survey on livestock breeds of the region. However, these classification attempts were done through phenotypic characteristics of the animal and only limited activities on genetic characterization have been conducted on some breeds of cattle, goats and chicken (IBC, 2004).

Characterization of nine goat breeds, namely: Afar, Western Highland, Hararghe Highland, Western Lowland, Anglo-Nubian, Toggenberg breeds, crosses of Anglo-

Nubian with Somali, Hararghe Highland and Toggenberg with Hararghe Highland have been conducted by Addisu (2002) using blood protein polymorphism. Tesfaye (2004) classified Ethiopian goats into 8 distinct genetic entities using 15 microsatellite DNA markers.

There is little quantified information as to the impact of livestock interventions on the diversity of indigenous farm AnGR. The extent to which the exotic genotypes have diffused into the indigenous populations and the level of dilution is not objectively assessed. In the absence of a clearly defined breeding policy, crossbreeding is bound to cause genetic erosion resulting in loss of adaptation and loss of probably unique genetic identities of indigenous AnGR (IBC, 2004).

2.5 Goats productivity improvement attempts in Ethiopia

Goat production had received little attention for many years (Animut *et al.,* 2000) though Ethiopian Institute of Agricultural Research (EIAR) established a research program in small ruminants in 1970 with the objective of studying management practices associated with breed evaluation and improvement programs. The goat research program was started at Holetta and Melka-Werer Research Centers (EARO, 2000). However, goat research has been largely neglected in the country. This is because research programs on highland goats at Holetta and the Adal goat at Werer were discontinued shortly after the start. A full-fledged goat research program representing the semi-arid mixed farming systems has been established in 1992 at the Adami Tulu Research Center (Aschalew *et al*., 2000). However, Adami Tulu Research Center alone was unable to satisfy the requirements of goat research for semi-arid areas of the country.

Goat production gained attention following the launching of Dairy Goat Development Program (DGDP) in September 1988 by FARM Africa (Teffera, 2000). DGDP was initiated by FARM Africa in collaboration with the MoA, former Alamaya University of agriculture and Awassa College of Agriculture (ACA) and several international and local NGOs. The objectives were to identify and characterize the indigenous goats, to describe the traditional goat husbandry practices in different production systems, and to develop

and test methods for the rapid survey of livestock and means of productivity improvement (Teffera, 2000).

Recently, the Ethiopian Sheep and Goat Productivity Improvement Program (ESGPIP) which was established with a Cooperative Agreement between the Prairie View A & M Research Foundation (PVAMRF) and USAID/Ethiopia is working on goats. The overall objective of the program is to sustainable increase the productivity of small ruminants in Ethiopia to improve food and economic securities (Teffera, 2008).

2.6 Comparison of indigenous and crossbred goats

Safari (2005) made a study on growth performance of small East African (SEA) goats and crosses between Norwegian x SEA goats at village level in Tanzania and found that crossbreed goats were superior in body weight gain. The author concluded that exotic breeds with higher growth potential can be used to upgrade performance of the indigenous SEA goats with due consideration given to their long term effect. Similarly, positive effects of crossbreeding on growth rates were also reported from China using Boer goats (Nimbkar *et al*., 2000; Jiabi *et al*., 2004) and India using Alpine and Toggenburg goats (Nimbkar *et al*., 1996).

Lebbie, (1993) compared indigenous and crossbred [Saanen x Indigenous] goats for milk production in Malawi and found that indigenous does produce an average of 32.5±20.1 liters in 144±50 days while crossbreds averaged 42.9±27.1 liters in 172±103 days. In the same study, on a daily basis, indigenous does averaged 226±94 ml while crossbred averaged 252±60 ml. The authors concluded that, with only minor modifications to traditional practice, it is possible to produce usable amounts of milk from both indigenous and crossbred Malawi goats; secondly, the removing of this milk did not have adverse effects on the doe, either in terms of bodyweight or of reproductive performance, but with adverse effect on kid mortality; and under subsistence-farming conditions, crossbreds do not offer significant advantage over indigenous stock.

A study from Ethiopia by Galal *et al*. (1982) on crossbreeding indicated that a substantial increase in milk production has been demonstrated at the 50% level of crossbreeding

between Saanen and Ethiopian highland goats. In harsher areas, however, there have been adaptation problems for first crosses of Saanen x lowland goats, indicating that a lower level of exotic genotype might be more suitable. Taking this recommendation a study was conducted in Melka Werer Research Center comparing the productivity of indigenous purebred Adal and quarter-bred Saanen (Awgichew *et al.*, 1988). Awgichew *et al*. (1988) evaluated the productivity of indigenous Adal goats and generated data for estimating genetic parameters for the breed. The Adal goat is a slow maturing breed with relatively low productivity. Females attain mature body weight of 33 kg at 3 to 4 years of age. Maximum milk production of Adal goat was about 25 kg from a 12-week lactation period, and the breed exhibited a maximum twinning rate of 40% until their third kidding. Reproductive rates were depressed when they were mated at less than 12-months intervals. According to the same author, there were no differences between purebred Adal and quarter-bred Saanen does in any of the reproductive traits recorded. Crossbred does produced more milk than purebred does. Breed had no effect on birth weight; however, crossbred progenies were heavier than purebred Adal goats at 3 months and 6 months. At 12 months there were no differences in weight between breeds. There were no differences in mortality between purebred and crossbred kids (Awgichew *et al*., 1988). There was no significant breed **x** year interactions in any production parameters which indicates that the superior productivity of crossbred does was maintained in the "poorer" as well as the "better" environmental years of the comparison. Milk production was increased by some 30% without loss of reproductive capacity, increased mortality, or increased mature body size which would necessitate an increase in feed resources for herd maintenance. It was concluded by the same author that, for the nomadic pastoralists around Melka Werer the quarter-bred Saanen x Adal doe has much to offer.

Highland goats seem to produce more kids per kidding than the Afar due to a higher twinning rate of about 50%. Average milk production by the indigenous highland goats from a 12-week lactation was only 19 kg and this was increased to 52 kg in half-bred Saanen does, with a slight reduction in reproductive rates and a marginal increase in the growth potential of crossbreds (Awgichew *et al*., 1988; Aschalew *et al*., 2000).

Similarly, a comparison made between Somali and Anglo-Nubian goats (FARM Africa, 1996) managed uniformly at Alemaya University showed that milk production for the first 6 weeks of lactation (41 kg or 0.97 kg/day vs. 125.3 kg or 2.98 kg/day) and litter size were higher for Anglo-Nubian.

During the implementation of the DGDP, the analysis of the project results showed that milk and meat outputs were increased in crossbred goats (Nubian x local), leading to an average increase in gross per capita income of 19% for the beneficiaries (Wagayehu and Habtemariam, 1994). Wagayehu and Habtemariam (1994) noted, however, that the long-term success of a goat improvement strategy based on crossbreeding with exotic breeds remains unproven. In similar study but with different approach and after the completion of the Project, Workneh (2003) found different result. Workneh (2003) applied a broad economic evaluation model and considered all possible benefits of goats (marketable and non-marketable values) and stated that the use of marketable values of goats as a sole base for comparison between different breeds cannot sufficiently represent the true benefit that the farmer obtain in subsistence goat farming. The same author found that crossbred goats (Nubian x local) did not perform better than indigenous goats on comparisons based on land, metabolic weight and labor inputs.

Generally, indigenous goats of Ethiopia are commonly slaughtered at around yearling age when their body weights are 15 to 20 kg. Because of their relatively low growth potential, increased meat production from the indigenous breeds so far evaluated is expected to come from increased numbers of animals rather than from increased growth rates (Zinash, 1999). Genetic progress in milk production and body weight gain from indigenous goats could be achieved through designing a sustainable within breed selection program as the traits are moderately heritable. The quick fix short cut solution through crossbreeding may be a recipe for failure given the host of examples available throughout the developing world from the fact that such attempt may endanger the adapted animal genetic resources in the face of climate change.

2.7 Simulation models and analysis

Simulation is a technique for using computer to imitate the operations of various kinds of real world facilities or processes. The facilities or processes of interest are called a system. In order to study the system we need assumptions which usually take a form of mathematical or logical relationships constitute a model, which is used to try and gain understanding as to how the corresponding system behaves. If the relationship which composes the model is simple enough it may be possible to use mathematical methods (such as algebra, calculus, or probability) to obtain exact information on question of interest, this is called an analytic solution. However, most real world systems are too complex to allow realistic models to be evaluated analytically and these models must be studied by means of simulation (León-Velarde *et al*., 2006).

2.7.1 Models versus real situations

In general model is simple representation of reality. A model is said valid (suitable) by coopering trends of simulated and real world responses than isolated statistical tests (Leon-Velardo and Quiroz, 2001).

2.7.2 Importance of modeling

Modeler, of any kind, frequently states that simulation modeling is vitally important to address key issues in social and economic systems, where controlled experimentation would either prohibitively costly or downright impossible. To modelers researchers who define 'research' as including only controlled experimentation are somewhat like the person who has lost his keys at night but is only looking for them in area illuminated by the street lamp because that is where the best light is (Nicholson, 2007). The point is that our conception of which methods are most appropriate often lead to a broader perception about which questions are most relevant, interesting, and worthy of funding (Nicholson, 2007).

A related issue is the type of research in which simulation modeling is often used. According to Nicholson (2007), much research involving simulation models falls into the subject matter category (i.e. it provides policy makers, decision-makers, and managers with concept and knowledge with which to make decisions about general sets of

problems that must address) or into the problem-solving category (i.e. it addresses a particular decision process for a specific decision-maker). Mayer (2002) noted that the development of formal models is often justified because they can be used for manipulations and experiments which would be impractical, too expensive, too lengthy or impossible (in real world social and economic systems).

3 Objectives of the study

3.1 General objectives

- To assess the utilization and management condition of crossbred goats in the study areas.
- To develop a biophysical model for crossbred goats.

3.1.1 Specific objectives

- To study the performance of crossbred goats under on-station and on-farm conditions.
- To document the current uses of crossbred goats provided as compared to the local goats in the study sites.
- To look into possible alternative management schemes for crossbred goats.
- To assess the utilization and breeding objectives of different goat breeds in the study sites
- To find out which goat breed (local or crossbreed goats) a farmer choose and the reasons why.
- To develop a simple biophysical model and to use it to compare the productivity of crossbred goats in the three districts.

4 Materials and Methods

4.1 Study districts

The study was conducted in three districts and at Haramaya University. In this study three districts out of the seven DGDP functional districts were selected because they had the largest number of beneficiaries during the implementation period. These districts are Kombolcha and Gursum in Eastern Haraghe, Oromia Region and Konso in SNNP Region. Haramaya University was used as a source of data for biophysical model preparation as it has accumulated a lot of data during its service as a breeding place before distribution to these districts.

4.1.1 Location and topography of the study sites

The study locations are shown in Figure 1. Gursum and Kombolcha districts and Haramaya University are located in eastern Ethiopia while Konso district is located in the southern Ethiopia. Gursum is located in the Eastern Hararghe region of Oromia Regional State ' 60" N latitude, 42° 23' 60" E longitude (www.google.earth.com). The Gursum district is 78% plain, 14% mountain and 8% plateau with an altitude range between 1,500 and 2,400 m.a.s.l (Gursum District Agricultural Office, 2008). Komblocha has an altitude range of 1800 – 2400 m.a.s.l. (Kombolcha District Agricultural Office, 2008). The Special District of Konso has 600m – 2100 m altitude (Konso District Agricultural Office, 2008). Konso is located at 5° 17' 36" N latitude and 37° 29' 05" E longitude (www.google.earth.com). Haramaya University is situated at 9° 26' N, 42° 03' E with an elevation of 1980 m.a.s.l (www.google.earth.com). The University had served as a crossbreeding station from 1989 to 1997 where indigenous and exotic breeds were crossbred and distributed to farmers at age of sexual maturity (Teffera, 2000).

Figure 1. Geographical Information for Kombolcha, Gursum and Konso districts and Haramaya University. (Arrows 1, 2 , 3 & 4 representing Haramaya University and Kombolcha, Gursum and Konso districts respectively).

4.1.2 Demography

Oromia region and its zone, Eastern Hararghe, has an estimated total population of 27,158,471 and 2,739,390 respectively. Gursum and Kombolcha have a total population of about 154,853 and 140,769, respectively (CSA, 2008). SNNPR has about 15,042,531 total population and the special District in SNNPR, Konso, is estimated to have a population of 234,987 (CSA, 2008). Both, Eastern Hararghe Zone and SNNPR are well known for their densely populated lands and small farm size per individual farmers (CSA, 2008). In Oromia region there are about 22,453,335 cattle, 9,098,255 sheep and 7,439,725 goats. Eastern Hararghe Zone takes about 5.5%, 3.5%, 16.8% share of the cattle, sheep and goat population of Oromiya region respectively (CSA, 2009). The role of goats in providing the highly demanded goat milk is widely recognized, especially by the poor farming households (CSA, 2010).

The SNNPR has an estimated 10,543,129 heads of cattle 4,935,092 heads of sheep and 4,057,497 goats representing 20.5%, 18.8% and 17.6% of the nation, respectively (CSA, 2010). In Konso district there are about 140,257 cattle, 135,244 sheep and 205,337 goats (CSA, 2009).

Table 2. Description of the study districts

Characteristic	*Districts*		
	Kombolcha	Gursum	Konso
Altitude range (m above sea level)	1200-2460	1200-2950	600 – 2100
Arable land (%)	16.8	15.7	64.29**
Pasture (%)	1.7	8.9	19.29**
Forest (%)	3.9	13.2	0.71**
Remaining land (residences, degraded, unusable) (%)	77.6	62.2	15.71**
Population*	140,769	182253	234,987
Area cover (square kilometers)	441.1	876.57	2,276.25
Population density (people per sq. km)	263	241.4	98.49
Cash crops	Khat, fruits and vegetables	Coffee, khat	Cotton and Coffee

Sources: Wikipedia, the free encyclopedia; * CSA 2008; ** Konso District Agricultural Office, 2008

4.1.3 Climate

According to information from Gursum District Agricultural Office (2008), Gursum has three agro-ecological zones: 14% highland, 36% semi-arid and 50% arid. The annual rainfall in Gursum ranges from 600 to 750mm and the daily temperature ranged from 18°C to 25°C. Likewise, according to information from Kombolcha and Konso District Agricultural offices (2008), Kombolcha has an annual rainfall ranging from 600 to 900mm which is almost similar to that of Konso which ranged from 550 to 850mm. The agro-ecological zones of Kombolcha are semi-arid (74%) and arid (26%) while Konso has 30% dry semi-arid and 70% arid. Konso has an average daily temperature of 28°C. Haramaya University shares similar climate to that of Gursum and Kombolcha except that it is much cooler and receives more rain. During the years 1991 to 1993 Haramaya University obtained an average annual rainfall of 728.3mm and mean daily temperature of 17.2°C (NMA, 2008).

4.1.4 Soil

According to information from Kombolcha and Konso District Agricultural offices (2008) the major soil type in Kombolcha (particularly in Billisuma Peasant Association) is black soil (50%), sandy and clay soils have equal values (25% each); Konso district has 40% sandy soil, 35% clay soil, 15% black soil and 10% other soil types. The major soil type in Gursum is sandy (Gursum District Agricultural Office, 2008). The predominant soil at Haramaya University is alluvial vertisol (Tamire, 1982).

4.1.5 Agriculture

Sorghum, maize, vegetables, coffee, and khat are the major crops produced in the two districts of Eastern Hararghe. According to information from Gursum District Agricultural Office (2008), the districts has a total livestock population of 205,952 and goat account 26% (53,864) of the whole livestock number.

Konso produces sorghum, maize, ‘teff’, wheat, barley, finger millet, haricot bean in their order of area cultivated while maize is the staple crop. The Konso people are intensive agriculturists who subsist primarily on millet and maize, which is grown primarily on an exceptionally intensive agriculture involving irrigation and terracing of mountain slopes (http://www.forafricanart.com). To protect the fields, the Konso people maintain their cattle

in stalls and feed them by hand. They use both the milk and the meat of cattle and the meat of sheep and goats as food, and the animals' dung for fertilizer.

4.2 Sampling Methods

4.2.1 Sampling crossbreed goat owners (field survey)

Three Districts were purposefully selected to assess the utilization and management condition of crossbreed goats kept in the hands of farmers. Two districts were taken from the eastern Ethiopia FARM Africa project while one district was from the project areas in southern Ethiopia. The three areas were selected as they had the largest number of beneficiaries during the implementation period of DGDP (September 1988 – June 1997). At the end of 1996, the three districts constituted 61.3% of the total households (269) who receive crossbred goats (FARM Africa, 1996).

After obtaining a list of 250 farmers who had received the crossbred goats, 180 representative farmers were selected. A list of farmers (name and Kebele) was then prepared with the help of Kombolcha, Gursum, and Konso District Agricultural and Rural Development Bureaus, farmers, Development Agents (DAs), community animal health workers and paravets. The criteria set to include farmers into the study were only two: a farmer has to live in the study area and should have at least one crossbred goat during the interview period, which is confirmed by asking the farmer himself and/or observing the goat physically. Since crossbred goats were the limiting breeds of goat due attention is given for the criteria that the farmer to be interviewed should have crossbred goat. However, most of the farmers had at least one or two goats.

The actual blood level of the crosses is not known, only few farmers know the blood level of their goats. Generally, the exotic blood level of the crossbred goats in the areas was less than or equal to 50%.

4.2.2 Sampling for the Biophysical Model

A biophysical simulation model was developed using the data obtained from the Haramaya University.

Data collected since 1980 by the attendants of the goat farm in the University were available. For the purpose of this study, however, three years (1991, 1992, and 1993) data were used for the maximum number of crossbred goats were registered and recorded during this period. During these three years, a total of 167 crossbred goats, 13 purebred Anglo-Nubian goats and 246 local goats were living and these were considered in the analysis.

4.3 Data analysis of the field survey

A survey was conducted using a semi-structured questionnaire (Appendix part (8.2)). The data obtained from the questionnaire were analyzed using Chi-square test, correlation, and linear regression. Average of each inputs and outputs at flock and/or individual goat level was estimated. Chi-square test was employed for comparing indigenous and crossbred goats in terms of purposes of keeping, utilization and livestock inventory. Correlation and linear regression was used to study the correlation and its magnitude between inputs and outputs in the crossbred goat production system. The software used for the analysis was SPSS14 and Microsoft Excel.

4.4 Developing the biophysical model

The biophysical model was developed using a regression model. The analysis was made at individual goat level. To simplify the processes of the analysis, a conceptual framework was developed. After showing the conceptual frame of the goat farming system variety of methods are used to find out the inputs and outputs in the farm which is discussed here after.

4.4.1 Conceptual framework

The purpose of conceptual framework was to make things clear and understandable and to give insight how the system works. In this conceptual model (Table 3) the goats were divided into age and sex groups with due emphasis to the differences in inputs they received and outputs they produce. It is assumed that each age and sex group has its own input and output.

Table 3. The conceptual layout of the bio-physical inputs and outputs in Haramaya University's goat farm

Age group	*Sex groups*	*Inputs*	*Outputs*
Kids that feed on milk only (< 1 month of age)	Male	Feed (milk), labor, medical	Growth, manure
	Female	Feed (milk), labor, medical	Growth, manure
Kids that start eating roughage (1 – 3 months of age)	Male	Feed (milk, forage), labor, medical cares	Growth, manure
	Female	Feed (milk, forage), labor, medical cares	Growth, manure
Kids from weaning to yearling (3 – 12 months of age)	Male	Feed, labor, medical	Growth, manure
	Female	Feed, labor, medical	Growth, pregnancy, manure
Mature goats (> 12 months of age)	Male	Feed, labor, medical	Growth, breeding, manure
	Female	Feed, labor, medical	Growth, pregnancy, birth, milk, manure

In the above outputs, pregnancy, birth and breeding were not considered in this study since the goats were not kept for breeding, and were distributed to the farmers at age of sexual maturity before giving birth. Therefore, there was no information about pregnancy and birth rates of the crossbred goats. Other outputs (manure and meat) were studied with the major inputs (feed, labor, and health care), however. Both inputs and outputs were quantified at individual goat level.

4.4.1.1 Inputs

The major inputs in goat production system are feed, labor and medical treatments. Other additional costs which should not be ignored especially when making economic simulation model include buck service cost, housing, house repairing, electricity, missionary and other costs.

4.4.1.1.1 Labor input

Labor input in the farm was determined by counting the number of employees and their working time in the farm. There were five flock attendants, four guards, one health

technicians, one storekeeper, and five field forage workers. The employees worked 8 hours per day and five days per week.

