View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Epsilon Archive for Student Projects

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Veterinary Medicine and Animal Science
Department of Animal Breeding and Genetics

Estimates of economic values for important traits of two indigenous sheep breeds of Ethiopia

Kahsa Tadel Gebre

Examensarbete / Swedish University of Agricultural Sciences
Department of Animal Breeding and Genetics

455

Uppsala 2009

Master's Thesis, 30 hp

Erasmus Mundus Programme
– European Master in Animal Breeding and Genetics

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Veterinary Medicine and Animal Science
Department of Animal Breeding and Genetics

Estimates of economic values for important traits of two indigenous sheep breeds of Ethiopia

Kahsa Tadel Gebre

Supervisors:
Prof. Johann Sölkner, BOKU, Vienna
Dr. Birgit Fuerst-Waltl, BOKU, Vienna
Dr. Maria Wurzinger, BOKU, Vienna
Prof. Jan Philipsson, SLU, Department of Animal Breeding and Genetics

Examiner:
Birgitta Malmfors, SLU, Department of Animal Breeding and Genetics

Credits: 30 HEC
Course title: Degree project in Animal Science
Course code: EX0556
Programme: Erasmus Mundus programme
– European Master in Animal Breeding and Genetics
Level: Advanced, A2E

Place of publication: Uppsala
Year of publication: 2009
Name of series: Examensarbete / Swedish University of Agricultural Sciences
Department of Animal Breeding and Genetics, 455
On-line publication: http://epsilon.slu.se

Key words: Sheep, Menz, Horro, Bio-economic model, economic values, Ethiopia

Education and Culture
Erasmus Mundus

DEDICATION

This work is dedicated to my beloved guardian mother Kebebush Kebede Abirha and to my parents: my father Tadel Gebre Meressa and my mother Alem Debess Nigussie.

PREFACE

This thesis is part of my M.Sc. study, under the European Master in Animal Breeding and Genetics (EM-ABG) which is financially supported by the Erasmus Mundus scholarship. The thesis aimed at estimation of economic value for important traits of two indigenous sheep breeds of Ethiopia.

Even though, the country is home of diverse populations of sheep; with large role both to the livelihood of resource-poor farmers and the national economy, the current level of on-farm productivity in the smallholder production system is low. Moreover, national sheep breeding schemes which were carried out did not result in major genetic improvement in the sheep population. Among several reasons for failure of the genetic improvement, lack of clear definition of breeding objectives was the most likely obstacle.

In the selection index theory, the aggregate genotype is usually defined as a linear function of traits to be improved; each multiplied by its economic value, which is the value of a unit change in the mean of the trait while keeping the other traits in the aggregate genotype constant. Therefore, breeding objectives have to be defined in economic terms and traits should be included in the breeding goal according to their economic importance. To do so, economic values for important traits in the breeding goal need to be calculated to establish the economic Total Merit Index (TMI) and to assess their impact on the future farm production as well market requirements for the sustainability of breeding programs.

For that reason, economic values for important traits of Menz and Horro indigenous sheep breeds of Ethiopia were derived, adapting the computer program Bio-economic model based on deterministic approach. Furthermore, sensitivity analysis was carried out to determine the robustness of economic values while changing the level of factors.

ACKNOWLEDGMENT

I would like to express my deepest respect and most sincere gratitude to my supervisor, Prof. Johann (Hans) Sölkner for his guidance and encouragement at all stages of my work. His constructive criticism and comments from the initial conception to the end of this work is highly appreciated. I am also indebted to express my heartfelt gratitude and respect to Dr. Birgit Fuerst-Waltl for her advice, encouragement, constructive comments and support starting from the initial conception to the end of this work. My gratitude also extends to Dr. Maria Wurzinger for her encouragement and relevant comments.

I would like also to extend my sincere appreciation and respect to my Co-supervisor Prof. Jan Philipsson for his advice, precise comments, encouragement and sharing his idea. My deep gratitude also goes to my local supervisor Dr. Aynalem Haile for all his critical advices, constructive comments and support during my stay at ILRI as well in the Menz and Shambu research sites for data collection.

I would like also to express my heartfelt gratitude and respect to Prof. Birgitta Malmfors for opening up the opportunity to carry out my thesis in my home land and for her excellent treatment as study coordinator during my stay.

I also wish to express my heartfelt thanks to Gemeda Duguma and Tadele Mirkena for all their advice, encouragement and support by providing relevant information.