In this analysis, workers employed for some weeks during the years to accomplish seasonal works like harvesting and storing the forage are not considered. This is done to avoid season-wise over estimation of labor input. Though the work is done in the harvest season, it has no relationship with the performance of the goats in the same season. Drivers were excluded in the analysis as they were not serving the farm only, and have little to do with the goat production. This was done to avoid overestimation of the daily labor input in the farm.

Labor input was estimated on an individual goat bases. To estimate the labor intake of individual goat, monthly labor input in the farm was divided by the average number of goats in that month, which gives the monthly labor intake of each goat.

Workneh (2000) used either weight or number, as needed, of goats as a base to fractionate the total labor each goat receive. But in this study only number of goats can be used satisfactorily. The reasons are described below.

The main labor requirements in the farm were attending the flock in the field, guarding the barn, de-warming, vaccination, hoof trimming, dipping/spraying, feeding, cleaning the barn, and watering. Except the last three, the other labor requirements depend mainly on the number of goats than on their weight. However, feeding and watering goats and cleaning the barn mainly depend on the total weight of the flock as per the recommendation by Workneh (2000).

Feeding goats in this farm was not a routine. It is done in cases when a goat can't graze or need supplementation (especially lactating goats). Goats are watered from tap water by filling a watering trough tank. So labor requirements for both feeding and watering could be well estimated as a function of number of goats than body weight. Though, the only labor demand, cleaning the barn mainly depend on the total weight of the flock than the number; we took the number of goats as a factor. This is because as it is only one of the total labor requirements, considering it independently from other labor demanding sections incurs a lot of complication.

4.4.1.1.2 Medical inputs

Inputs for medical care were obtained from health records of individual goats. Medical care in the farm include de-warming, vaccination, weighing, dipping, hoof trimming, and treating sick animals. We can group the above medical care into two, preventive actions and treatments. Using linear regression, we related the preventive measures with the occurrence of diseases. We also considered disease occurrences over time (per year).

4.4.1.1.3 Feed intake

Like all other livestock production systems, in goat production too, feeds are the major input. There were two major feeding systems in Haramaya University's Farm. The first is a group of goats receiving supplementary feed and the other group receives no supplementation. Goats which received supplementation were lactating goats, pure exotic serving bucks and some weak weaning kids. The rest of the flock was entirely fed on grazing pasture, a pasture which is grass legume mixture. The major species in the pasture were *Chloris gayana*, *Setaria sphacelata*, *Desmodium intortum* (Green Leaf), *Desmodium uncinatum* (Silver Leaf). The goats graze the pasture continuously. Note that both crossbred and indigenous (Somali) goats grazed together during the day.

4.4.1.2 Outputs

Goats have a lot of outputs: meat, manure, milk, skin, prestige, financing, insurance, social importance, etc (Workneh, 2000). These benefits could be classified into three main categories. These could be marketable or non-marketable physical, socio-economic and socio-cultural benefits (Workneh, 2000). In this study, physical products such as meat, milk and manure were considered as the study tried to develop a bio-physical model.

4.4.2 Predicting feed intake of goats in the pasture land

To estimate voluntary feed intake of goats on a pasture many approaches could be used. Generally, three effects are considered in many works (e.g., Arnold *et al*., 1977; Christian *et al*., 1978; Sibbald *et al*., 1979; CIP, 2006; Leon-Velarde and Quiroz, 2001) to estimate the feed intake. The first is the animal effect, in particular the animal size. The second is the

forage availability and the third, the effect of forage quality. However, certain of these factors may not appear in some works. The equation of ARC (1980), for example, does not involve availability of forage in a pasture since they are derived from fitting a wide range of data on *ad lib* intake. Bosman (1996) also consider *ad lib* intake but used a different approach; he used only the animal factor.

McKinney (1972) based on his experiments with ewes over three years, developed satisfactory equation by considering availability of forage as the only explicative variable. The only model considering physiological hypothesis controlling intake of sheep is developed by Forbes (1995)

The model of Arnold *et al*. (1977), Christian *et al*. (1978), Sibbald *et al*. (1979), CIP (2006) and Leon-Velarde and Quiroz (2001) take all the three factors into consideration. They separately consider animal and plant factors influencing feed intake of grazing animal.

In this study we stick to the approaches attempted by the above authors (Arnold *et al*., 1977; Christian *et al*., 1978; Sibbald *et al*., 1979; CIP, 2006; Leon-Velarde and Quiroz, 2001)due to the fact that, the area (Haramaya University Campus – Eastern Hararghae) is known by its erratic rainfall and great seasonal variation in both availability and quality of forages. According to CIP (2006) voluntary intake of forage under grazing is a function of potential dry matter intake of the animal and availability and digestibility factors of the forage.

4.4.2.1 Potential dry matter intake (PDMI) – animal factor

The potential dry matter intake is determined by the physical characters and productivity of the animal. Physically; potential dry matter intake is affected mainly by the rumen size, which is in turn a function of the animal size. It is derived from daily feed requirement of goats (Table 4) according to Ensminger (2002). Productivity of goats also affects the potential dry matter intake (Table 5 & 6).

Table 4. Dry matter requirement of goats

Body weight (kg) of the goat	*Dry matter intake per animal*	
	(2 mcal ME/Kg)[1] % BW	(2.4 mcal ME/Kg)[2] % BW
10	3.6	3.0
20	3.0	2.5
30	2.7	2.2
40	2.5	2.1
50	2.4	2.0
60	2.3	1.9

1 = good quality roughages furnish about 2mcal ME/Kg dry matter
2 = roughage concentrate mixed rations are sometimes necessary to increase the energy content of the diet to 2.5 or 3.0 mcal ME/Kg of dry matter.

NB: mcal= mega calori; ME= metabolizable energy; Kg= kilogram

Source: Ensminger (2002)

Table 5. Additional feed requirements for all goat sizes

Pregy[1]	***Weight gain 50g/day***	***Weight gain 100g/day***	***Weight gain 150g/day***
0.71 kg	0.18 kg	0.36 kg	0.54 kg

1 = additional feed requirements for pregnancy (all goat sizes) for the last 60 days.

Source: Ensminger (2002).

Table 6. Additional nutrient requirements (total digestible nutrient- TDN) for milk production per pound at different fat percentages

Fat % of the milk	***TDN (Kg) of the feed***	***Fat % of the milk***	***TDN (Kg) of the feed***
2.5	0.151	4.5	0.159
3.0	0.153	5.0	0.161
3.5	0.155	5.5	0.163
4.0	0.157	6.0	0.166

Source: Ensminger (2002)

4.4.2.2 Pasture effect on the intake of the animal

Forage availability and digestibility directly affect the potential dry matter intake of grazing animals (CIP, 2006). Their quantification in model is reviewed bellow.

4.4.2.2.1 Availability Factor

$FCD = 1-e^{(-0.001664*DD)}$

Where,

FCD = intake correction factor due to availability (0-1)

DD = Instantaneous availability of pasture (Kg MS ha^{-1})

-0.001664 = coefficient value for temperate pasture that can vary for other pasture types.

Source: Abreu (1975)

4.4.2.2.2 Digestibility Factor

The digestibility correction factor considers a linear relationship, in which the maximum value of voluntary intake is achieved with forage digestibility of 80% and it diminishes as up to 1/3 of potential intake with 40% digestibility (CIP 2006).

FCG = (1.675*DGC)-0.34

Where,

FCG = Correction factor due to digestibility (0-1)

DGC = Digestibility of consumed DM (0-1)

4.4.2.2.3 Digestibility of consumed dry matter (DGC)

The model calculates a selectivity index that modifies the average digestibility of the pasture being grazed to estimate the digestibility of the consumed DM. The digestibility of the selected DM can be up to 25% higher than the average forage digestibility (CIP 2006).

DGC = DGO*IS

Where,

DGC = Digestibility of the consumed pasture (0-1)

DGO = Digestibility of the offered pasture (0-1)

IS = Selectivity index (1-1.25)

Digestibility of the feed stuffs available in literature (Gohl, 1981) was used to estimate the digestibility of forages offered.

4.4.2.2.4 Pasture Selectivity Index (IS)

The estimated selectivity index takes into account the difference between the average digestibility of the pasture offered (DGO) and the digestibility of the forage consumed (DGC) caused by the opportunity of the animal to select for the diversity and availability of pasture (CIP, 2006).

IS = 1+SD*SC

Where,

SD = correction factor due to pasture digestibility

SC = correction factor due to pasture availability

4.4.2.2.5 Correction factor for selectivity due to forage digestibility

When the digestibility of a pasture offered (DGO) is equal or greater than 80%, the selection is null, regardless of the availability of forage. A value of DGO equal to 40% is associated with a value of selectivity equivalent to 25%.

SD = 0.5-(0.625*DGO)

Where

SD = correction factor due to pasture digestibility (0 when DGO > 80%)

DGO = Digestibility of the pasture offered (0-1)

4.4.2.2.6 Correction factor for selectivity due to forage availability (SC)

The maximum selectivity of a pasture by the animal occurs when the pasture utilization factor is smaller than 10% and is at minimum (zero) when the pasture utilization is greater than 50%.

SC=1.25-(2.5*PU)

Where,

SC = correction factor due to pasture availability

PU = Percentage of pasture utilization (0.1 – 0.5)

4.4.2.2.7 Percentage of Pasture Utilization (PU)

PU = (PDMI*FCD*N)/DD

Where,

PU = Percentage of pasture utilization (0-1)

PDMI = Potential DM intake

FCD = Intake correction factor for availability (0-1)

N = Number of animals (stocking rate)

DD = Instantaneous pasture availability.

4.4.2.2.8 Instantaneous pasture availability (DD)

The instantaneous pasture availability is corrected by considering potential intake, the loss attributed to animal trampling, and the senescence of green material (CIP, 2006).

To estimate herbage senescence, the correction is applied when forage availability ranges between 1500 and 3000 Kg DM/ha. When availability is lower, senescence takes a fixed value of 2% of available herbage, and at greater levels of availability it represents 5% of the dry matter. According to Bircham, (1981) availability increases the level of dead plant material.

SEN = (0.00003*DDi) – 0.025

DD = [DDi – (CA*1.2 – (DDi*SEN))] + TA

Where,

SEN = Senescence index

DDi = Instantaneous forage availability day i, (Kg DM/ha/day)

CA = Stacking rate (AU/ha)

TA = Growth rate of the pasture (kg DM/ha/day)

4.4.2.2.9 Growth rate of a pasture

Growth rate of the pasture was estimated using Leon-velarda (1991) model. In his model the most important factors - rainfall, temperature, and soil nutrients, which influence growth rate of plants are considered.

Forage growth rate (FGR) = FGRo*FFA*RF*FT*FF

Where,

FGRo = measured growth rate.

FFA = factor of forage availability

RF = rainfall factor

FT = factor by temperature

FF = factor of fertility; use the minimum from FN, FP and Fpot

Factor forage availability (FFA) = -0.175 + 0.0009*FAi – 0.0000002*FA2

Rainfall factor = 0.132 + 0.02*R -0.00007*R2

Factor by temperature = -0.44 + 0.09*T – 0.01*T2

Factor by nitrogen (FN) = 0.0035*N

Factor by phosphorus (FP) = 0.0002 + 0.021*P

Factor by potassium (Fpot) = 0.003*K

FGRo is determined from two points in time forage availability data collected in June and August 1990.

This method is advantageous over the others in that:

i. It includes major environmental factors which influence growth rate of plants.
ii. It also considers genetic factor by incorporating at least one measured growth rate into the formula.

4.4.2.3 Voluntary intake of forage under grazing

The predicted voluntary intake (CVO) is based on several factors that directly affect the potential dry matter intake (White *et al*., 1979).

CVO = PDMI*FCG*FCD

Where,

CVO = voluntary dry matter intake (Kg DM animal/day)

PDMI = Potential dry matter intake (Kg DM animal/day)

FCG = Correction factor due to forage digestibility (0-1)

FCD = Correction factor due to forage availability (0-1)

4.4.3 Intake of milk and concentrate

In this part we considered un-weaned kids and goats supplemented with concentrate feeds. Un-weaned kids may take milk. Adults and doe may take concentrate besides the forages grazed. The difficulty of estimating intake of forage while supplemented or take milk is simplified by the models of Graham *et al*. (1976), Edelsten & Newton (1977) and White *et al*. (1983) (Table 7).

All these authors assumed that milk or concentrates are consumed up to the limit of availability. Therefore, the amount of forage consumed is the same as potential intake of the goat minus the milk or concentrate consumed.

Table 7. Intake of forage of un-weaned goats and supplemented adult goats

	Model	***Sources***
Intake of un-weaned kids	INT – INTML	Edelsten & Newton (1977)
Intake of concentrate*	INT – R*CONC	White *et al*. (1983)

* R = 1, a fixed coefficient of intake of concentrate. According to Edelsten & Newton (1977) R = 0.54

Where,

INT= potential intake

INTMIL = intake of milk

CONC = concentrate offered

4.4.4 Feed intake of goats bellow one month age

By default, kids bellow one-month of age are assumed to consume milk only. The amount of milk suckled by these goats is estimated using a mathematical model showed bellow FARM-africa (1996_b).

Milk yield (kg) = (weight of kids at 6 weeks – birth weight) * 1.2/0.13

4.4.5 Estimate of outputs of the farm

There are a lot of outputs that goats could offer, like meat, manure, milk, skin, prestige, financing, insurance, social importance, etc… Workneh, (2000) grouped the above benefits into three: physical, socio-economic and socio-cultural benefits. According to the same

author physical outputs include milk, meat and manure. These physical outputs are the main concern of this paper as the model developed will be a biophysical model.

4.4.5.1 Meat production

Meat production is estimated from the amount of body weight gains or losses. Amount of weight gained or lost is estimated from the growth rate of individual goats. Monthly weight record of individual goat was used to find the growth rate of each goat.

4.4.5.2 Milk production

The amount of milk produced by a doe is the sum of milk consumed by kids and milk off take by owners. However, since the does in the flock were not milked, the total amount of milk produced by doe was the same as the amount of milk suckled by kids. A model used by FARM-africa (1996_b) is used to estimate a total milk production of goat in 6 weeks.

Milk yield (kg) = (weight of kids at 6 weeks – birth weight) * 1.2/0.13

Here, we assumed that the milk production of the doe calculated for 6 weeks remains constant and the same for other 6 weeks (until weaning of the kids). The bases for the assumption are:

i. No any milk measures made in the lactation time to get a better milk intake estimate.

ii. This model estimates milk intake logically, i.e. it takes rate of weight gain as a factor when milk is a sole feed of the kid.

4.4.5.3 Fecal output

Fecal DM is the total quantities of all feeds consumed by each animal group multiplied by the fraction of indigestible nutrients (1 - TDN) of each feed. The TDN values are reduced 4% for the low production group and 8% for the medium and high production groups to account for the reductions in digestibility under multiple increases of intake over maintenance intake (Fox *et al*., 2004).

5 Results and Discussion

5.1 Preference between different livestock types

In this study it was found that 49.7% of the respondents preferred small animals (40.4%, 5.0%, 4.3% of respondents preferred goat, sheep and chicken respectively) to cattle. Perhaps still cattle have been preferred by farmers, as can be seen from the number of respondents who prefer cattle but this is quite different when seen in individual district bases. In Gursum, 84.9% of the respondents chose cattle as their primary choice than other livestock types. Gursum farmers have more interest ($p<0.01$) towards cattle than smaller ruminants (goat) as compared to the other two districts. A reverse result was found in Kombolcha and Konso. In Kombolcha, 67.44% of the respondents preferred small animals than cattle as their first chice. Goats get the highest preference by the farmers than all other animals (55.77% of the respondents). Similar to Kombolcha, in Konso districts goats have more preference (50.77% of the respondents) to cattle (33.85% of the respondents) and sheep (10.77% of the respondents) (Apendex - table 1).

5.2 Preference and purpose for keeping different breeds of goats

After looking at the preferred type of livestock in the districts the next step would be to get which breed of goat interested the farmers. It was found that 91.6% of the respondents prefer crossbred goats as their first choice to local goats. The reasons for the choice of crossbred goats were also assessed (Table 8). The respondents highly appreciated ($p<0.01$) their physical, productive and reproductive features including horn type, behavior, milk production, quality of meat, growth rate and fertility of crossbred goats to local goats. This showed that the farmers liked most of the features of crossbred goats compared to their local goats. Compared to indigenous goats, some characteristics of crossbreds were not liked by farmers, however. Features such as ability to walk long distance, longevity and disease tolerance were significantly ($p<0.01$) greater for indigenous goats than crossbred goats indicating that the adaptive features of indigenous goats were better than to even low-grade exotic blood. The exotic blood level of crossbred goats in Kombolcha and Gursum was

estimated to range from 0.6 to 50% (Workneh, 2000) while such information about blood level of crossbred goats in Konso was unavailable.

Table 8 Response of the farmers comparing the Physical, productive, behavioral and reproductive aspects of indigenous and crossbred goats

Characteristic	Breed	Number of respondents	Mean	Std. Error	Sig.
Size of the goat	indigenous	93	4.20	0.06	0.00
	crossbred	192	4.94	0.02	
Color of the goat	indigenous	94	4.56	0.06	0.00
	crossbred	192	4.94	0.02	
Horn of the goat	indigenous	94	4.40	0.07	0.00
	crossbred	192	4.89	0.02	
Heat tolerance	indigenous	94	4.67	0.07	0.07
	crossbred	192	4.51	0.05	
Cold tolerance	indigenous	94	4.41	0.06	0.09
	crossbred	192	4.26	0.06	
Behavior of the goat	indigenous	93	4.25	0.08	0.00
	crossbred	192	4.88	0.03	
Amount of milk the goat give	indigenous	93	3.86	0.08	0.00
	crossbred	190	4.94	0.03	
Quality of the meat	indigenous	93	4.40	0.08	0.00
	crossbred	192	4.91	0.02	
Growth rate of the goat	indigenous	94	3.90	0.07	0.00
	crossbred	192	4.96	0.02	
Ability to walk long distance	indigenous	94	4.69	0.07	0.00
	crossbred	192	3.88	0.06	
Fertility of the goat	indigenous	94	4.39	0.07	0.00
	crossbred	192	4.88	0.03	
Longevity of the goat	indigenous	94	4.67	0.06	0.00
	crossbred	192	4.14	0.05	
Disease tolerance of the goat	indigenous	94	4.53	0.07	0.00
	crossbred	192	3.84	0.05	
Drought tolerance to the goat	indigenous	93	4.58	0.07	0.06
	crossbred	192	4.40	0.06	

Local goats were appreciated by farmers due to their adaptive behavior. It was necessary to see if there was any difference in purposes for which each breed of goat was reared. It was found that there was no significant ($p > 0.05$) difference between indigenous and crossbred goats for the purpose they are kept including for meat, manure, blood consumption, skin,

prestige, and ceremonial services. However, there was significant ($p<0.01$) difference between indigenous and crossbred goats in purposes such as, milk production, use as a saving and income sources. All the above three uses were significantly higher for crossbred goats than indigenous goats. Meaning the crossbred goats were serving as a milking animal, as a saving and income source better than indigenous goats. It was surprising that crossbred goats were serving as a saving more than the indigenous goats, which is not in agreement with what was reported by Workneh (2000).

Figure 2. Goats of same age and management (owned by same farmer) but different size due to difference in breed. The animal on the left is a crossbred (Nubian X Konso) while on the right is local Konso breed.

5.3 Inputs in the goat farms

5.3.1 Feeds

One of the most important inputs in goat farming is feed. Grazing, crop residues, industrial byproducts, and tree legumes in cut and carry system were the major sources of feed in the areas. Grazing was very rare in the areas and the most common methods of grazing goats in the areas were tethering followed by herded and tethering mixed. About 74% of Kombolcha and 86% of Gursum and 94% of Konso districts crossbred goat owners feed their goats by way of tethering. The use of communal grazing land to feed their goats was not common in the districts. Particularly in Konso no respondent grazed his animals in communal grazing land. Similarly, Workneh (2000), Kassa (2000) and FARM Africa (2006) reported that communal grazing is rare in these areas.

Regarding crop residues, different crop residues were used in the districts. The most important crop residues in Kombolcha were sorghum and maize residues, kaht leftover and left-over of vegetable were used in their order of importance. Similar pattern was found in Konso except that there was no Kaht leftover. In Gursum, maize, Kaht leftover, pea and sweet potato were the most important crop residues used to feed the goats. All these crop residues were fed equally to both indigenous and crossbred goats (90.5% of respondents feed crossbred and indigenous goats together).