I am very grateful also to the International Livestock research Institute (ILRI) for allowing me to use its computer, library and other facilities. My most sincere thanks and appreciation are also due to the ILRI staff members for their kind assistance during my stay.

I would like also to express my deepest appreciation to EM-ABG programe for giving me a unique opportunity to pursue my study in different countries which helps me to get different experiences and for its full financial support not only my allowance but also for my field trip expenses during data collection.

A special appreciation is due to my sister Birhan Haile-Mariam and to my Brothers Araya Gebre-Medihin, Tekeste Nigussie and Yohaness Halefom for their strong encouragement and unreserved support to pursue my study. I am also very grateful to my family and all my friends for their commitment.

TABLE OF CONTENTS

TABLE OF CONTENTS

ABSTRACT

A bio-economic model based on a deterministic approach was adapted to estimate economic values for important traits of Menz and Horro which are indigenous sheep breeds of Ethiopia. A meat sheep with lamb fattening and rearing of young sheep for replacement was modeled. Traits considered were fattening (daily gain), live weight (ewe mature live weight) and functional traits (length of productive life, lambing interval, and litter size, stillbirth and lamb survival). Economic values were derived independently to avoid double counting and economic values were obtained (in €) per ewe place and year and genetic standard deviation. Negative economic values for length of productive life and ewe mature live weight were obtained for both breeds. For Menz, economic values per genetic standard deviation were 0.63 (daily gain), -0.77 (mature ewe live weight), -0.97 (length of productive life), 1.57 (lambing interval), 0.98 (litter size), 0.41 (stillbirth) and 2.20 (lamb survival). Furthermore, economic values of 1.35 (daily gain), -1.26 (mature ewe live weight), -1.15 (length of productive life), 1.98 (lambing interval), 3.67 (litter size), 0.56 (stillbirth) and 3.25 (lamb survival) were achieved for Horro. Setting economic values of length of productive life and mature ewe live weight to zero, relative economic values for the trait complexes (in %) fattening: functional were 11 : 89 and 12.5 : 87.5 for Menz and Horro sheep, respectively. Economic values for litter size, lambing interval and lamb survival were sensitive to changes of prices of breeding rams in both breeds.

Keywords: Sheep, Menz, Horro, Bio-economic model, economic values, Ethiopia

LIST OF TABLES

1. INTRODUCTION

Even though, livestock production in the Tropics and Subtropics is mostly influenced by the seasonal scarcity and low quality of feed resources, livestock make a substantial contribution to the well being of the people. Particularly, small ruminants are important in feeding the rapidly expanding population of the developing world under typical harsh environmental conditions, due to their low feed and area requirement, short generation interval, faster growth rate and higher environmental adaptability compared to the large ruminants (Tibbo et al., 2006). Besides, importance of small ruminant production to sustainable food production in tropical Africa has grown quite substantially, such positive development efforts need to be supported through appropriate research and development activities to enhance productivity of locally available breeds by minimizing the prevailing production constraints (Wilson, 1989).

Ethiopia is home for an estimate 25 million (CSA, 2007) sheep, about 9 sheep breeds and 6 sheep breed groups (Solomon et al., 2007) which are distributed in different agro-ecological zones and mainly raised in the highlands (1500-2500 m.a.s.l.) and in the lowlands (less than1500 m.a.s.l.) where agro-pastoral systems are found (MAO, 2000) .

75% of the sheep population; are found in the highlands of the country, while the remaining 25% are distributed in the lowlands (Mukasa-Mugerwa and Lahlou-Kassi, 1995). Though, Aklilu (2005) recently reported that there is an even distribution of sheep population in the highland and lowland areas. Sheep production in the crop-livestock production systems of the highland areas has a very important role in contributing to the food security as well as in generating direct cash income.

In spite of the large population of sheep and the role of sheep both to the livelihood of resource-poor farmers and the national economy at large; the current level of on-farm productivity in the smallholder production systems is low; with off-take rate 33% (EPA, 2002) and average lamb carcass weight of 10 kg. Their productivity is constrained due to various factors involving biological and environmental aspects as well as socioeconomic factors. Among those reasons for this failure, also lack of adequate breeding programs was an important obstacle.