In this study, an attempt was made to estimate the amount of feed given to the whole flock (Table 9). It was found that in Kombolcha and Gursum districts there was no significant ($p<0.01$) difference with respect to total amount of feed and supplementary energy and protein feed given per TLU. However, in Konso district both total amount of feed and supplementary energy fed per TLU are smaller ($p<0.01$) than for Kombolcha and Gursum.

Table 9. Estimate of dry matter intake per TLU*/day

Supplementary feeds	*Districts*	*Number of respondents*	*Mean amount of feed (DMKg/ TLU/day)*	*Std. Error*
Supplementary energy feed	Kombolcha	47	1.17	0.17
	Gursum	80	0.97	0.11
	Konso	65	0.39	0.07
	Total	192	0.82	0.07
Supplementary protein feed	Kombolcha	47	0.12	0.09
	Gursum	80	0.07	0.06
	Konso	65	0.18	0.06
	Total	192	0.12	0.04
Total feed	Kombolcha	47	2.60	0.22
	Gursum	80	2.44	0.15
	Konso	65	1.09	0.11
	Total	192	2.02	0.10

*1 TLU (Tropical Livestock Unit) = 250 kg tropical cow; a head of cattle = 0.7TLU; a sheep or goat = 0.1TLU; donkey = 0.5TLU (Jahnke, 1982).

The total amount of feed offered to crossbred goats was found to influence their performance. However, protein supplementary feeds (leguminous feeds) take the leading role in influencing the productivity of crossbred goats (Fig. 3).

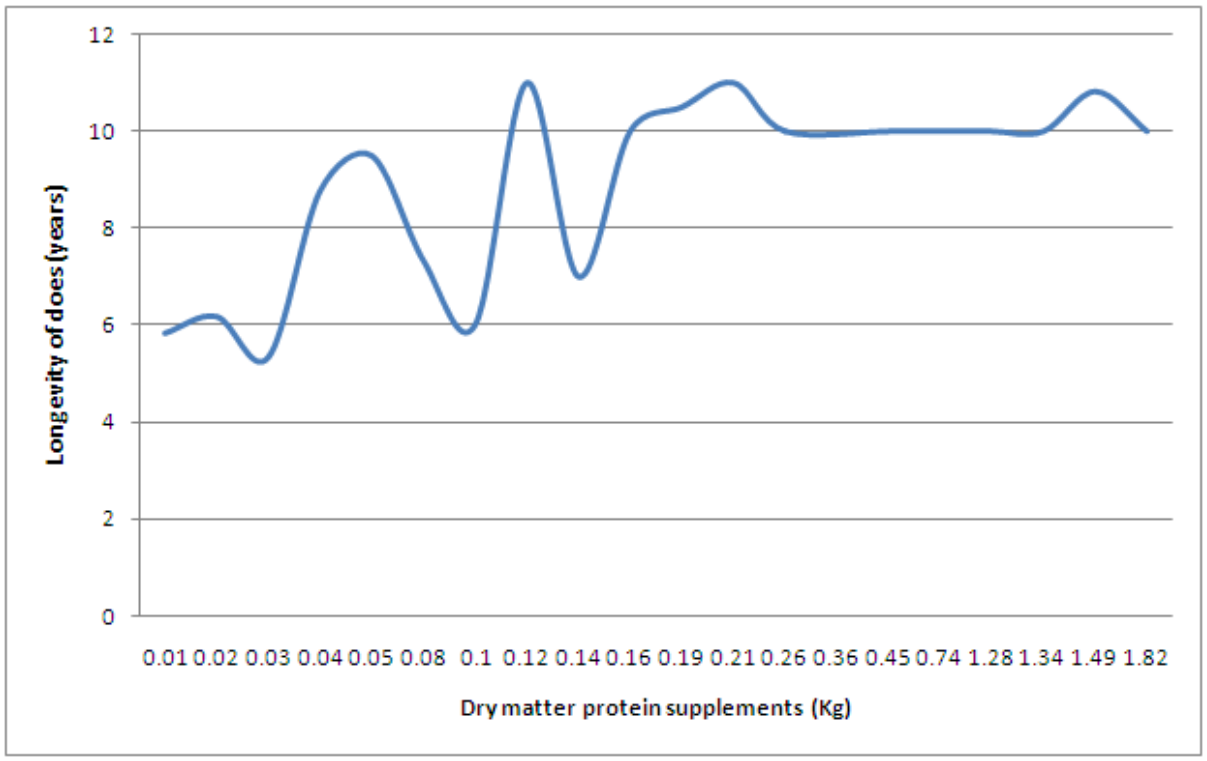

Figure 3. Protein supplementary feeds (leguminous feeds) influencing longevity of crossbred goats.

5.3.2 Labor

In all the study areas, only family labor was used in goat farming and no laborer was hired for the farming. Generally, goat farming consumes an average of 3.17 individuals per flock (Table 10). The average number of family members participated in goat farming was significantly ($p<0.01$) higher in Konso than Kombolcha and Gursum may be due to higher number of mean family size in Konso. However, there was no significant ($p<0.05$) difference among Kombolcha and Gursum districts in labor spent per goat flock. Workneh (2000) also reported that about 3-4 children in the family participated in the goat production in Kombolcha and Gursum.

Table 10. Number of family member participate in goat farming

Districts	*Number of families*	*Mean number of family members*	*Std. Error*
Kombolcha	44	2.14	0.17
Gursum	57	2.21	0.11
Konso	65	4.72 [a]	0.27

[a]: significantly different at p<0.01

5.3.3 Medical cares

The other major input in the goat farming was medical treatments. An average of 29.26 and 57.26 Birr spent per year for medical cares of indigenous and crossbred goats, respectively. Between districts, significant (p<0.01) difference was observed in amount of money spent for medical cares. Farmers of Gursum spent more (p<0.01) for medical cares of both indigenous and crossbred goats than farmers in Kombolcha and Konso districts. Likewise, farmers in Kombolcha district spent significantly (p<0.05) higher amount of money than in Konso district for both breeds. This could be due to better medical facilities in Gursume than the other districts. Between breed comparison showed that significantly (p<0.01) higher amount of money was spent for medical cares of crossbred goats than indigenous goats (Table 11).

Table 11. Amount of money spent for medical cares of local and crossbred goats per year in the three districts

Type of breeds	*Location*	*No of flock*	*Mean money (Birr)*	*Std. Error*
Indigenous goats	Kombolcha	19	23.95 [a]	7.57
	Gursum	30	74.84 [a]	7.34
	Konso	54	5.82 [a]	1.83
	Total	103	29.27 [a]	4.01
Crossbred goats	Kombolcha	38	35.66 [a]	6.58
	Gursum	63	116.35 [a]	7.85
	Konso	65	12.61 [a]	4.79
	Total	166	57.26 [a]	5.28

[a]: significantly different at p<0.01

Medical care was one of the inputs, which was highly uneven between the districts. The results obtained showed that medical care was one of the pillars in the productivity of crossbred goats. Figure 4 shows the influence of medical care on longevity of females. Longevity of females was an important factor, since it had a direct impact on total number of births and total milk yield that a doe can give before it dies or culled from the flock. Figure 5 shows how much medical care influences life-time milk yield of a doe.

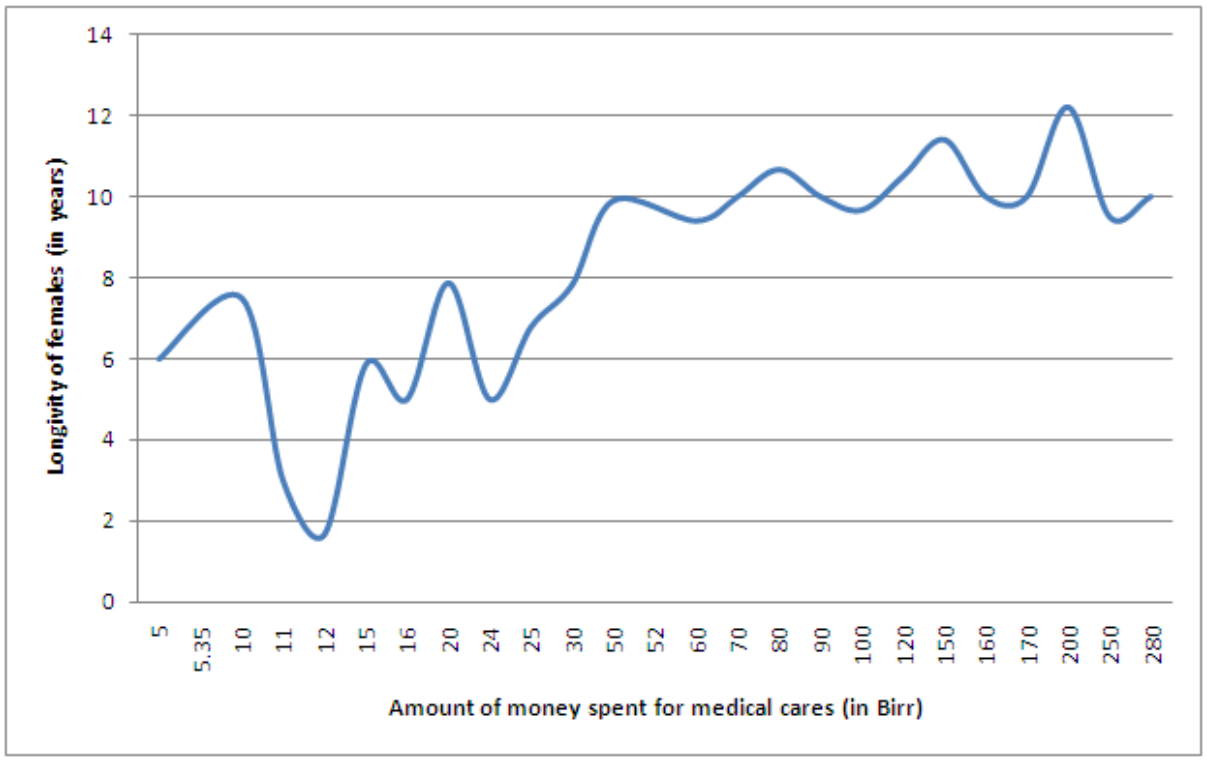

Figure 4. Average money spent for medical cares vs. longevity of females (in years)

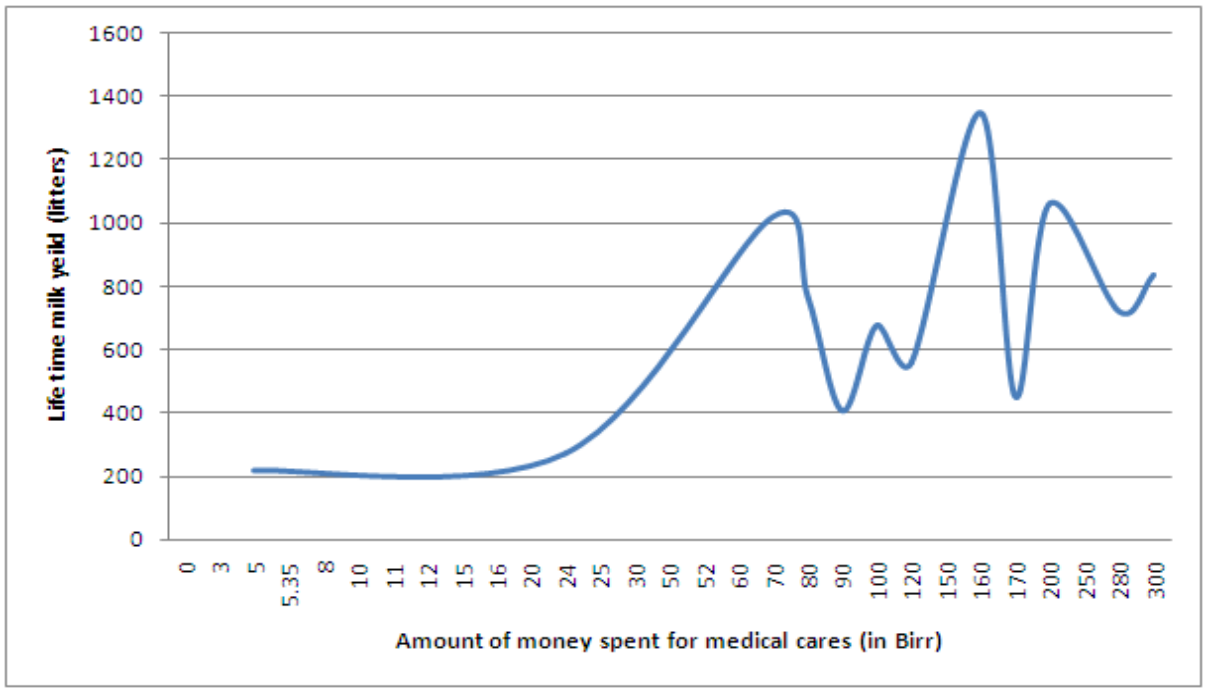

Figure 5. Average money spent for medical cares vs. average life-time milk yield (in litters)

5.3.4 Breeding

The most common type of breeding in the three districts was controlled breeding. In Kombolcha 80% of crossbred goat owners practice control breeding obtaining crossbred buck mainly from their own flock which was kept for meat production (64.29%). Similarly in Konso district about 98.36% of respondents practice control breeding getting bucks mainly through borrowing (79.66%). In Gursum most of the farmers ($p<0.01$) get buck service by paying to the buck owners in-kind, usually a Kilogram of maize for each service (Table 12).

Table 12. Source of breeding buck

Source of crossbred buck	*Districts*		
	Kombolcha	Gursum	Konso
Own buck just for service (%)	17.0	15.0	15.4
Own buck for meat production (%)	57.4	3.8	1.5
Borrowed (%)	6.4	10.0	72.3
Paying for serving buck (%)	8.5	58.0	1.5
Other sources/no responded (%)	10.7	13.2	9.2
Total (%)	100.0	100.0	100.0

Controlled breeding is being highly practiced by the crossbreed owners in all the three districts mainly because of their interest to the crossbred goats (91.6% of respondents prefer crossbred than indigenous) and skills they obtain during DGDP (Teffera, 2000).

5.4 Outputs of goats

5.4.1 Milk yield

Anglo-Nubian goat, which is a common dual-purpose goat, has high milk yield. The progenies of the crossbreds also had higher milk yield from heterosis effect and additive gene action. Hetrosis is the occurrence of higher performance in the offspring than the average of the parents. Therefore hetrosis is effective in crossbreeding because it will decrease the effect of inbreeding depression while additive gene action is the most important factor as milk yield is a quantitative trait. Crossbred does had significantly ($p<0.001$) higher average daily milk yield and lactation length and higher ($p<0.05$) average life-time milk yield than local does (Table 13). The performance of crossbred goats was not similar in all districts, however. Crossbred goats in Kombolcha had significantly ($p<0.001$) higher average daily milk yield followed by Gursum and Konso. Average lactation length was significantly ($p<0.001$) higher in Gursum than in the two districts. There was no significant difference ($p>0.05$) in average lactation length between Kombolcha and Konso (Table 14).

Several authors (Galal *et al*., 1982; Awgichew *et al*., 1988; Wegayehu and Habtemariam, 1994; Workneh, 2000; Aschalew *et al*., 2000; Lebbie, 1993; Workneh, 2003) have found that crossbred of Nubian, Saanen, Toggenberg, with local breeds like Adal, Hararghe, Somali and Small East African goats produce more milk than the local goats with improved lactation length.

Galal *et al*. (1982) found that milk yield increased by 50% in Saanen crossbred but the crossbreds were less adaptive to the areas than local breeds (Adal). Similarly, Lebbie, (1993) in Malawi also concluded that crossbred (Saanen x indigenous) do not offer significant advantage than local goats under subsistence farming conditions. Similarly, Workneh (2000) reached the same conclusion. Awgichew *et al.* (1988), however, reported about 30% increase in milk productivity from quarter-breed Saanen without loss of reproductive capacity,

increased mortality, or increased mature body size than the pure Adal goats. Similarly, Aschalew *et al*. (2000) found about 33 kg increase in milk yield in 12-week lactation with only slight reduction in reproductive rates and a marginal increase in the growth potential of crossbred goats. This study also found that crossbreds have significantly ($p<0.001$) higher daily milk yield than the locals. Higher mortality of crossbreds was noted compared to local breeds, however.

Table 13. Average daily milk yield (litters) and lactation length of local and crossbred goats

	Districts	*Number of respondents*	*Mean*	*Std. Error*
Daily milk yield (in litters)	Indigenous	51	0.38	0.06
	Crossbred	148	0.56[a]	0.08
	Overall	199	0.52	0.06
Lactation length (in months)	Indigenous	48	3.07	0.13
	Crossbred	141	4.20 [a]	0.14
	Overall	189	3.91	0.11

[a] : significantly different at $p<0.01$

Table 14. Average daily milk yield (in litters) and lactation length of crossbred goats in different districts

	Districts	*Number of flocks*	*Mean*	*Std. Error*
Milk yield (in litters)[a]	Kombolcha	45	0.82 [a]	0.17
	Gursum	78	0.51 [a]	0.06
	Konso	25	0.29 [a]	0.11
Lactation length (in months)	Kombolcha	44	3.41	0.15
	Gursum	75	4.91 [a]	0.20
	Konso	22	3.34	0.27

[a] : significantly different at $p<0.01$

Table 15. Milk yield (in litters) of crossbred and indigenous does in all their life time

	Number of respondents	*Mean milk yield (in litters)*	*95% Confidence Interval*	
			Lower Bound	Upper Bound
Indigenous	48	670.0	1890.11	2579.50
Crossbred	134	969.30 [a]	2798.24	3663.80

[a]: significantly different at $p<0.05$

Though crossbred goats give higher milk, in one of the three districts goats are not reared for their milk. In Kombolcha about 92%, Gursum 99% and Konso 42% of the respondents milked their goats. In Kombolcha 23% of the respondents and 4% in Gursum sell goat milk while none of the respondents in Konso sell goat milk. Therefore, milk is both source of income and protein for the families of Kombolcha and Gursum. However, in Konso district it is still a taboo to sell milk or adults to drink goat milk. Goats are milked in Konso only if there is a child in the family (personal interview).

The two factors which were found to be most important in milk production were feed intake and medical care (figures 6&7). From the total amount of feed intake, protein supplements (leguminous trees) were more important.

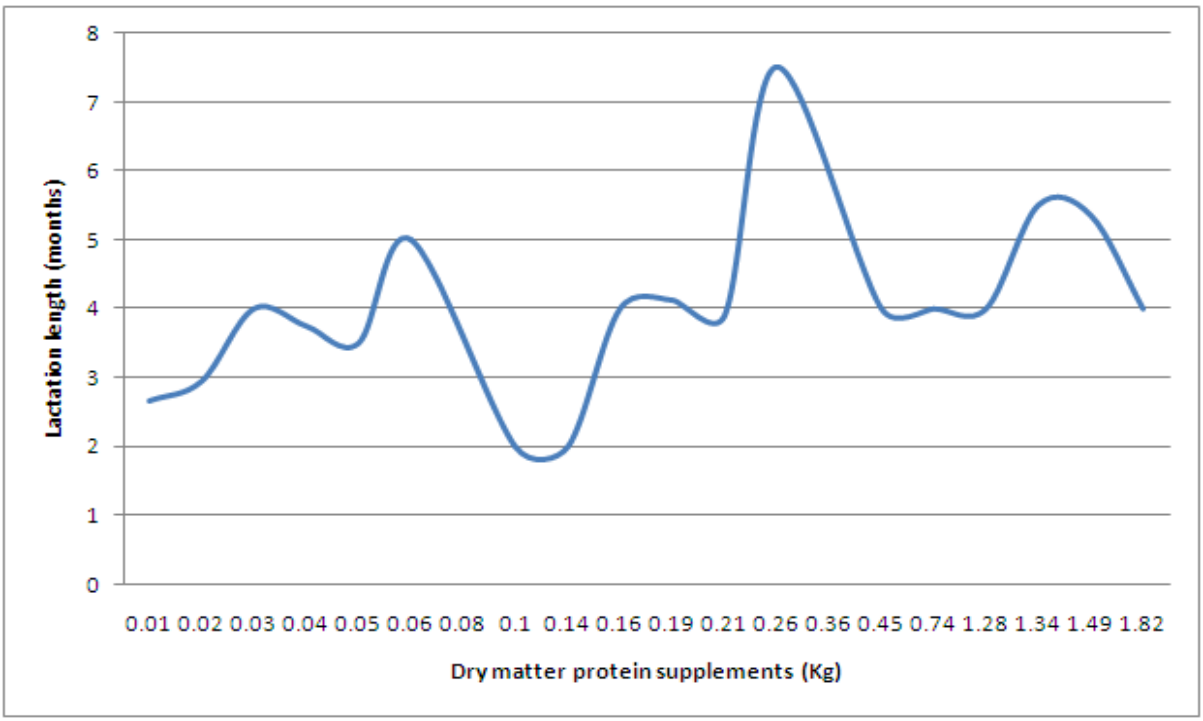

Figure 6. Influence of protein supplementation (leguminous feeds) on lactation length

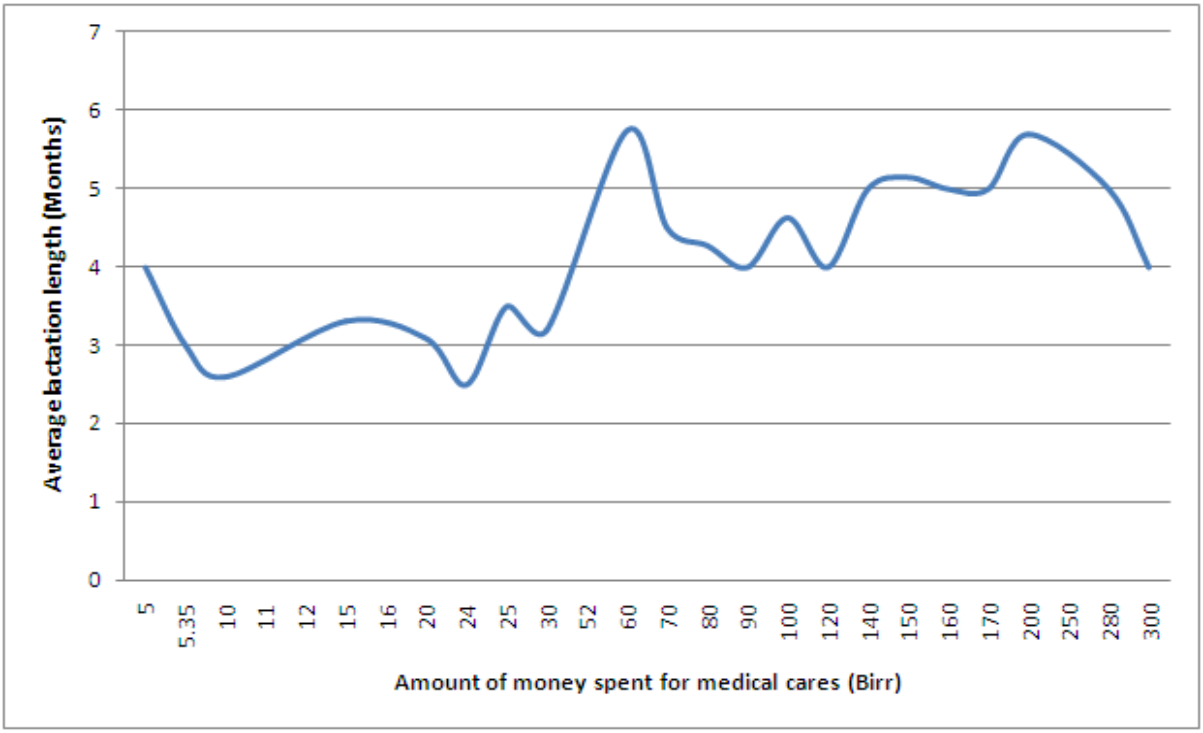

Figure 7. Average amount of money spent for medical cases vs. lactation length

The amount of money spent for medical cares per goat per year has notable influence when it was between Birr 30 and 200 (figure 7). It had little influence if the money spent was bellow 30 Birr and above 200 Birr. This could be due to the fact that; though one has made better medical care the other factors like feed may hinder further increase in lactation length. Also, the lower value (30 Birr) of medical care illustrate that medical care should be well practiced to make crossbred goats productive. The graph showed high increase in amount of money spent for medical cases of crossbred goats without additional benefits from the goats. Therefore, Economic scale should be advised to farmers so that the marginal benefit is reached without excess use of scarce resources and money.

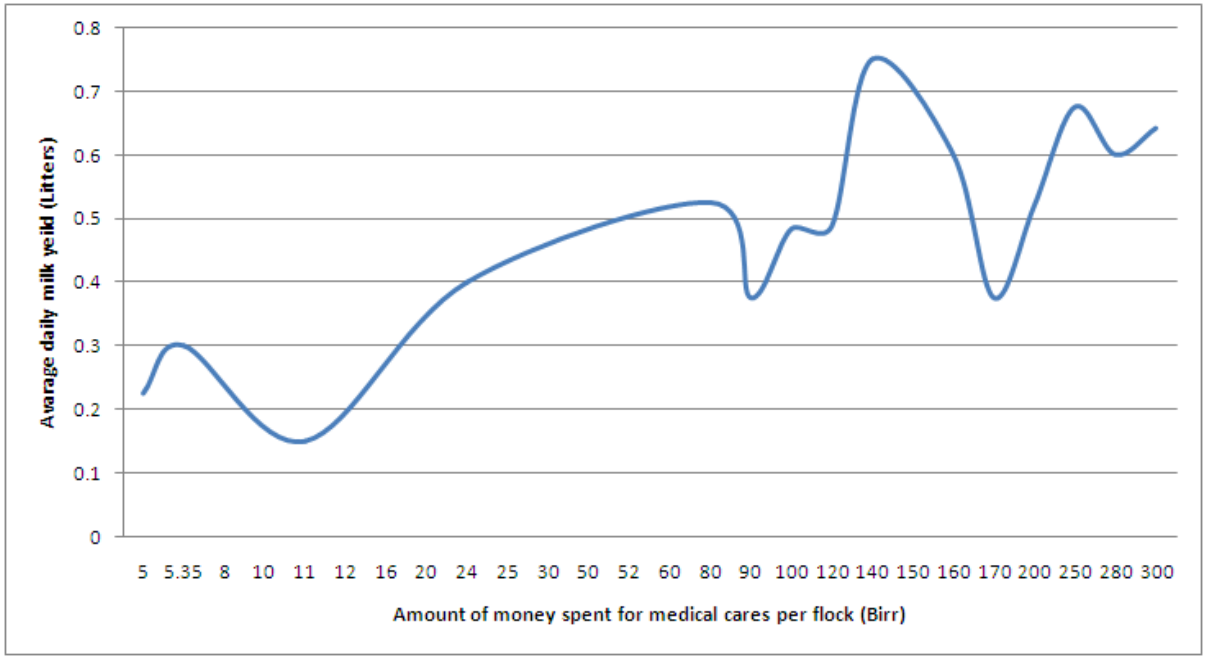

Figure 8. Average amount of money spent for medical cares per year per crossbred goat (Birr) vs. daily milk yield (litters)

Bellow a regression model was built to see which types of input is much more importantly influence lactation length (Table 16).

Table 16. Regression coefficient of lactation length of crossbred goats

Model		*Unstandardized Coefficients*		*Standardized Coefficients*	*t*	*Sig.*
		B	*Std. Error*	*Beta*		
1	*(Constant)*	*3.93*	*.32*		*12.28*	*.00*
	labor per goat	*-.44*	*.32*	*-.128*	*-1.39*	*.17*
	medical care cost per goat	*.00*	*.00*	*.197*	*2.11*	*.04*
	DM protein given per TLU	*.97*	*.32*	*.277*	*3.02*	*.00*

Lactation length = 4.152 + -0.504 (labor spent per goat) + 0.005 (medical care cost per goat) + 0.97 (DM protein feeds given per TLU)

Lactation length was found to be significantly ($p<0.05$) influenced by dry matter protein intake and medical care costs. In the regression model labor spent per goat did not significantly influenced lactation length. Also, labor spent per goat was inversely proportional to lactation length. This result was found may be due to a highest labor input in Konso while the lactation length of the goats was the shortest out of the whole study districts. However, in reality, the increase in labor can't result in decrease in lactation length. Therefore, the model is just an indication of the situation exists in the three study sites and may not be a representative for other cases of goat production. This shows that to develop models which can be universally applicable for all goat production systems large sample and wider study area is important.

5.4.2 Longevity and number of birth in life of doe

Remarkable result was obtained in studying the number of years goats spent in the farm and amount of kids obtained per doe before death (Table 17). It is better to be reminded that for female goats longevity of the goats was asked while for male goats finding longevity was difficult, as they are mostly sold before death. Therefore, for male goats, the number of years a goat stayed in a farm and longevity for female goats was included in the survey questionnaire. Crossbred does live significantly ($p<0.01$) longer in Gursum than in Kombolcha followed by Konso. In the contrary, number of years male goats stayed in a farm was higher in Konso than Gursum ($p<0.01$) and Kombolcha ($p<0.05$). Compared to the other

two districts majority of the respondents in Konso (35% of the respondents) sell their goats only when they need money rather than selling them on appropriate time and this could be the reason why many males stayed longer in their farms.

The number of kids a crossbred doe produce in its life span in the farm was significantly ($p<0.01$) different in the three districts: In Kombolcha the highest number of kids were obtained in life-time of a doe followed by Gursum and Konso. Amount of money spent for medical care, Protein supplements given and breed of the goat affect longevity of goats. Longevity of a doe and the number of kids obtained in doe's life-time were significantly higher for local breeds than crossbred goats. This result was contradictory to the belief that crossbred goats have higher productivity than indigenous goats. Crossbred goats had higher ($p<0.01$) birth and twining rate. However, they produced fewer ($p<0.01$) overall kids than the local goats in their life due to their shorter longevity ($p<0.001$).

Table 17. Longevity and lifetime kids produced per doe by breed

characters	*Goat breeds*	*Number of respondents*	*Mean*	*Std. Error*
Longevity of doe in years	indigenous	52	11.7 $_a$	0.38
	crossbred	180	8.7	0.21
Number of kids a doe gave throughout its entire lifetime	indigenous	51	11.9 $_a$	0.46
	crossbred	182	10.7	0.23

$_a$: significantly different at $p<0.05$

5.4.3 Number of goats added per flock per year

Assessing number of crossbred goats added to a flock per year showed significant ($p<0.01$) difference between districts and among breeds (Table 18 and Appendix - Table 8.20). Number of goats added to a flock per year was significantly ($p<0.01$) higher in Kombolcha than Gursum and Konso. However, number of goats added to the farm except through purchase showed different result. Number of goats added to the farm except through purchase was significantly ($p<0.01$) lower in Konso while no difference was observed

between Kombolcha and Gursum. Similarly, number of goats born per year follows the same pattern to that of ‘goat added to the farm except through purchase’.

There was significant difference ($p<0.01$) in number of goats added to a flock per year between Kombolcha and Gursum districts but there was no significant difference ($p>0.05$) in number of births per flock in the two districts. Also, there was no significant ($p>0.05$) difference in number of goats added to Kombolcha and Gursum through all routes if goats bought are excluded. Therefore, the difference in the two districts didn't arise from birth. It rather arose mainly from the higher rate of purchase of crossbred goats in Kombolcha. When Gursum and Konso districts are compared there was no significant difference in number of goats added to a flock except due to birth. This shows that the significantly higher number of goats added to a flock per year in Gursum than in Konso was solely from the higher birth rate of goats in Gursum.

Between breeds comparison was also made in respect to number of goats added to a farm per year. Number of goat added to a flock per year, goats born per year and goats added to a flock except bought per year were significantly ($p<0.01$) higher for crossbred goats than indigenous goats. However, there was no significant ($p>0.05$) difference between breeds in number of goats bought into a farm. It was also found that contribution of birth to the added number of goats was much higher than other sources. Therefore, higher birth of crossbred was the major cause for higher number of goats added to a flock per year.

Table 18. Number of goats added to the farm per year

	Breed	*Number of respondents*	*Mean*	*Std. Error*	*Sig.*
number of goats born per year	Indigenous	192	0.31	0.06	*.000*
	Crossbred	192	0.82	0.07	
number of goats purchased per year	Indigenous	192	0.08	0.02	*.566*
	Crossbred	192	0.06	0.02	
other sources of goat addition (donated, borrowed, exchanged)	Indigenous	192	0.01	0.01	*.000*
	Crossbred	192	0.10	0.02	
Total number of goats added to a flock per year	Indigenous	192	0.40	0.06	*.000*
	Crossbred	192	0.98	0.08	
Total number of goats added to a flock per year except through purchase	Indigenous	192	0.32	0.06	*.000*
	Crossbred	192	0.92	0.07	

5.4.4 Number of goats exit per flock per year

Number of crossbred goat exit from a farm was significantly ($p<0.05$) different between districts (Appendix - Table 8.21& 8.22). Kombolcha and Gursum had significantly ($p<0.05$) higher number of goat exit than Konso. There was no variation in exits between Gursum and Kombolcha. Similarly, goat exit except due to death and abortion followed the same pattern to that of the total goat exited from a farm. When exit from farm compared between breeds, crossbred goats had significantly higher ($p<0.01$) exit from a farm than indigenous goats (Table 19). Differences in sell and death between breeds were the major causes for the difference in goat exit between breeds. Death takes the leading role and contributed 39.6% to exits from a farm. Sales of goats contributed 34.6% to the exits. Nonetheless, it is worthy to note here that the crossbred goats had higher ($p<0.01$) exit except deaths and abortion.

There was significant difference in the three districts and between breed with reference to number of doe aborted (Appendix - Table 8.23& 8.24). Gursum district has the lowest ($p<0.01$) abortion rate than other districts. There was no significant ($p>0.05$) difference in average abortion rate per flock per year between Kombolcha and Konso. Between breed variation in abortion per flock per year was significant ($p<0.01$). Though crossbred does had significantly ($p<0.01$) higher birth rate, they had the highest rate of abortion than the local goats. There were about 12.7 abortions out of 100 pregnancies in crossbred goat while only about 4.8 aborted for every 100 pregnancies in indigenous goats (Table 20).

Table 19. Analysis of variance for the number of goats exited from a farm by breed

		Sum of Squares	*d.f.*	*Mean Square*	*F*	*Sig.*
number of goats exit from a farm per year	Between Breeds	27.09	1	27.09	21.80	0.000
	Within Breeds	474.91	382	1.24		
	Total	502.00	383			
number of goats exit from a farm per year except through death and abortion	Between Breeds	6.25	1	6.25	8.80	0.003
	Within Breeds	271.50	382	0.71		
	Total	277.75	383			

Table 20. Percentage of aborted doe as compared to total births

Goat breed	*Number of kidding per year*		*Number goats aborted in the last 12 months*		
	Mean births per flock	Sum	Mean abortion per flock	Sum	No of abortions per every 100 pregnancies
Indigenous	0.31	60.00	0.02	3.00	4.76
Crossbred	0.82	158.00	0.12	23.00	12.71

5.4.5 Reproductive performances

The reproductive performance and marketable age of crossbred goats show variation between different districts and between breeds. For example, age at sexual maturity of male crossbred goats, age at first kidding and marketable age of male crossbred goats was significantly ($p<0.01$) higher in Gursum than in the other two districts. The age at sexual maturity of female crossbred goats was significantly ($p<0.05$) higher in Gursum and Konso than in Kombolcha. Kidding interval of crossbred goats was significantly ($p<0.01$) higher in Konso than in the two districts and it was higher ($p<0.05$) in Kombolcha than Gursum. Average marketable age of female goats was significantly ($p<0.01$) different between Kombolcha and Konso while no significant ($p>0.05$) difference was observed between Gursum and Konso.

Comparing local and crossbred goats in their reproductive performance, the following results were obtained (Table 21). There was no significant difference in average age at sexual maturity of male goats and marketable age of female goats across breeds. Crossbred goats show superior performance ($p<0.01$) in age at first kidding and marketable age of males to local goats while they had lower ($p<0.01$) kidding interval than their local counterparts. Female crossbred goats had lower ($p<0.05$) sexual maturity than local female.

Table 21. Reproductive performance and marketable age of crossbred and local goats

	Breeds	*Number of flocks*	*Mean*	*Std. Error*
Average age at sexual maturity of male goats in months	indigenous	50	16.31	0.72
	crossbred	184	15.28	0.49
Average age at sexual maturity of female goats in months	indigenous	50	16.00	0.71
	crossbred	184	14.12	0.42
Average age at first kidding in months	indigenous	52	20.92	0.75
	crossbred	180	18.57	0.41
Average kidding interval in months	indigenous	52	6.74	0.26
	crossbred	184	8.16	0.21
Average marketable age of young male stock in years	indigenous	51	2.60	0.15
	crossbred	184	2.08	0.08
Average marketable age of young female stock in years	indigenous	50	2.39	0.45
	crossbred	182	1.96	0.08

5.4.6 Manure

Goat manure was also the other valuable product obtained from goat farms. It was found that an average of 96% of the respondents use goat manure solely as a fertilizer while others (3.3% of the respondents) used it as a source of income. Workneh (2000) in his study in Kombolcha and Gursum obtained manure the second important physical product next to meat. Similarly, importance of manure to the farmers was noticed by Kassa (2000).

5.5 Diseases

Concerning common diseases threatening crossbred goats, mange and other external parasitic diseases, diarrhea, ‘tel’ (liver fluke) were mentioned as the three most important diseases in their order of importance in Kombolcha district. In Gursum diarrhea and bloating were listed as the most important diseases followed by mange. In Konso mange was mentioned as the first most important disease while pneumonia was the second and internal parasitic diseases as the third. However, only 30.16% of the respondents said that diseases (all types of disease)

are the first most important cause of death for crossbred goats and 20.63% of the respondents said that they didn't know the cause of the deaths.

In Gursum, where more money was spent for internal and external parasitic treatments against mite infection was the second important disease while in the other districts mange was the first most important disease. In Konso where internal parasite treatment was minimal ($p<0.001$) it was the third most important disease while not that much problem in Kombolcha and Gursum where more internal parasitic treatment was practiced. These results were similar to that obtained in Alemaya University except that pneumonia was predominant only in Konso and not in the other districts. The difference in occurrence of pneumonia in the three districts could be due to the difference in housing pattern. Most Kombolcha and Gursum farmers house their goat in the family house while in Konso separate loose house without wall was common.

5.6 Developing the Simulation Model

To develop these models a total of 165 crossbred goats and 257 indigenous (Somali breed) goats included in the study. Finally the model uses a 20,907 daily record of the crossbred goats to fit the models. In these models, inputs like feed (energy and protein) and labor and medical costs and output like manure, and weight gain were included. Since the goats were kept in the farm only till they rich sexual maturity, outputs like milk yield and births could not be recorded.

Different models have been developed using different combinations of inputs:

Let:

- Total medical care cost per goat tile day of evaluation (in birr) = MC
- Daily total dry matter feed intake per goat on the day of evaluation (in DMkg) = FI
- Daily total dry matter protein intake per goat on the day of evaluation (in DMkg) = PI
- Daily total dry matter energy intake per goat on the day of evaluation (in DMkg) = EI
- Labor per goat (in man-hour/day) on the day of evaluation = LG

Model 1:

Weight = 1.364 + 0.136MC + 15.925FI + 12.027LG

Model 2:

Weight = 1.364 + 0.136MC + 100.16PI + 12.027LG

Model 3:

Weight = 1.364 + 0.136MC + 21.305EI + 12.027LG

Model 4:

Weight = -1.17 + 28.723FI+ 12.619LG

Model 5:

Weight = -1.17 + 38.426EI + 12.619LG

Model 6:

Weight = -1.17 + 180.649PI + 12.619LG

Out of all these models Model 4 could be more valuable as it can be used in a field condition and will not vary with change in cost of medical care. Therefore below, the summery of the model and its ANOVA tables are presented (Table 22 & 23).

Table 22 Summary of Model 4

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.741(a)	.549	.549	3.786

- a Predictors: (Constant), Daily total dry matter feed intake per goat on the day of evaluation (in DMkg), Labor per goat (in man-hour/day) on the day of evaluation

Table 23 ANOVA table of Model 4

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	364810.219	2	182405.109	12725.356	.000(a)
	Residual	299637.704	20904	14.334		
	Total	664447.923	20906			

- a Predictors: (Constant), Daily total dry matter feed intake per goat on the day of evaluation (in DMkg), Labor per goat (in man-hour/day) on the day of evaluation
- b Dependent Variable: Daily weight

5.7 How to use the models

5.7.1 Comparing the productivity of flocks of crossbred goats in the three study sites using the models

Using these models one can compare the productivity (particularly body weight) of crossbred goats in different districts. Here an average flock productivity of the three districts (Kombolcha, Konso and Gursum) will be compared. Having the average feed intake (kg) and labor consumed (a man hours) at day 'x', and average medical care costs in money tile day 'x' of a goat in flock one can estimate the average body weight of a goat in the flock. The average weight of a goat in a flock is the sum of the weight of all goats in the flock divided by their number. In the survey data an average feed intake, labor demand and medical care cost of a goat in a flock was collected/ calculated as there was no information about individual goats of a flock. All the data were collected on flock base and an average input values were calculated for a goat in a flock and used here to get an average weight of a goat per flock using the models developed above.

NB: In cases where individual goat data is available individual goats can be compared in their productivity (weight gain).

Table 24 Mean body weight (Kg) of a goat in a flock

	N	*Mean body weight*	*Std. Deviation*	*Std. Error*
Kombolcha	43	14.17	4.89	0.74
Gursum	57	17.53	6.07	0.80
Konso	65	17.71	10.11	1.25
Total	165	16.72	7.80	0.61

Table 25 Goats body weight mean comparison for the three districts

(I) name of district	*(J) name of district*	*Mean Difference (I-J)*	*Std. Error*	*Sig.*
Kombolcha	Gursum	-3.35	1.56	0.08
	Konso	-3.53	1.51	0.05
Gursum	Kombolcha	3.35	1.56	0.08
	Konso	-0.18	1.40	0.99
Konso	Kombolcha	3.52	1.51	0.05
	Gursum	0.18	1.40	0.99

It was found that the average body weight of a crossbred goat in Gursum, Kombolcha and Konso is about 17.5kg, 14.17kg, and 17.71kg respectively. However, there was no significant difference ($p<0.05$) in average body weight of a goat in a flock (Table 24 & 25).

5.7.2 Managing goat farm using these models

The models also can be used for planning purpose too by forecasting (assuming) some values in the model. This would be much helpful for the goat keepers as s/he will rear her/his crossbred goat on the calculator before taking them to the field.

Example: Let a farmer need his goat to attain about 50Kg just before sell. Then, s/he wants what would be the medical care cost till the goat reaches 50Kg.

Let:

- The labor input for that goat remain the same throughout and let it be 1.5 man hours per day
- Feed intake would be about 3% of the body weight (1.5 DMkg/day)

Therefore:

Weight = 1.364 + 0.136MC + 15.925FI + 12.027LG

50Kg = 1.364 + 0.136MC + 15.925 (1.5) + 12.027 (1.5)

50Kg = 1.364 + 0.136MC + 23.888 + 18.040

MC = 6.708/ 0.136

= <u>49.32 Birr</u>

If the labor input decreased to 1 man-hour/day the MC (medical care cost) would increase to 93.54 Birr while MC (medical care cost) would be -5.31 Birr if the labor increases to 2.5 man hour/day. This negative value of MC (medical care cost) could be a signal for the fact that increasing the labor any more would not give any more benefit. Therefore the farmer can have a labor input bellow 2.5 man-hours/day/goat.

5.8 Diseases and major causes of diseases in Haramaya University Farm

Pneumonia was the first important disease in the farm followed by mange, heart water and diarrhea (Table 26). Similar result was found by Omoike, (2006) in Nigeria where the flocks have similar management practices like Haramaya's farm goats. The reasons for higher prevalence of pneumonia and mange could be due to the thorny and muddy house of the goats coupled with shortage of feed during the dry season. The free entry of the nearby farmers' livestock into the grazing fields of the farm could be a cause for the other two diseases (Haramaya University Goat Farm unpublished report, 1983).

Table 26. Major diseases and problems of goats in Haramaya University farm (1981-1983 GC)

Row labels	***dry season***	***short rainy***	***long rainy***	***Grand Total***
Body injury	4	0	0	4
Coughing	13	4	0	17
Diarrhea	18	6	11	35
Eye infection	0	0	1	1
Foot rot	0	11	0	11
Heart water	34	0	1	35
Mange	13	41	5	59
Milk deficiency	0	0	3	3
No colostrum	1	0	0	1
Paralysis on 2 legs	0	0	2	2
Pink eye	0	0	3	3
Pneumonia	61	18	6	85
Puncture vagina	1	0	0	1
Right front leg broke (tied)	1	0	0	1
Streptothricosis	1	0	0	1
Grand Total	**147**	**80**	**32**	**259**

As shown in the table (Table 26), the occurrence of all diseases except foot rot and mange was predominant in dry season. This could be due to stress caused by feed shortage. Foot rot and mange were most common in short rainy season.

Table 27. Major causes of goats death in Haramaya University Farm (1981-1983 GC)

ID No of the died goats and reason for death	*dry season*	*short rainy*	*long rainy*	*total*
1204 (died)(pneumonia)	1	0	0	1
1207(died) (heart water)	1	0	0	1
1209(died) (heart water and pneumonia)	1	0	0	1
1212(died) (heart water)	1	0	0	1
182(died)(pneumonia)	0	1	0	1
186(died)(heart water + lung)	0	1	0	1
190(died) of starvation	0	0	1	1
191(died) tramped by the dam	0	0	1	1
194(died) (heart water)	1	0	0	1
196(died) (heart water)	1	0	0	1
Grand Total	6	2	2	10

The results summarized in Table 27 shows that the incidence of death was very high in dry season than in the other two seasons which was the same to that of the occurrence of the diseases.

6 Conclusions and Recommendations

6.1 Conclusions

The performances of crossbred goats in the three districts were compared by considering the three districts as separate treatments. The results revealed that failure to provide the necessary inputs to the animals could result in significant loss in productivity of crossbred goats. Therefore, the introduction of this improved breed should be accompanied with improved management practices. For example, in Konso where significantly lower amount of feed was offered per TLU and the least health care was practiced, crossbred goats had significantly lower production performances than the other two districts. Similarly, in Kombolcha, where health care was lower than in Gursum, the longevity of female goats was lower than the in latter.

The differences between the districts in the productivity of crossbred goats have arisen mainly from management differences, mainly in feed supplementation and health care for the goats. From total feed offered to goats, protein supplements showed much more impact on the performance of crossbred goats. The amount of labor spent per goat did not show any pattern in influencing the productivity of crossbred goats. Therefore, increasing the number of family members participating in goat management should result in a significant increase in feed offered and health care given to goats otherwise increasing labor input will not serve the purpose.

This study revealed that controlled breeding was highly practiced by crossbred goat owning farmers. Controlled breeding is the basic skill needed to improve livestock performance through breeding. In the three districts, controlled breeding was a very common practice (though the study focuses only on crossbred owners). This is an important breakthrough or impact of the project (DGDP) as it paved the way for anyone who wishes to introduce new genes into these districts. Furthermore, the practices of borrowing of good performing buck (in Konso) paying for good buck (in Gursum) indicated how much it is easier to introduce new well performing breeds into these areas.

Concerning the purpose of keeping goats, the study showed that the crossbred goats are mainly reared because of their higher milk yield and income than indigenous goats.

The study also revealed that farmers show different levels of appreciation to each of the characteristics of indigenous and crossbred goats. Indigenous goats are preferred for their adaptive quality traits compared to crossbred goats. Productive, reproductive and physical features of the crossbreds interest farmers better than the indigenous goats.

The crossbred goats had higher productivity than indigenous goats but they required higher cost for health care. Crossbred goats had higher daily milk yield, lactation length, lifetime milk yield and births per year than local goats. Local breeds on the other hand were superior in some features such us in the number of births per lifetime of doe and longevity of doe.

Crossbred goats had higher death rate and lower longevity than indigenous despite higher medical care they received.

Generally, the majority of the interviewed farmers (91.6% of respondents) had shown interest towards crossbred goats than indigenous goats.

6.2 Recommendations

Based on the result of the study, we make the following recommendations:

- Introduction of improved breed should be accompanied with introduction of improved feeding and health care. And the accompanied infrastructure and human power and skill needed.

- Crossbred goats are better milk producers than indigenous goats. Crossbred goats show this higher performance under conditions where local goats were also maintained. Therefore, if adaptability problem of crossbred goats can be improved, they could be used as a good dairy goat particularly in Gursum and Kombolcha, where marketing and drinking of goat milk is more common than in Konso.

- Health care was found to be one of the most important factors that influence the productivity of crossbred goats. Therefore, while introducing exotic genes it is much important to give due attention to health care given to the goats.

- Some productivity aspects like number of kids born per doe in its lifetime and longevity was higher for indigenous goats than crossbred goats showing the importance of indigenous goats particularly in smallholder farming systems. Therefore, within breed selection could be one way to improve local breeds for use to resource poor goat farming system.

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8 Appendix

8.1 Tables of survey data summarized from the questionnair

Table 8.1. Choice of animal types

Districts	% of respondents who choose these animals first				
	cattle	sheep	goat	chicken	Total
Kombolcha	32.56	2.33	55.81	9.30	100
Gursum	84.91	-	15.09	-	100
Konso	33.85	10.77	50.77	4.62	100

Table 8.2. Number of indigenous and crossbred goats in the different districts

Districts	Total number of crossbreed and indigenous goats in the different districts					
	type of goat breed					
	indigenous			crossbred		
	Sum	Range	Mean	Sum	Range	Mean
Kombolcha	68.00	10.00	1.48	127.00	4.00	2.70
Gursum	74.00	4.00	.95	252.00	9.00	3.15
Konso	121.00	7.00	1.86	192.00	8.00	2.95

Table 8.3. Summary of total livestock number and individual livestock number per flock in each district

Districts	Mean number of livestock per flock					
	all livestock	cattle	sheep	goat	chicken	donkey
Kombolcha	10.06	1.8511	1.1915	4.1915	2.5745	.2553
Gursum	8.19	1.6500	.7375	4.1125	1.4625	.2125
Konso	12.45	1.6462	2.8615	4.8462	3.0308	.0000
Total	10.09	1.6979	1.5677	4.3802	2.2656	.1510

Table 8.4. Summary of mean family size and mean land holding in the districtes

District	Total people living in the family	Number of male less than 7 year	Number of female less than 7 year	Number of male between 7 and 14 years	Number of female between 7 and 14 years	Total farmland size (cultivated + fallow land) in ha	crop land owned in Ha	Fallow land size owned in Ha	grazing land size owned in Ha	crop land rent in Ha	Fallow land size rent in Ha	grazing land size rent in Ha
Kombolcha	4.81	1.60	1.38	1.00	.86	.6574	.6362	.0106	.0000	.0000	.0000	.0000
Gursum	7.10	2.46	2.10	1.43	1.11	1.0656	1.0719	.0250	.0000	.0000	.0250	.0000
Konso	7.11	1.57	1.80	1.68	2.05	.8742	.7032	.0343	.0202	.1050	.0066	.0000
Total	6.54	1.94	1.82	1.41	1.37	.9021	.8464	.0245	.0066	.0344	.0128	.0000

Table 8.5. Variation in family size, crop land and grazing land holding and livestock owned in a farm between districts

Tukey HSD

Dependent Variable	(I) districtID	(J) districtID	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Upper Bound	Lower Bound
Total people living in the family	Kombolcha	Gursum	-2.293(*)	.475	.000	-3.41	-1.17
		Konso	-2.299(*)	.493	.000	-3.46	-1.13
	Gursum	Kombolcha	2.293(*)	.475	.000	1.17	3.41
		Konso	-.006	.432	1.000	-1.03	1.01
	Konso	Kombolcha	2.299(*)	.493	.000	1.13	3.46
		Gursum	.006	.432	1.000	-1.01	1.03
Total farmland size (cultivated + fallow land) in ha	Kombolcha	Gursum	-.40818(*)	.09993	.000	-.6443	-.1720
		Konso	-.21676	.10713	.110	-.4699	.0364
	Gursum	Kombolcha	.40818(*)	.09993	.000	.1720	.6443
		Konso	.19141	.09424	.108	-.0313	.4141
	Konso	Kombolcha	.21676	.10713	.110	-.0364	.4699
		Gursum	-.19141	.09424	.108	-.4141	.0313
grazing land size in Ha	Kombolcha	Gursum	.00000	.00865	1.000	-.0204	.0204
		Konso	-.02016	.00911	.071	-.0417	.0014
	Gursum	Kombolcha	.00000	.00865	1.000	-.0204	.0204
		Konso	-.02016(*)	.00797	.033	-.0390	-.0013
	Konso	Kombolcha	.02016	.00911	.071	-.0014	.0417

Dependent Variable	(I) districtID	(J) districtID	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Upper Bound	Lower Bound
		Gursum	.02016(*)	.00797	.033	.0013	.0390
Total livestock number	Kombolcha	Gursum	1.876	.872	.082	-.18	3.94
		Konso	-2.382(*)	.909	.026	-4.53	-.24
	Gursum	Kombolcha	-1.876	.872	.082	-3.94	.18
		Konso	-4.259(*)	.793	.000	-6.13	-2.39
	Konso	Kombolcha	2.382(*)	.909	.026	.24	4.53
		Gursum	4.259(*)	.793	.000	2.39	6.13
Number of cattle	Kombolcha	Gursum	.20106	.21598	.621	-.3092	.7113
		Konso	.20491	.22501	.634	-.3266	.7365
	Gursum	Kombolcha	-.20106	.21598	.621	-.7113	.3092
		Konso	.00385	.19624	1.000	-.4597	.4674
	Konso	Kombolcha	-.20491	.22501	.634	-.7365	.3266
		Gursum	-.00385	.19624	1.000	-.4674	.4597
Number of sheep	Kombolcha	Gursum	.45399	.28874	.260	-.2281	1.1361
		Konso	-1.67005(*)	.30082	.000	-2.3807	-.9594
	Gursum	Kombolcha	-.45399	.28874	.260	-1.1361	.2281
		Konso	-2.12404(*)	.26235	.000	-2.7438	-1.5043
	Konso	Kombolcha	1.67005(*)	.30082	.000	.9594	2.3807
		Gursum	2.12404(*)	.26235	.000	1.5043	2.7438
Number of goat	Kombolcha	Gursum	.07899	.38831	.977	-.8383	.9963
		Konso	-.65466	.40455	.240	-1.6103	.3010
	Gursum	Kombolcha	-.07899	.38831	.977	-.9963	.8383
		Konso	-.73365	.35282	.097	-1.5671	.0998
	Konso	Kombolcha	.65466	.40455	.240	-.3010	1.6103
		Gursum	.73365	.35282	.097	-.0998	1.5671

* The mean difference is significant at the .05 level.

Table 8.6. Significance of money spent for medical cases of indigenous and crossbred goats

Dependent Variable	(I) districtID	(J) districtID	Mean Difference (I-J)	Std. Error	Sig.
Money spent for medical cases of indigenous goats	Kombolcha	Gursum	-50.88596(*)	8.08223	.000
		Konso	18.13255(*)	7.35289	.015
	Gursum	Kombolcha	50.88596(*)	8.08223	.000
		Konso	69.01852(*)	6.27701	.000
	Konso	Kombolcha	-18.13255(*)	7.35289	.015
		Gursum	-69.01852(*)	6.27701	.000
Money spent for medical cases of crossbreed goats	Kombolcha	Gursum	-80.69131(*)	10.13304	.000
		Konso	23.05251(*)	10.07422	.023
	Gursum	Kombolcha	80.69131(*)	10.13304	.000
		Konso	103.74382(*)	8.72206	.000
	Konso	Kombolcha	-23.05251(*)	10.07422	.023
		Gursum	-103.74382(*)	8.72206	.000

Table 8.7. ANOVA table of reproductive performance and marketable age of crossbred and local goats

		Sum of Squares	df	Mean Square	F	Sig.
Average age at sexual maturity of male goats in months	Between Groups	41.719	1	41.719	1.025	.312
	Within Groups	9440.281	232	40.691		
	Total	9482.000	233			
Average age at sexual maturity of female goats in months	Between Groups	139.426	1	139.426	4.542	.034
	Within Groups	7122.238	232	30.699		
	Total	7261.663	233			
Average age at first kidding	Between Groups	222.966	1	222.966	7.333	.007
	Within Groups	6993.753	230	30.408		
	Total	7216.720	231			
Average kidding interval	Between Groups	81.430	1	81.430	11.020	.001
	Within Groups	1729.175	234	7.390		
	Total	1810.605	235			
Average marketable age	Between Groups	10.941	1	10.941	9.899	.002

		Sum of Squares	df	Mean Square	F	Sig.
of young male goats in years	Within Groups	257.517	233	1.105		
	Total	268.458	234			
Average marketable age of young female goats in years	Between Groups	7.419	1	7.419	2.380	.124
	Within Groups	717.051	230	3.118		
	Total	724.470	231			

Table 8.8. Reproductive performance and marketable age of crossbred goats in different districts

		Number of flocks	Mean	Std. Error
Average age at sexual maturity of male crossbred goats in months	Kombolcha	46	12.6522	0.08
	Gursum	74	18.9122	0.08
	Konso	64	12.9688	0.11
	Total	184	15.2799	0.04
Average age at sexual maturity of female crossbred goats in months	Kombolcha	46	12.5870	0.09
	Gursum	73	15.2260	0.06
	Konso	65	13.9538	0.11
	Total	184	14.1168	0.03
Average age at first kidding of crossbred goats	Kombolcha	44	17.1818	0.08
	Gursum	73	21.4658	0.07
	Konso	63	16.1905	0.09
	Total	180	18.5722	0.03
Average kidding interval of crossbred goats	Kombolcha	46	8.0761	0.02
	Gursum	73	6.8562	0.02
	Konso	65	9.6769	0.06
	Total	184	8.1576	0.02
Average marketable age of male crossbred goats in years	Kombolcha	45	1.4111	0.02
	Gursum	76	2.6283	0.01
	Konso	63	1.8857	0.02
	Total	184	2.0764	0.01
Average marketable age of female crossbred goats in	Kombolcha	45	1.4093	0.03
	Gursum	75	2.1667	0.01

		Number of flocks	Mean	Std. Error
years	Konso	62	2.1006	0.02
	Total	182	1.9569	0.01

Table 8.9. Multiple Comparisons of reproductive performance and marketable age of crossbred goats in different districts

Turkey HSD

Dependent Variable	(I) name of district	(J) name of district	Mean Difference (I-J)	Std. Error	Sig.
Average age at sexual maturity of male goats in months	Kombolcha	Gursum	-6.25999(*)	1.12724	.000
		Konso	-.31658	1.16050	.960
	Gursum	Kombolcha	6.25999(*)	1.12724	.000
		Konso	5.94341(*)	1.02483	.000
	Konso	Kombolcha	.31658	1.16050	.960
		Gursum	-5.94341(*)	1.02483	.000
Average age at sexual maturity of female goats in months	Kombolcha	Gursum	-2.63907(*)	1.05432	.035
		Konso	-1.36689	1.07911	.416
	Gursum	Kombolcha	2.63907(*)	1.05432	.035
		Konso	1.27218	.95513	.379
	Konso	Kombolcha	1.36689	1.07911	.416
		Gursum	-1.27218	.95513	.379
Average age at first kidding	Kombolcha	Gursum	-4.28394(*)	.95465	.000
		Konso	.99134	.98273	.572
	Gursum	Kombolcha	4.28394(*)	.95465	.000
		Konso	5.27528(*)	.86015	.000
	Konso	Kombolcha	-.99134	.98273	.572
		Gursum	-5.27528(*)	.86015	.000
Average kidding interval	Kombolcha	Gursum	1.21992(*)	.49981	.041
		Konso	-1.60084(*)	.51157	.006
	Gursum	Kombolcha	-1.21992(*)	.49981	.041
		Konso	-2.82076(*)	.45279	.000
	Konso	Kombolcha	1.60084(*)	.51157	.006
		Gursum	2.82076(*)	.45279	.000

Dependent Variable	(I) name of district	(J) name of district	Mean Difference (I-J)	Std. Error	Sig.
Average marketable age of young male goats in years	Kombolcha	Gursum	-1.21718(*)	.17209	.000
		Konso	-.47460(*)	.17857	.023
	Gursum	Kombolcha	1.21718(*)	.17209	.000
		Konso	.74258(*)	.15589	.000
	Konso	Kombolcha	.47460(*)	.17857	.023
		Gursum	-.74258(*)	.15589	.000
Average marketable age of young female goats in years	Kombolcha	Gursum	-.75733(*)	.20157	.001
		Konso	-.69125(*)	.20934	.003
	Gursum	Kombolcha	.75733(*)	.20157	.001
		Konso	.06609	.18348	.931
	Konso	Kombolcha	.69125(*)	.20934	.003
		Gursum	-.06609	.18348	.931

* The mean difference is significant at the .05 level.

Table 8.10. Longevity of goats and kids obtained per female in its life in the three districts

		Number of flocks	Mean	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Years male crossbred goats stayed in a farm	Kombolcha	45	5.5667	0.00	5.1856	5.9478
	Gursum	76	5.0724	0.00	4.8127	5.3320
	Konso	60	6.3875	0.01	5.7427	7.0323
	Total	181	5.6312	0.00	5.3649	5.8975
Longevity of crossbred female goats in years	Kombolcha	44	8.2955	0.01	7.8055	8.7854
	Gursum	76	10.4934	0.00	10.0649	10.9219
	Konso	60	6.8112	0.01	6.0266	7.5958
	Total	180	8.7287	0.00	8.3196	9.1379
Number of kids a crossbred doe get through out its life	Kombolcha	44	12.7614	0.01	11.8013	13.7214
	Gursum	78	10.7308	0.00	10.0359	11.4256
	Konso	60	9.1000	0.00	8.6597	9.5403
	Total	182	10.6841	0.00	10.2395	11.1286

Table 8.11. Multiple Comparisons of longevity of goats and kids obtained per female in its life in the three districts

Tukey HSD

Dependent Variable	(I) name of district	(J) name of district	Mean Differenc(I-J)	Std. Error	Sig.
Years male crossbred goats stayed in a farm	Kombolcha	Gursum	.49430	.32616	.286
		Konso	-.82083(*)	.34195	.046
	Gursum	Kombolcha	-.49430	.32616	.286
		Konso	-1.31513(*)	.29946	.000
	Konso	Kombolcha	.82083(*)	.34195	.046
		Gursum	1.31513(*)	.29946	.000
Longevity of female crossbred goats in years	Kombolcha	Gursum	-2.19797(*)	.43181	.000
		Konso	1.48429(*)	.45242	.004
	Gursum	Kombolcha	2.19797(*)	.43181	.000
		Konso	3.68225(*)	.39366	.000
	Konso	Kombolcha	-1.48429(*)	.45242	.004
		Gursum	-3.68225(*)	.39366	.000
Number of kids a crossbred doe get throughout its life	Kombolcha	Gursum	2.03059(*)	.51422	.000
		Konso	3.66136(*)	.54132	.000
	Gursum	Kombolcha	-2.03059(*)	.51422	.000
		Konso	1.63077(*)	.46834	.002
	Konso	Kombolcha	-3.66136(*)	.54132	.000
		Gursum	-1.63077(*)	.46834	.002

* The mean difference is significant at the .05 level.

Table 8.12. ANOVA table of longevity of local and crossbred goats and kids obtained per female in its life

		Sum of Squares	df	Mean Square	F	Sig.
Years male crossbred goats stayed in a farm	Between Groups	.348	1	.348	.114	.736
	Within Groups	706.369	231	3.058		
	Total	706.717	232			
Longevity of female goats in years	Between Groups	347.478	1	347.478	45.112	.000
	Within Groups	1771.593	230	7.703		

		Sum of Squares	df	Mean Square	F	Sig.
	Total	2119.071	231			
Number of kids a doe get throughout its life	Between Groups	61.977	1	61.977	6.503	.011
	Within Groups	2201.594	231	9.531		
	Total	2263.571	232			

Table 8.13. ANOVA table of average milk yield (in litters) and lactation length of local and crossbred goats

		Sum of Squares	df	Mean Square	F	Sig.
average milk yield (in litters)	Between Groups	13.197	1	13.197	17.266	.000
	Within Groups	150.575	197	.764		
	Total	163.772	198			
Average lactation length in months	Between Groups	45.799	1	45.799	20.217	.000
	Within Groups	423.616	187	2.265		
	Total	469.415	188			

Table 8.14. Multiple Comparisons of Average milk yield (in litters) and lactation length of crossbred goats in different districts

Tukey HSD

Dependent Variable	(I) name of district	(J) name of district	Std. Error	Sig.
average milk yield (in litters) of crossbred goat	Kombolcha	Gursum	.145	.000
		Konso	.193	.000
	Gursum	Kombolcha	.145	.000
		Konso	.178	.000
	Konso	Kombolcha	.193	.000
		Gursum	.178	.000
Average lactation length of crossbred goat in months	Kombolcha	Gursum	.281	.000
		Konso	.386	.980
	Gursum	Kombolcha	.281	.000
		Konso	.359	.000
	Konso	Kombolcha	.387	.980

Dependent Variable	(I) name of district	(J) name of district	Std. Error	Sig.
		Gursum	.359	.000

* The mean difference is significant at the .05 level.

Table 8.15. Number of kids born and does aborted per year

		Number of respondents	Mean	Std. Deviation
Number of doe aborted in the last 12 months	Indigenous	174	.017	0.00
	Crossbred	190	.121	0.00
	Total	364	.071	0.00
number of goats born per year	Indigenous	192	.310	0.00
	Crossbred	192	.820	0.01
	Total	384	.570	0.00

Table 8.16. Number crossbred goats aborted per flock in the last 12 months

	Number of flocks	Mean	Std. Deviation	Minimum	Maximum
Kombolcha	45	.2444	0.01	.00	2.00
Gursum	80	.0375	0.00	.00	2.00
Konso	65	.1385	0.01	.00	2.00
Total	190	.1211	0.00	.00	2.00

Table 8.17. Multiple comparisons of number crossbred goats aborted in the last 12 months in the three districts

Tukey HSD

(I) name of district	(J) name of district	Mean Difference (I-J)	Std. Error	Sig.
Kombolcha	Gursum	.20694(*)	.06807	.008
	Konso	.10598	.07084	.295
Gursum	Kombolcha	-.20694(*)	.06807	.008
	Konso	-.10096	.06100	.225
Konso	Kombolcha	-.10598	.07084	.295
	Gursum	.10096	.06100	.225

* The mean difference is significant at the .05 level.

Table 8.18. ANOVA table of number of local and crossbred goats added to the farm per year

		Sum of Squares	df	Mean Square	F	Sig.
number of goats born per year	Between breeds	25.010	1	25.010	32.143	.000
	Within breeds	297.229	382	.778		
	Total	322.240	383			
number of goats bought per year	Between breeds	.023	1	.023	.331	.566
	Within breeds	27.078	382	.071		
	Total	27.102	383			
other sources of goat addition (donated, borrowed, exchanged)	Between breeds	.844	1	.844	17.793	.000
	Within breeds	18.115	382	.047		
	Total	18.958	383			
number of goats added to a flock per year	Between breeds	33.253	1	33.253	35.594	.000
	Within breeds	356.870	382	.934		
	Total	390.122	383			
number of goats added except bought	Between breeds	35.042	1	35.042	40.880	.000
	Within breeds	327.448	382	.857		
	Total	362.490	383			

Table 8.19. Number of crossbred goats added in a flock per year in different districts

		Number of flocks	Mean	Std. Deviation
number of crossbred goats born per year	Kombolcha	47	1.0851	0.02
	Gursum	80	.9625	0.01
	Konso	65	.4615	0.01
	Total	192	.8229	0.01
number of crossbred goats bought per year	Kombolcha	47	.15	0.01
	Gursum	80	.04	0.00
	Konso	65	.03	0.00
	Total	192	.06	0.00
other sources of crossbred	Kombolcha	47	.23	0.01

		Number of flocks	Mean	Std. Deviation
goat addition (donated, borrowed, exchanged)	Gursum	80	.09	0.00
	Konso	65	.02	0.00
	Total	192	.10	0.00
Total number of crossbred goats added to a flock per year	Kombolcha	47	1.47	0.02
	Gursum	80	1.09	0.01
	Konso	65	.51	0.01
	Total	192	.98	0.01
Total number of crossbred goats added except through bought	Kombolcha	47	1.32	0.02
	Gursum	80	1.05	0.01
	Konso	65	.48	0.01
	Total	192	.92	0.01

Table 8.20. Multiple Comparisons of number of crossbred goats added in a flock per year in different districts

Tukey HSD

Dependent Variable	(I) name of district	(J) name of district	Mean Difference (I-J)	Std. Error	Sig.
number of crossbred goats born per year	Kombolcha	Gursum	.12261	.16627	.742
		Konso	.62357(*)	.17323	.001
	Gursum	Kombolcha	-.12261	.16627	.742
		Konso	.50096(*)	.15108	.003
	Konso	Kombolcha	-.62357(*)	.17323	.001
		Gursum	-.50096(*)	.15108	.003
number of crossbred goats bought per year	Kombolcha	Gursum	.111(*)	.044	.032
		Konso	.118(*)	.046	.028
	Gursum	Kombolcha	-.111(*)	.044	.032
		Konso	.007	.040	.984
	Konso	Kombolcha	-.118(*)	.046	.028
		Gursum	-.007	.040	.984
other sources of crossbred goat addition (donated, borrowed, exchanged)	Kombolcha	Gursum	.147(*)	.053	.017
		Konso	.219(*)	.055	.000
	Gursum	Kombolcha	-.147(*)	.053	.017
		Konso	.072	.048	.296

Dependent Variable	(I) name of district	(J) name of district	Mean Difference (I-J)	Std. Error	Sig.
	Konso	Kombolcha	-.219(*)	.055	.000
		Gursum	-.072	.048	.296
Total number of crossbred goats added to a flock per year	Kombolcha	Gursum	.381	.181	.091
		Konso	.960(*)	.188	.000
	Gursum	Kombolcha	-.381	.181	.091
		Konso	.580(*)	.164	.001
	Konso	Kombolcha	-.960(*)	.188	.000
		Gursum	-.580(*)	.164	.001
Total number of crossbred goats added to a flock per year except through bought	Kombolcha	Gursum	.269	.176	.281
		Konso	.842(*)	.184	.000
	Gursum	Kombolcha	-.269	.176	.281
		Konso	.573(*)	.160	.001
	Konso	Kombolcha	-.842(*)	.184	.000
		Gursum	-.573(*)	.160	.001

* The mean difference is significant at the .05 level.

Table 8.21. Number of crossbred goats exit in a flock per year in different districts

		Number of flocks	Mean	Std. Deviation
number of crossbred goats sold per year per flock	Kombolcha	47	.47	0.02
	Gursum	80	.34	0.01
	Konso	65	.11	0.01
	Total	192	.29	0.00
number of crossbred goats slaughtered per year per flock	Kombolcha	47	.06	0.01
	Gursum	80	.13	0.01
	Konso	65	.06	0.00
	Total	192	.09	0.00
number of crossbred goats died per year per flock	Kombolcha	47	.45	0.01
	Gursum	80	.49	0.01
	Konso	65	.22	0.01
	Total	192	.39	0.00
number of crossbred gats lend	Kombolcha	47	.00	0.00

		Number of flocks	Mean	Std. Deviation
per year per flock	Gursum	80	.01	0.00
	Konso	65	.09	0.01
	Total	192	.04	0.00
number of crossbred goats gifted per year per flock	Kombolcha	47	.23	0.02
	Gursum	80	.06	0.01
	Konso	65	.00	0.00
	Total	192	.08	0.00
number of crossbred goat aborted in a flock per year	Kombolcha	45	.24	0.01
	Gursum	80	.04	0.00
	Konso	65	.14	0.01
	Total	190	.12	0.00
Total number of crossbred goats exit from a flock per year	Kombolcha	47	1.21	0.03
	Gursum	80	1.04	0.02
	Konso	65	.48	0.01
	Total	192	.89	0.01
Total number of crossbred goats exit per flock in a year except death and abortion	Kombolcha	47	.77	0.03
	Gursum	80	.54	0.01
	Konso	65	.26	0.01
	Total	192	.50	0.01

Table 8.22. Multiple Comparisons Number of crossbred goats exit in a flock per year in different districts

Tukey HSD

Dependent Variable	(I) name of district	(J) name of district	Mean Difference (I-J)	Std. Error	Sig.
number of crossbred goats sold per year per flock	Kombolcha	Gursum	.131	.116	.502
		Konso	.360(*)	.121	.009
	Gursum	Kombolcha	-.131	.116	.502
		Konso	.230	.106	.079
	Konso	Kombolcha	-.360(*)	.121	.009
		Gursum	-.230	.106	.079
number of crossbred goats	Kombolcha	Gursum	-.061	.065	.611

Dependent Variable	(I) name of district	(J) name of district	Mean Difference (I-J)	Std. Error	Sig.
slaughtered per year per flock		Konso	.002	.067	.999
	Gursum	Kombolcha	.061	.065	.611
		Konso	.063	.059	.526
	Konso	Kombolcha	-.002	.067	.999
		Gursum	-.063	.059	.526
number of crossbred goats died per year per flock	Kombolcha	Gursum	-.041	.146	.958
		Konso	.231	.152	.281
	Gursum	Kombolcha	.041	.146	.958
		Konso	.272	.132	.102
	Konso	Kombolcha	-.231	.152	.281
		Gursum	-.272	.132	.102
number of crossbred gats lend per year per flock	Kombolcha	Gursum	-.013	.043	.955
		Konso	-.092	.045	.103
	Gursum	Kombolcha	.013	.043	.955
		Konso	-.080	.039	.107
	Konso	Kombolcha	.092	.045	.103
		Gursum	.080	.039	.107
number of crossbred goats gifted per year per flock	Kombolcha	Gursum	.172	.111	.273
		Konso	.234	.116	.110
	Gursum	Kombolcha	-.172	.111	.273
		Konso	.063	.101	.810
	Konso	Kombolcha	-.234	.116	.110
		Gursum	-.063	.101	.810
number of crossbred goat aborted in a flock per year	Kombolcha	Gursum	.207(*)	.068	.008
		Konso	.106	.071	.295
	Gursum	Kombolcha	-.207(*)	.068	.008
		Konso	-.101	.061	.225
	Konso	Kombolcha	-.106	.071	.295
		Gursum	.101	.061	.225
Total number of crossbred goats exit from a flock per year	Kombolcha	Gursum	.175	.248	.759
		Konso	.736(*)	.258	.013
	Gursum	Kombolcha	-.175	.248	.759

Dependent Variable	(I) name of district	(J) name of district	Mean Difference (I-J)	Std. Error	Sig.
	Konso	Konso	.561(*)	.225	.036
		Kombolcha	-.736(*)	.258	.013
		Gursum	-.561(*)	.225	.036
Total number of crossbred goats exit per flock in a year except death and abortion	Kombolcha	Gursum	.228	.188	.444
		Konso	.504(*)	.195	.028
	Gursum	Kombolcha	-.228	.188	.444
		Konso	.276	.170	.240
	Konso	Kombolcha	-.504(*)	.195	.028
		Gursum	-.276	.170	.240

* The mean difference is significant at the .05 level.

Table 8.23. Number of local and crossbred goat exit in a flock per year

		Number of respondents	Mean	Std. Deviation
number of goats sold per year per flock	Indigenous	192	.14	0.00
	Crossbred	192	.29	0.00
	Total	384	.22	0.00
number of goats slaughtered per year per flock	Indigenous	192	.09	0.00
	Crossbred	192	.09	0.00
	Total	384	.09	0.00
number of goats died per year per flock	Indigenous	192	.11	0.00
	Crossbred	192	.39	0.00
	Total	384	.25	0.00
number of gats lend per year per flock	Indigenous	192	.01	0.00
	Crossbred	192	.04	0.00
	Total	384	.02	0.00
number of goats gifted per year per flock	Indigenous	192	.01	0.00
	Crossbred	192	.08	0.00
	Total	384	.05	0.00

		Number of respondents	Mean	Std. Deviation
Number of doe aborted in the last 12 months per flock	Indigenous	174	.017	0.00
	Crossbred	190	.121	0.00
	Total	364	.071	0.00
Total number of goats exit from a farm per year per flock	Indigenous	192	.36	0.00
	Crossbred	192	.89	0.01
	Total	384	.63	0.00
Total number of goats exit except through death and abortion per flock per year	Indigenous	192	.245	0.00
	Crossbred	192	.500	0.01
	Total	384	.372	0.00

Table 8.24. ANOVA table of number of local and crossbred goat exit in a flock per year

		Sum of Squares	df	Mean Square	F	Sig.
number of goats sold per year	Between breeds	2.190	1	2.190	6.594	.011
	Within breeds	126.870	382	.332		
	Total	129.060	383			
number of goats slaughtered per year	Between breeds	.000	1	.000	.000	1.000
	Within breeds	38.990	382	.102		
	Total	38.990	383			
number of goats died per year	Between breeds	7.315	1	7.315	19.116	.000
	Within breeds	146.182	382	.383		
	Total	153.497	383			
number of gats lend per year	Between breeds	.094	1	.094	3.051	.082
	Within breeds	11.740	382	.031		
	Total	11.833	383			
number of goats gifted per year	Between breeds	.510	1	.510	2.684	.102
	Within breeds	72.646	382	.190		
	Total	73.156	383			
Number of doe aborted in the last 12 months per flock	Between breeds	.979	1	.979	12.149	.001
	Within breeds	29.164	362	.081		

		Sum of Squares	df	Mean Square	F	Sig.
	Total	30.143	363			
Total number of goats exit from a farm per year per flock	Between breeds	27.094	1	27.094	21.793	.000
	Within breeds	474.906	382	1.243		
	Total	502.000	383			
Total number of goats exit except through death and abortion per flock per year	Between breeds	6.253	1	6.253	8.798	.003
	Within breeds	271.495	382	.711		
	Total	277.747	383			

* The mean difference is significant at the .05 level.

Table 8.25. Correlations between weight of the animal and daily total amount of feed and labor received and medical care costs till the days of analysis.

		weight of the animal	total amount of feed intake per day	daily man hour input per goat	medical care costs till the days of analysis
weight of the animal	Pearson Correlation	1	.732(**)	.363(**)	.571(**)
	Sig. (2-tailed)		.000	.000	.000
	N	20907	20907	20907	35
total amount of feed intake per day	Pearson Correlation	.732(**)	1	.352(**)	.360(*)
	Sig. (2-tailed)	.000		.000	.034
	N	20907	20907	20907	35
daily man hour input per goat	Pearson Correlation	.363(**)	.352(**)	1	.247
	Sig. (2-tailed)	.000	.000		.152
	N	20907	20907	20907	35
medical care costs till the days of analysis	Pearson Correlation	.571(**)	.360(*)	.247	1
	Sig. (2-tailed)	.000	.034	.152	
	N	35	35	35	36

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

8.2 Questionnaire

Goat Breeds Utilization and Productivity of Crossbreed Goats in Eastern and Southern Ethiopia and Biophysical Model

This project is supervised by ASARECA (Association for Strengthen Agricultural Research in Eastern and Central Africa) – Animal Agricultural Research Network (A-AARNET) and International Livestock Research Institute and coordinated by Adami-Tulu Agricultural Research Centre.

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Date _____/_____/____

Name of enumerator _____ code _____

Zone _____

District _____

PA _____

Altitude _____

Longitude _____

Latitude _____

Objective of the study: is to develop biophysical and economic models that can be used to analyse cost and benefits of crossbreeding programs and to compare the net benefit of indigenous goats with crossbreeds. This finally will lead to identification of appropriate breeding programs for the future use with respect to different production systems.

Notes to the enumerator

- Politely introduce yourself to farmers/pastoralists
- Tell them briefly the objective of the study
- Administer questionnaires politely
- The respondents should be thanked for his/her time.
- Record the response carefully
  Fill the responses in the space provided or mark alternative response (s) where appropriate with an "**X**".

Household General Information

1. Household head Name _____ **Age** _____
2. Interviewee Name _____ **Age** _____ **Sex** _____

3.Interviewee Position in household *(Tick one box)*

. Household head ☐
. Spouse of head ☐
. Relative ☐
. Son ☐
. Daughter ☐

Other (specify)
. _____ ☐

4. Interviewee Education level

.. Illiterate ☐
. Writing and reading ☐
:. Grade ☐

5. Marital status of the Household head

A. Married ☐
B. Divorced ☐
C. Widowed ☐

6. Religion of the Household head_____

7. Ethnic of the Household head_____

8. Number of all People Living in The House *(by age and sex)*

Children	No
Males ≤ 15 yrs	
Females ≤ 15yrs	
Adults	
Males >15	
Females >15	

9. Land holding (in ha)

	Own	Rented
.. Crops (including fallow land)		
. fallow land (at the interview time)		
. Grazing		
). Other (specify) _____		
Total area		

10. Type of grazing land and ownership

	Own		Rented		Communal	
	X	Amount (ha)	X	Amount (ha)	X	Amount (ha)
A. Open grassland						
B. Tree covered grassland						
C. Bush/shrub grassland						
D. Stone covered grassland						
E. fallow land						
Other (specify) F. _____						

** (Tick one or more boxes in the" X" column. Then show their specific amount in 'ha' or specify the name of the grazing land.)*

10.1. How much do you rent the grazing land per hectare?
_____ birr/ha

11. Trend in land holding

Trend in land holding		Reason
A. Decreasing	☐	_____
B. Increasing	☐	_____
C. Stable	☐	_____

12. What is your major farming activity? *(Tick one box)*

A. Livestock production	
B. Crop production	
C. Both	

13. On which you depend for food and income
(Tick one or more box (in "X" column) and rank (in "R" column))

Farming activity	Food		Income	
	X	R	X	R
A. Livestock production				
B. Crop production				
C. other (specify) _____				

14. Numbers of livestock kept *(Tick one box)*

Livestock	Number	Most Important Species *(rank Up to 3)*	Purpose of keeping the animal (write the top three purposes)
A. Cattle			
B. Sheep			
C. Goats			
D. Chickens			
E. Pigs			
F. Donkeys			
G. Mules			
H. Camels			
I. Horses			

GOATS PRODUCTION SYSTEM

1. Production system *(Tick one box)*

Crop-livestock system	
Agro-pastoralists	
Pastoralists	

2. Type of management *(Tick one box)*

Extensive	
Semi-intensive	
intensive/backyard	

3. Mobility *(Tick one or more boxes in each column)*

	Livestock	Family
A. Sedentary		
B. Transhumant		
C. Nomadic		

3.1. If transhumance or nomadic which livestock species and age class move?

Species	Age class	Season of Mobility	Length
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

4. Members of household who own goat

Head	
Spouse	
Head/spouse together	

Sons ☐
Daughters ☐
The whole family ☐
Others Specify
_____ ☐

5. Goat flock herded *(tick one or more boxes as needed)*

Together with cattle ☐
Together with sheep ☐
Together with camel ☐
Together with calves ☐
Together with equines ☐
Goat herded separately ☐

6. How goat flock herded during the day time? *(tick one or more boxes as needed)*

all breeds of goats together ☐
different breeds of goats separated ☐
Male and female are separated ☐
kids are separated ☐
All goats herded together ☐
Other specify
_____ ☐

7. Way of herding

Goats of a household run as a flock ☐
Goats of more than one household run as a flock ☐
Other specify ☐
_____

8. If the answer is b, how many household mix their goats together _____

9. Do you give your goat for some one else as 'rebi'?

A. Yes ☐ B. No ☐

9.1. if yes, tell me the breed types *(tick on or more box)*

A. indigenous ☐ B. crossbred ☐
C. exotic ☐

10. If your answer for question 9 is "yes", why do you give as 'rebi'? *(Tick one or more box(in "X" column) and rank (in "R" column))*

Reasons	X	R
. Shortage of labor	☐	☐
. Feed shortage	☐	☐
. Large flock size	☐	☐
Other specify	☐	☐
. _____		

11. What is the agreement during giving your goats as 'rebi'

_____

12. Grazing method

	X	Amount in 'ha'
A. Free grazing	☐	_____
B. Herded	☐	_____
C. Paddock	☐	_____
D. Tethered	☐	
E. Zero-grazing	☐	
Other (specify)		

13. Length of grazing times (in hours):

Morning from _____to _____
After noon _____to_____
The whole day _____hours

14. Use of communal grazing

A. Yes ☐ B. No ☐

15. Trend in communal grazing areas?

A. Decreasing ☐ B. Increasing ☐ C. Stable ☐

16. Crop residues used for goat

A. Wheat ☐
B. Barley ☐
C. Sorghum ☐
D. Maize ☐
E. Bean ☐
F. Pea ☐
G. Lentil ☐
H. Chick pea ☐
Other Specify
I._____ ☐
F. _____ ☐

16.1. List the three most important crop residues

. 1 _____
. _____
. 3 _____

17. source of the crop residues for goats

		Amount / year
. bought from market	☐	_____
. From my own crops	☐	_____
. Other sources (specify)		
_____	☐	_____

15.1. Reason

_____

18. Supplements used for goat *(Tick one or more box(in "X" column) and write its amount (kg/week) in the second column)*	**X**	**Amount (Kg/ Week)**
A. Minerals (salts)/vitamins		_____
B. protein concentrates (meat meal, blood meal, bone meal)		_____
C. energy concentrates (wheat barn, wheat bran, cereals)		_____
D. legumes		_____
E. oil seed meals		_____

19. Is there seasonal fluctuation in feed supply?

A. Yes ☐
B. No ☐

20. At which season of the year do you experience feed shortage?

_____

21. What is your copping mechanism?

_____
_____
_____

25. Source of water*(Tick one or more boxes in each column)*

	Dry season	Wet season
A. freely available water sources as river, dam etc	☐	☐
B. Pipe water	☐	☐

25.1. Could you specify the total amount of money you spend per week for watering your whole goats?

_____ Birr/week

26. Distance to nearest watering point for adult animals is about *(Tick one box in each column)*

	Dry season	Wet season
A. Watered at home	☐	☐
B. 1km	☐	☐
C. 5 km	☐	☐
D. 10 km	☐	☐
E. 15km	☐	☐

27. Frequency of watering for adult animals *(Tick one box in each column)*

	Wet season	Dry season
A. Freely available	☐	☐

28. Are kids watered with the adults?

A. Yes		B. .No	

C. Once a day
D. Once in 2 days
E. Once in 3 days
F. Other (specify)
G. _____

29.1. If "No", describe watering distance and frequency

Watering distance _____

watering frequency _____

Housing in goats

1. Do you house different breeds of goats in separate houses/enclosure

A. Yes ☐ B. No ☐

2. Are kids housed with adults? *(Tick one box)*

A. Yes ☐ B. No ☐

3. Housing/enclosure for adult and kid goats *(Tick one or more boxes; **Tick on the "kids" column only if your answer for question 2 is "No")***

		Adults	Kids
With roof	A. In family house		
	B. Separate house		
	C. Veranda		
Without roof	D. Kraal		
	E. Yard		
	F. None		
	Other (specify) G. _____		

4.Type of housing materials *(Tick one or more boxes in each column)*

	Roof	Wall	Floor
A. Iron sheets			
B. Grass/Bushes			
C. Wood			
D. Stone/bricks			
E. Earth/mud			
F. Concrete			
Other (specify) G. _____			

Goat Breeding

1. Source of buck (s) with in the last 12 months *(Tick one or more boxes in the "X" column and write their corresponding numbers in the "Number" column.)*

	X	Number
A. Own buck just for service		
B. own buck for meat production		
C. borrowed		
D. paying for serving buck		
E. any available buck		

1.1. *If you are paying for serving buck, how much do you pay for each service?*

_____ Birr.

2. Breeding/mating *type* *(Tick one or more boxes and rank)*

	X	R
A. Controlled		
B. Uncontrolled		

GOAT PRODUCTS AND MARKETING

1. Method of sale *(Tick one or more boxes)*

A. Sold at market ☐
B. Sold to neighbour ☐
C. Sold to traders ☐
D. Sold to butchers ☐

2. Reasons for selling *(Tick one or more boxes)*

A. Cash needed ☐
B. Disposal/culling ☐

3. How many livestock do you slaughter this year? *(Write in number)*

Animals	For festival	For cultural ceremonies	For religious purposes	Just to eat

A. Goat				
B. Sheep				
C. Cattle				
D. Camel				
E. Poultry				
Other (specify) F. _____				

4. What is the source of these goats? *(Write in number)*

Source of goats for slaughter	Number			
	Local breed 1	Local breed 2	Local X Local	Local X Exotic
A. Your own goats				
B. Purchased				
C. Gifts				
Other sources (specify) D. _____				

5. Do you buy meat than slaughtering your animals?

A. Yes ☐ B. No ☐

6. If yes why do you buy?

A. When I need small quantity ☐ B. I just want my animal alive ☐

C. I want to keep my animals for more serious time ☐

D. My animals are more productive I am buying ☐

7. What breed of goat do you have?

A. Indigenous ☐ B. Exotic ☐ C. Crossbreed ☐

8. Goat breed types and their numbers in the flock.

Goat breed	**Sources** *(choose one or more numbers indicated bellow as appropriate)* *1	**Number**
Indigenous (types) A. _____ B. _____ C. _____	A. _____ B. _____ C. _____	A. _____ B. _____ C. _____
Crossbred (types) D. _____ E. _____ F. _____	D. _____ E. _____ F. _____	D. _____ E. _____ F. _____
exotic (types) G. _____ H. _____ I. _____	G. _____ H. _____ I. _____	G. _____ H. _____ J. _____

*[1] Sources of the goat breeds

Inherited (1), Marketed (2), NGO/Project (3), State farm (4), Neighbour (5)
Gift (6) other (specify) _____ (7)

Castration/entries/exits/culling

1. Castration

1.1. Do you castrate? *(Tick one box)*

A. Yes ☐
B. No ☐

1.2. If no, Give reason why not _____

1.3. If "yes", at what age do you castrate? *(Tick one or more boxes)*

	Local breed 1	Local breed 2	Local X Local	Local X Exotic	Pure exotic
A. < 1 months	☐	☐	☐	☐	☐
B. 1-3 months	☐	☐	☐	☐	☐
C. 3-12 months	☐	☐	☐	☐	☐
D. > 12 months	☐	☐	☐	☐	☐

2. Entries and Exit

Numbers of animals added to the herd in the last 12 months *(Enter numbers)*

	Local breed 1		Local breed 2		Local X Local		Local X Exotic		Pure exotic	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
A. Born										
B. Bought										
C. Donated										
D. Exchanged										
E. borrowed										

2.2. Numbers of animals reduced from the herd in the last 12 months *(Enter numbers)*

	Local breed 1		Local breed 2		Local X Local		LocalX Exotic		Pure exotic	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	female
A. Sold										
B. Slaughtered										
C. Exchanged										
D. borrowed										
E. Died										
F. Stolen										
G. Donated										

CROSSBREED (LOCAL BREED X EXOTIC)-BREED SPECIFIC INFORMATION

COMPLETE THIS FORM FOR A CROSSBREED (LOCAL BREED X EXOTIC).
If crossing of two breeds has resulted in a genotype that is recognised and maintained as a breed, then also use this form for this breed.

CROSSBREED (LOCAL BREED X EXOTIC)

1. Common/local name (s) _____
Code _____

2. Numbers by sex *(Enter numbers)*

	Number
A. Intact male	
B. Castrated male	
C. Female	

4. Tend in this breed (*Tick in one box)*

A. Increasing	
B. Stable	
C. Decreasing	
D. Unknown	

3. Numbers by age and sex *(Enter numbers)*

Age groups	Status of the animal	Make "X" mark if present in your flock	Number
Kids < 1 month	Male		
	Female		
Kids 1 – 3 months	Male		
	Female		
Weaned kids 3 - 12 Months	Male		
	Female Non-lactating pregnant		
	Female Non lactating non pregnant		
Mature goats > 12 months	Male for Fattening		
	Male Breeder		
	Male as Capital		
	Female for Fattening		
	Female Pregnant Non-lactating		
	Female Empty Lactating		
	Female Empty Non-lactating		
	Female as Capital		

5. Prolificacy*

	X	R
A. Singletons		
B. Twins		
C. Triplets		
D. Quadruplet		

** Tick in the "X" column if they occur. Then rank top three in the "R" column; 1 for primary occurrence, etc.*

6. Purpose of keeping goat * *(Tick one or more boxes)*

	Male		Female	
A. Meat				
B. Milk				
C. Breeding				
D. Manure				
E. Blood				
F. Hide				
G. Savings				
H. Wealth status				
I. Dowry				
J. Ceremonies				
K. Income				
Other (specify) L. _____				

** Tick any purpose considered in first half of box; one or more boxes to be ticked in a column. Then rank top three by writing in second half of a box; 1 for primary purpose, 2 for second, 3 for third.*

7. Quality of traits perceived by owner for this breed *(For each trait tick one box in a row)*

(For each trait tick one box in a row)

	No opinion	Not important	Poor	Average	Good
A. Size…….. ……					
B. Colour ……...					
C. Horns ……					
D. Heat tolerance……					
E. Cold tolerance……					
F. Character….. ……..……..					
G. Milk yield ……					
H. Meat quality……					
I. Growth rate …….					
J. Ability to walk long distances					
K. Fertility ……					
L. Longevity……..					
M. Disease tolerance…….....					
N. Drought tolerance…….					
Other (specify) O. _____					

THE PRODUCTION SYSTEM

Feeding Goats

1. Grazing method *(Tick one or more boxes in the" X" column. Then show their specific amount in 'ha' or specify the name of the grazing land.)*

	X	R	Amount in 'ha'
A. Free grazing			_____

2. Do you feed your goats separately?

A. Yes ☐ B. No ☐

B. Herded _____
C. Paddock _____
D. Tethered _____
E. Zero-grazing ___
Other (specify)
F. _____

3. Do you feed this breed separately?

A. Yes ☐ B. No ☐

4. If you feed this breed separately, tell me if you group the goats into age classes.

A. Yes ☐ B. No ☐

5. If you say "No" for question 16, tell me about the type and amount of feed you used for this breed.

5.1. Feed offered to the local Crossbreed *(tick in the first box if you used that feed and show the amount in the space provided)*

Hay (kg/day)	Legumes (Kg/day)	Crop residue (kg/ day)	Concentrate (kg/ day)	Other (specify) _____
☐ _____	☐ _____	☐ _____	☐ _____	☐ _____

5.2. Grazing land for local Crossbreed *(tick in the first box if you used that grazing land and show the amount in the space provided)*

Natural pasture (ha)	Established pasture (ha)	Fallow land (ha)	Other (specify) _____
☐ _____	☐ _____	☐ _____	☐ _____

6. If you say "yes" for question 16, what goat age classes do you use for the grouping?

Age Classes

Kids that feed on milk only (A1-male, A2-females)

Kids that doesn't wean but start eating roughage. (B1-male, B2-females)

Kids that wean up to maturity (C1-male, C2-females)

mature goats (D1-male, D2-females)

6.1. Age classes you made in your flock.

(Write the alphabets that are indicated in bracket. You may write more than one alphabets when age groups in the left are mixed)

A. Group 1 _____
B. Group 2 _____
C. Group 3 _____
D. Group 4 _____
E. Group 5 _____
F. Group 6 _____

7. To each group what and how much feed do you offer?

7.1. Feeds offered to each group *(Make tick mark(X) in the first column if you used the feed for that group and write the amount of feed in the second column)*

	Hay (kg/day)	Legumes (Kg/day)	Crop residue (kg/ day)	Concentrate (kg/ day)	Other (specify) _____
Group 1	☐ _____	☐ _____	☐ _____	☐ _____	☐ _____
Group 2	☐ _____	☐ _____	☐ _____	☐ _____	☐ _____
Group 3	☐ _____	☐ _____	☐ _____	☐ _____	☐ _____
Group 4	☐ _____	☐ _____	☐ _____	☐ _____	☐ _____
Group 5	☐ _____	☐ _____	☐ _____	☐ _____	☐ _____
Group 6	☐ _____	☐ _____	☐ _____	☐ _____	☐ _____

7.2. grazing land for each group *(Make tick mark (X) in the first column if you used the land for that group and write the amount of land (ha) in the second column)*

	Natural pasture (ha)	Established pasture (ha)	Fallow land (ha)	Other (specify) _____
Group 1	☐ _____	☐ _____	☐ _____	☐ _____

Group 2	☐ _____	☐ _____	☐ _____	☐ _____
Group 3	☐ _____	☐ _____	☐ _____	☐ _____
Group 4	☐ _____	☐ _____	☐ _____	☐ _____
Group 5	☐ _____	☐ _____	☐ _____	☐ _____
Group 6	☐ _____	☐ _____	☐ _____	☐ _____

8. Supplements used for goat *(Tick one or more box(in "X" column) and write its amount (kg/week) in the second column)*	**X**	**Amount (Kg/ Week)**	**Age groups** * *(which are mainly supplemented with these feeds)*
A. Minerals (salts)/vitamins		_____	_____
B. protein concentrates (meat meal, blood meal, bone meal)		_____	_____
C. energy concentrates (wheat barn, wheat bran, cereals)		_____	_____
D. legumes		_____	_____
E. oil seed meals		_____	_____

** (write **age group** numbers form 1 – 6, you may write more than one group as appropriate c.)*

7.3. Animals which are supplemented*		X	Amount (Kg/week)
Kids 1 – 3 months	Male		_____
	Female		
Weaned kids up to maturity (3 - 12 Months)	Male		_____
	Female; Non-lactating pregnant		
	Female; Non lactating non pregnant		
Mature goats > 12 months	Male; for Fattening		_____
	Male; Breeder		_____
	Male; as Capital		_____
	Female; for Fattening		
	Female; Pregnant Non-lactating		
	Female; Empty Lactating		
	Female; Empty Non-lactating		
	Female; as Capital		

***** *(Tick one or more box (in "X" column) and write its amount (kg/week) in the second column)*

8. Members of household and hired labour responsible for goat activities

(write the number of family or hired labours in each box in each column and row;
of the household and the second refers to hired labour). (*F = family, H = Hired)

	Adults				**Children**			
	Males (>15y)		Females (>15y)		Boys (≤15y)		Girls (≤15y)	
	F*	H	F	H	F	H	F	H
A. Purchasing goat								
B. Selling goat								
C. Herding								
D. Breeding								
E. Caring for sick animals								

F. Feeding								
G. Milking								
H. Making dairy products								
I. Selling dairy products								
Other (specify)								
J._____								

8.1. Number of family members or hired labour involved in the above activities *(write in number)*

Family members *(write in number)*				Hired labour *(write in number)*			
Male		Female		Male		Female	
≤ 15 year	> 15 years	≤ 15 year	> 15 years	≤ 15 year	> 15 years	≤ 15 year	> 15 years

8.2. How much do you pay for the hired labour *(birr/individual)*

Male		Female	
≤ 15 year	> 15 years	≤ 15 year	> 15 years

CROSSBREED (LOCAL BREED X EXOTIC) - PRODUCTION CHARACTERISTICS

1. Average age at sexual maturity

Male animals		Months
Female animals		Months

2. Age at first kidding

Average		Months
Maximum		Months
Minimum		Months

3. kidding interval

Average		Months
Maximum		Months
Minimum		Months

4. Kidding pattern, occurrence of most births *(Tick one or more boxes then rank top three in second half of box)*

January		July	
February		August	
March		September	
April		October	
May		November	
June		December	

5. Average marketable age of young stock

Males		Months
Females		Months

6. Is the breed milked? *(Tick one box)*

A. Yes
B. No

7. Milk production per animal per day * *Assume 1 litre = 1 kg*

Average		Litres*
Maximum		Litres
Minimum		Litres

8. Lactation length

Average		Months
Maximum		Months
Minimum		Months

9. Frequency of milking *(Tick one box)*

A. Once a day
B. Twice a day

10. Average weaning age of kids *(Tick one box)*

A. <2 months
B. 2.5 months
C. 3.5 months

C. Three times a day ☐

D. 4.5 months ☐
E. > 5 Months ☐

11. Milk feeding up to weaning *(Tick one box)*

A. Unrestricted suckling ☐
B. Restricted suckling ☐
C. Bucket feeding ☐
Other (specify)
D. _____ ☐

12. If "restricted suckling" how much time the kids get milk.

A. Once a day ☐ C. Whole day only ☐
B. Twice a day ☐ D. Whole night only ☐

13. If you say bucket feeding, how much milk do you give to the kid per day?

_____ Kg/day

14. When did newly born kids start feeding some other type of feed than their doe milk?

_____ days.

15. at what age do kids wean?

A. _____ weaks

B. I don't know ☐

16. If you say "I don't know" why?

_____.

17. Do you take body weight measurements?

A. Yes ☐ B.No ☐

18. If yes, at what interval?

A. Week ☐ B. 15 days ☐ C. one month ☐ D. other (specify) _____ ☐

Goat housing

1. Do you house different breeds of goats in separate houses/enclosure

A. Yes ☐ B. No ☐

2. If "yes" specify the housing/enclosure for adult and kid goats *(Tick one or more boxes;* **Tick on the "kids" column only if kids are housed separately)**

		Adults	Kids
With roof	In family house	☐	☐
	Separate house	☐	☐
	Veranda	☐	☐

		Adults	Kids
Without roof	Kraal	☐	☐
	Yard	☐	☐
	None	☐	☐
	Other (specify) _____	☐	☐

Goats Health

1. Name of disease and type of treatments (or symptoms when name is not known) *(Tick one or more boxes)*

Name of a disease	Disease Code	Treatments	
		Modern	Traditional
A. _____		☐	☐
B. _____		☐	☐
C. _____		☐	☐
D. _____		☐	☐

1. If the treatments are traditional, specify

Disease Code

A. _____ ☐
B. _____ ☐
C. _____ ☐

2. For what diseases vaccinations are given *(Tick one box)*

Name of disease (or symptoms when name is not known)	Disease Code	Done routinely	Done when need arises
A. _____	☐	☐	☐
B. _____	☐	☐	☐
C. _____	☐	☐	☐
D. _____	☐	☐	☐

3. Disease tolerance/resistance of the breed (crossbreed)

1. Name of disease (or symptoms when name is not known)

Disease Code

A. _____ ☐
B. _____ ☐
C. _____ ☐
D. _____ ☐

4. How many times, per year, do you apply internal and external parasite treatments?

_____.

5. Which age group are mainly treated for internal and external parasite?

_____.

6. External parasite application methods *(Tick one or more box)*

		Modern	Traditional
A. None	☐		
B. Dip	☐	☐	☐
C. Spray	☐	☐	☐
D. Pour-on	☐	☐	☐
E. Rubbing	☐	☐	☐
Other (specify)			
F. _____	☐	☐	☐

7. Internal parasite application methods *(Tick one or more box)*

		Modern	Traditional
A. None	☐		
B. Drench	☐	☐	☐
C. Bolus/tablet	☐	☐	☐
	☐	☐	☐
Other (specify)			
D. _____	☐	☐	☐

8. Number of deaths in the last 12 months *(Enter numbers)*

	Kids that feed milk only	Kids that doesn't wean but start eating roughage	Kids that wean up to maturity	mature goats

9. Reasons for death *(Tick one or more boxes, then rank top 3)*

A. Predators	☐	☐
B. Disease	☐	☐
C. Accident	☐	☐
D. Poisoning	☐	☐
E. Unknown	☐	☐

Male				
Female				

F. Drought

Other (specify)

G. _____

Goat Breeding

1. Source of buck (s) within the last 12 months *(Tick one or more boxes in the "X" column and write their corresponding numbers in the "Number" column.)*

	X	Number
A. Own buck just for service		
B. own buck for meat production		
C. borrowed		
D. any available buck		

8.2.1.1.1.1 CROSSBREED (LOCAL BREED X EXOTIC)- Phenotypic description

1. Colour. *Enter number(s) from colour chart. If animals have more than one colure, complete the columns according to the frequency of colour combinations- the first raw for the frequently occurring colour.*

	Body		Head		Extremities	
A. Main colour		A. 1		A. 1		
B. Secondary colour		B.		B.		
C. third		C.		C.		
D. fourth		D.		D. 4		
E. fifth		E.		E.		

2. CROSSBREED (LOCAL BREED X EXOTIC) - Phenotypic description (cont.)

To complete this page, select an adult female and an adult intact male. If they are not present on the farm, indicate what other kind of age group you selected (e.g. kid, castrated buck, etc.)

13. Coat description		Females Adult		Males Adult
Pattern ……	Uniform…		…..	
	Pied……		…..	
	Spotty……		…..	
	Shaded…..		…..	
Hair length……	Short……...		…..	
	Medium…..		…..	
	Long……..		…..	
Hair type……..	Straight…...		…..	

		Females Adult		Males Adult
Toggles…….	Present……..		…..	
	Absent……..		…..	
Muzzle……..	Pigmented…		…..	
	Not pigmented…		…..	
Wattle……...	Present…….		…..	
	Absent……		…..	

17. Ears ___

Curly..……. ☐ ….. ☐

14. Long hair

Head …….. Present…… ☐ ….. ☐
Absent..….. ☐ ….. ☐

Neck …… Present..….. ☐ ….. ☐
Absent……. ☐ ….. ☐

Chest……. Present…… ☐ ….. ☐
Absent……. ☐ ….. ☐

Across the back Present….. ☐ ….. ☐
Absent…… ☐ ….. ☐

Legs……. Present…… ☐ ….. ☐
Absent……. ☐ ….. ☐

Thighs…….. Present…. ☐ ….. ☐
Absent……. ☐ ….. ☐

		Females Adult		Males Adult
Tail……..	Present..…..	☐	…..	☐
	Absent……	☐	…..	☐

15. Body

		cm		cm
Height at withers	…….		….	
Heart girth	……..		….	
Body length	…….		…..	

Shape…… hort/com-pact ☐ ….. ☐
Lanky/leggy ☐ ….. ☐
In between. ☐ ….. ☐

16. Face

Profile…….. Flat…… ☐ ….. ☐
Concave…. ☐ ….. ☐
Convex….. ☐ ….. ☐

Beard……. Present…... ☐ ….. ☐
Absent……. ☐ ….. ☐

Length (cm) ….. …….. ☐ ….. ☐

Orientation……. Upright...….. ☐ ….. ☐
Lateral ……. ☐ ….. ☐
Dropping.…. ☐ ….. ☐
Forward…… ☐ ….. ☐

18. Horns

Presence…… Yes……. ☐ ….. ☐
No……. ☐ ….. ☐

Shape…… Straight…... ☐ ….. ☐
Curved…….. ☐ ….. ☐
Spiral……. ☐ ….. ☐

Length (cm)…... ……. ☐ ….. ☐

Orientation…… Upright……. ☐ ….. ☐
Forward ...…. ☐ ….. ☐

		Females Adult		Males Adult
	Backward….	☐	…..	☐
	Lateral …….	☐	…..	☐
	Dropping…..	☐	…..	☐

19. Udder (after peak of lactation)

Size…….. Small…… ☐ ….. ☐
Medium…. ☐ ….. ☐
Large…..… ☐ ….. ☐

20. Testis

Size…….. Small…… . ….. ☐
Medium…. . ….. ☐
Large……. . ….. ☐

PURE INDIGENOUS/LOCAL BREED -BREED SPECIFIC INFORMATION

COMPLETE THIS FORM FOR A PURE LOCAL BREED.

BREED 1

1. Common/local name (s) _____

Code _____

2. Numbers by sex *(Enter numbers)*

	Number
A. Intact male	
B. Castrated male	
C. Female	

3. Tend in this breed (*Tick in one box)*

A. Increasing	
B. Stable	
C. Decreasing	
D. Unknown	

4. Numbers by age and sex *(Enter numbers)*

Age groups	Status of the animal	Make "X" mark if present in your flock	Number
Kids < 1 month	Male		
	Female		
Kids 1 – 3 months	Male		
	Female		
Weaned kids 3 - 12 Months	Male		
	Female Non-lactating pregnant		
	Female Non lactating non pregnant		
Mature goats > 12 months	Male for Fattening		
	Male Breeder		
	Male as Capital		
	Female for Fattening		
	Female Pregnant Non-lactating		
	Female Empty Lactating		
	Female Empty Non-lactating		
	Female as Capital		

5. Prolificacy*

	X	R
A. Singletons		
B. Twins		
C. Triplets		
D. Quadruplet		

** Tick in the "X" column if they occur. Then rank top three in the "R" column; 1 for primary occurrence, etc.*

6. Purpose of keeping goat * *(Tick one or more boxes)*

	Male		Female	
A. Meat				
B. Milk				
C. Breeding				
D. Manure				
E. Blood				
F. Hide				
G. Savings				
H. Wealth status				
I. Dowry				
J. Ceremonies				
K. Income				
Other (specify)				
L. _____				

** Tick any purpose considered in first half of box; one or more boxes to be ticked in a column. Then rank top three by writing in second half of a box; 1 for primary purpose, 2 for second, 3 for third.*

7. Quality of traits perceived by owner for this breed *(For each trait tick one box in a row)*

(For each trait tick one box in a row)

	No opinion	Not important	Poor	Average	Good
A. Size…….. …….					
B. Colour ……...					
C. Horns ……					
D. Heat tolerance……					
E. Cold tolerance……					
F. Character….. ……..……..					
G. Milk yield ……					
H. Meat quality……					
I. Growth rate …….					
J. Ability to walk long distances					
K. Fertility ……					
L. Longevity……..					
M. Disease tolerance…….....					
N. Drought tolerance…….					
Other (specify)					
O. _____					

THE PRODUCTION SYSTEM
Feeding Goats

1. Grazing method *(Tick one or more boxes in the" X" column. Then show their specific amount in 'ha' or specify the name of the grazing land.)*

	X	R	Amount in 'ha'
A. Free grazing			_____
B. Herded			_____
C. Paddock			_____
D. Tethered			_____
E. Zero-grazing			
Other(specify)			
F. _____			

5. If you say "No " for question 16, tell me about the type and amount of feed you used for this breed.

2. Do you feed your goats separately?

A. Yes ☐ B.No ☐

3. Do you feed this breed separately?

A. Yes ☐ B. No ☐

4. If you feed this breed separately, tell me if you group the goats into age classes.

A. Yes ☐ B. No ☐

5.1. Feed offered to the local breed 1 *(tick in the first box if you used that feed and show the amount in the space provided)*

Hay (kg/day)	Legumes (Kg/day)	Crop residue (kg/ day)	Concentrate (kg/ day)	Other (specify) _____
☐ _____	☐ _____	☐ _____	☐ _____	☐ _____

5.2. Grazing land for local breed 1 *(tick in the first box if you used that grazing land and show the amount in the space provided)*

Natural pasture (ha)	Established pasture (ha)	Fallow land (ha)	Other (specify) _____
☐ _____	☐ _____	☐ _____	☐ _____

6. If you say "yes" for question 16, what goat age classes do you use for the grouping?

Age Classes

Kids that feed on milk only (A1-male, A2-females)

Kids that doesn't wean but start eating roughage. (B1-male, B2-females)

Kids that wean up to maturity (C1-male, C2-females)

mature goats (D1-male, D2-females)

6.1. Age classes you made in your flock.

(Write the alphabets that are indicated in bracket. You may write more than one alphabets when age groups in the left are mixed)

A. Group 1 _____
B. Group 2 _____
C. Group 3 _____
D. Group 4 _____
E. Group 5 _____
F. Group 6 _____

7. To each group what and how much feed do you offer?

7.1. Feeds offered to each group *(Make tick mark(X) in the first column if you used the feed for that group and write the amount of feed in the second column)*

	Hay (kg/day)	Legumes (Kg/day)	Crop residue (kg/ day)	Concentrate (kg/ day)	Other (specify) _____
Group 1	☐ _____	☐ _____	☐ _____	☐ _____	☐ _____
Group 2	☐ _____	☐ _____	☐ _____	☐ _____	☐ _____
Group 3	☐ _____	☐ _____	☐ _____	☐ _____	☐ _____

Group 4	☐	_____	☐	_____	☐	_____	☐	_____	☐ _____
Group 5	☐	_____	☐	_____	☐	_____	☐	_____	☐ _____
Group 6	☐	_____	☐	_____	☐	_____	☐	_____	☐ _____

7.2. grazing land for each group *(Make tick mark (X) in the first column if you used the land for that group and write the amount of land (ha) in the second column)*

	Natural pasture (ha)		Established pasture (ha)		Fallow land (ha)		Other (specify) _____	
Group 1	☐	_____	☐	_____	☐	_____	☐	_____
Group 2	☐	_____	☐	_____	☐	_____	☐	_____
Group 3	☐	_____	☐	_____	☐	_____	☐	_____
Group 4	☐	_____	☐	_____	☐	_____	☐	_____
Group 5	☐	_____	☐	_____	☐	_____	☐	_____
Group 6	☐	_____	☐	_____	☐	_____	☐	_____

8. Supplements used for goat *(Tick one or more box(in "X" column) and write its amount (kg/week) in the second column)*	**X**	**Amount (Kg/ Week)**	**Age groups** * *(which are mainly supplemented with these feeds)*
A. Minerals (salts)/vitamins	☐	_____	
B. protein concentrates (meat meal, blood meal, bone meal)	☐	_____	
C. energy concentrates (wheat barn, wheat bran, cereals)	☐	_____	
D. legumes	☐	_____	
E. oil seed meals	☐	_____	

* *(write **age group** numbers form 1 – 6, you may write more than one group as appropriate c.)*

7.3. Animals which are supplemented*		X	Amount (Kg/week)
Kids 1 – 3 months	Male	☐	_____
	Female	☐	
Weaned kids up to maturity (3 - 12 Months)	Male	☐	_____
	Female; Non-lactating pregnant	☐	
	Female; Non lactating non pregnant	☐	
Mature goats > 12 months	Male; for Fattening	☐	_____
	Male; Breeder	☐	_____
	Male; as Capital	☐	_____
	Female; for Fattening	☐	
	Female; Pregnant Non-lactating	☐	
	Female; Empty Lactating	☐	
	Female; Empty Non-lactating	☐	
	Female; as Capital	☐	

***** *(Tick one or more box (in "X" column) and write its amount (kg/week) in the second column)*

8.1. Number of family members or hired labour involved in the above activities *(write in number)*

Family members *(write in number)*				Hired labour *(write in number)*			
Male		Female		Male		Female	
≤ 15 year	> 15 years	≤ 15 year	> 15 years	≤ 15 year	> 15 years	≤ 15 year	> 15 years

8.2. How much money do you pay per month for the hired labour *(birr/individual/month)*

Male		Female	
≤ 15 year	> 15 years	≤ 15 year	> 15 years

PURE INDIGENOUS/LOCAL BREED 1 - PRODUCTION CHARACTERISTICS

1. Average age at sexual maturity

Male animals ☐ Months

Female animals ☐ Months

2. Age at first kidding

Average ☐ Months

Maximum ☐ Months

Minimum ☐ Months

3. kidding interval

Average ☐ Months

Maximum ☐ Months

Minimum ☐ Months

5. Average marketable age of young stock

Males		Months
Females		Months

6. Is the breed milked? *(Tick one box)*

A. Yes ☐

B. No ☐

7. Milk production per animal per day * *Assume 1 litre = 1 kg*

Average ☐ Litres*

Maximum ☐ Litres

Minimum ☐ Litres

8. Lactation length

Average ☐ Months

Maximum ☐ Months

Minimum ☐ Months

9. Frequency of milking*(Tick one box)*

A. Once a day ☐

B. Twice a day ☐

C. Three times a day ☐

10. Average weaning age of kids*(Tick one box)*

A. <2 months ☐

B.2.5 months ☐

C.3.5 months ☐

D. 4.5 months ☐

E.> 5 Months ☐

11. Milk feeding up to weaning *(Tick one box)*

A. Unrestricted suckling ☐

B. Restricted suckling ☐

C. Bucket feeding ☐

Other (specify)

D. _____ ☐

12. If "restricted suckling" how much time the kids get milk.

A. 1. Once a day ☐

B. 2. Twice a day ☐

C. Whole day only ☐

D. Whole night only ☐

_____ Kg/day

14. When did newly born kids start feeding some other type of feed than their doe milk?

_____ days.

15. at what age do kids wean?

A. _____ weeks

B. I don't know ☐

16. If you say "I don't know" why?

_____.

17. Do you take body weight measurements?

A. Yes ☐ B. No ☐

18. If yes, at what interval?

A. Week ☐ B. 15 days ☐ C. one month ☐ D. other (specify) _____ ☐

Goat housing

1. Do you house different breeds of goats in separate houses/enclosure

A. Yes ☐ B. No ☐

2. If "yes" specify the hhousing/enclosure for adult and kid goats *(Tick one or more boxes;* **Tick on the "kids" column only if kids are housed separately)**

		Adults	Kids
With roof	A. In family house	☐	☐
	B. Separate house	☐	☐
	C. Veranda	☐	☐
Without roof	D. 4. Kraal	☐	☐
	E. 5. Yard	☐	☐
	F. 6. None	☐	☐
	Other (specify)		
	G. 7._____ _	☐	☐

Goats Health

1. Name of disease and type of treatments (or symptoms when name is not known) *(Tick one or more boxes)*

Name of a disease	Disease Code	Treatments: Modern	Treatments: Traditional
A. _____	☐	☐	☐
B. _____	☐	☐	☐
C. _____	☐	☐	☐
D. _____	☐	☐	☐

1.1. If the treatments are traditional, specify

	Disease Code
A. _____	☐
B. _____	☐
C. _____	☐

2. For what diseases vaccinations are given *(Tick one box)*

Name of disease (or symptoms when name is not known)	Disease Code	Done routinely	Done when need arises
A. _____	☐	☐	☐
B. _____	☐	☐	☐
C. _____	☐	☐	☐
D. _____	☐	☐	☐

3. Disease tolerance/resistance of the breed (local breed 1)

1. Name of disease (or symptoms when name is not known)	Disease Code

A. _____
B. _____
C. _____
D. _____

4. How many times, per year, do you apply internal and external parasite treatments?

_____.

5. Which age group are mainly treated for internal and external parasite?

_____.

6. External parasite application methods *(Tick one or more box)*

		Modern	Traditional
A. None			
B. Dip			
C. Spray			
D. Pour-on			
E. Rubbing			

Other (specify) ___ ___ ___

7. Internal parasite application methods *(Tick one or more box)*

		Modern	Traditional
A. None			
B. Drench			
C. Bolus/tablet			
Other (specify)			
D. _____			

8. Number of deaths in the last 12 months *(Enter numbers)*

	Kids that feed milk only	Kids that doesn't wean but start eating roughage	Kids that wean up to maturity	mature goats
Male				

9. Reasons for death *(Tick one or more boxes, then rank top 3)*

A. Predators		
B. Disease		
C. Accident		
D. Poisoning		
E. Unknown		
F. Drought		
Other (specify)		
G. _____		

Goat Breeding

1. Source of buck (s) within the last 12 months *(Tick one or more boxes in the "X" column and write their corresponding numbers in the "Number" column.)*

	X	Number
A. Own buck just for service		
B. own buck for meat production		
C. borrowed		
D. any available buck		

8.2.1.1.1.2 Pure indigenous/local breed 1 - Phenotypic description

12. Colour. *Enter number(s) from colour chart. If animals have more than one colure, complete the columns according to the frequency of colour combinations- the first raw for the frequently occurring colour.*

	Body	Head	Extremities
A. Main colour	A.	A.	

B. Secondary colour		B.		B.	
C. third		C.		C.	
D. fourth		D.		D.	
E. fifth		E.		E.	

13. Coat description

		Females Adult		Males Adult	
Pattern ……	Uniform…		…..		
	Pied……		…..		
	Spotty……		…..		
	Shaded…..		…..		
Hair length……	Short……...		…..		
	Medium…..		…..		
	Long…..…..		…..		
Hair type……..	Straight…...		…..		
	Curly..…….		…..		

14. Long hair

Head ……..	Present……		…..		
	Absent..…..		…..		
Neck ……	Present..…..		…..		
	Absent…….		…..		
Chest…….	Present……		…..		
	Absent…….		…..		
Across the back	Present…..		…..		
	Absent……		…..		
Legs…….	Present……		…..		
	Absent…….		…..		
Thighs……..	Present….		…..		
	Absent…….		…..		

		Females Adult		Males Adult	
Tail……..	Present..…..		…..		
	Absent……		…..		

15. Body

		cm		cm
Height at withers	…….		….	
Heart girth	……..		….	
Body length	…….		…..	

		Females Adult		Males Adult	
Toggles…….	Present……..		…..		
	Absent……..		…..		
Muzzle……..	Pigmented…		…..		
	Not pigmented….		…..		
Wattle……...	Present…….		…..		
	Absent……		…..		

17. Ears

Length (cm) …..	……..		…..		
Orientation…….	Upright...…..		…..		
	Lateral …….		…..		
	Dropping.….		…..		
	Forward……		…..		

18. Horns

Presence……	Yes…….		…..		
	No…….		…..		
Shape……	Straight…...		…..		
	Curved……..		…..		
	Spiral…….		…..		
Length (cm)…...	…….		…..		
Orientation……	Upright…….		…..		
	Forward ...….		…..		

		Females Adult		Males Adult	
	Backward….		…..		
	Lateral …….		…..		
	Dropping…..		…..		

19. Udder (after peak of lactation)

Size……..	Small……		…..		
	Medium….		…..		

					Large…..…		…..	
Shape……	ıort/com-pact		…..				
	Lanky/leggy		…..		**20. Testis**			
	In between.		…..		Size……..	Small……	.	…..	
16. Face						Medium….	.	…..	
Profile……..	Flat……		…..			Large…….	.	…..	
	Concave….		…..						
	Convex…..		…..						
Beard…….	Present…...		…..						
	Absent…….		…..						

DECLARATION

I, the under signed, declare that this is my own original work, has not been presented for a degree in any university that all sources of materials used for the thesis have been duly acknowledged.

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