According to Fewson (1993) a breeding objective is defined as, developing vital animals which will ensure that profit is as high as possible under future commercial conditions of production. Moreover, Hazal (1943) defined the aggregate genotype (i.e. the breeding goal) as a linear function of traits to be improved, each multiplied by its economic value, which is the value of a unit change in the trait while keeping the other traits in the aggregate genotype constant . Moreover, breeding goal traits have to be easy to measure, heritable, variable and not too many. Additionally, those traits should be included in the aggregate genotype according to their economic importance (Hazel, 1943; Philipsson et al., 2006).

For this reason, the objective of this study was to derive economic values for important traits of Horro and Menz indigenous sheep breeds of Ethiopia. Furthermore, to carried out sensitivity analysis for different scenarios to determine the robustness of economic values.

2. LITERATURE REVIEW

2.1 Sheep production and its socio-economic relevance in Ethiopia

2.1.1 Major Sheep production systems

In subsistence-oriented traditional production system, goats and sheep are important because they require low initial capital and maintenance costs, are able to use marginal land and crop residues, produce milk and meat in readily usable quantities, and are easily cared for by most family members. Furthermore, they are important in feeding the rapidly expanding population of the developing world under typical harsh environmental conditions (Tibbo et al., 2006). In Ethiopia, sheep production is mostly a traditional, low input and subsistence-oriented production system, the major sheep production systems are:

1. Mixed crop-livestock system

Mixed crop-livestock system is found in high altitude areas (above 3000 m.a.s.l.), where sheep is the main source of cash, manure, meat, skin and course wool (Mengistu, 2000). In these extreme altitudes, crop production is limited due to cold and frost conditions and precipitous terrain. Therefore, farming system is shifting to sheep/barley systems or sheep production alone (MOA, 1998; Tibbo, 2006). The sheep breed of this production system (Menz breed) survives under this stressful harsh environment with slow growth rate but, high annual reproduction rate under recurrent drought and grazing scarcity (Lemma, 2002). Overall, sheep production in the crop/livestock production systems of the highland areas has a very important role in contributing to the food security as well as in generating direct cash.

2. Pastoral production system

Pastoral production system is practiced in the arid and semi-arid lowland areas of the country (Afar nomadic pastoralists) where pastoralists keep large number of flocks and rely on livestock as their main source of livelihood. Livestock, including small ruminant production is associated with the purely livestock based nomadic pastoral production systems based largely on range, primarily using natural vegetation. As well, herd mobility is a strategy to achieve feed and water requirements (Mengistu, 2000). Besides, most of the export sheep comes from lowland area of the country.

2.1.2 Socio-economic relevance of sheep

Animal genetic resources in the Tropics play an important role from food product supply, manure (fertilizer and fuel), wool, hides and skin to transport and traction service beside to their socio-cultural relevance (Rege and Gibson, 2003). In addition to this, they are very vital as cash reserves and means of insurance in risk aversion for farmers with subsistence-oriented traditional farming system (Kosgey et al., 2004).

In most developing regions there has been a rise in the importance of livestock, those livestock form key components of the livelihood strategies of the world's poorest people. In Ethiopia , 80% of the smallholder farmers own cattle while only about 31-38% and 21-33% of the smallholder farmers own sheep and goat, respectively (Asfaw and Jabbar, 2008).

In Ethiopia, ruminants provide about 58% of the value of hide and skin production, 40% of fresh skins and hides production and 92% of the value of semi-processed skins and hides (Zelalem and Fletcher, 1991; ILCA, 1993; Kebede, 1995). Specifically, small ruminant provide about 12% of the value of livestock products consumed, 48% of the cash income generated at farm level, 46% of the value of national meat production, 25% of the domestic meat consumption with production surplus and 50% of the domestic wool requirement (Zelalem and Fletcher, 1991).

In 2004/05, the average net commercial off-take rate of sheep for smallholder farmers in highland and lowland areas of Ethiopia was 7%. Moreover, in 2005/06 the off-take rate of sheep for national consumption was 13% (Asfaw and Jabbar, 2008) and the study conclude that not only the net commercial off-take rates are low but also the bulk of this net commercial off-take is of low quality which doesn't meet the needs of meat export abattoirs.

The annual national mutton production is 78 thousand metric tonnes, because of the high average off-take rates which were estimated to be about 35% (Workneh, 2006). Furthermore, sheep contributes 20.9% of the total ruminant livestock meat output and 13.9% of the total domestic meat production, with live animal and chilled meat export surpluses.

Per capita consumption of small ruminant meat (Kg/person/year) in Ethiopia is 2.1 kg (EARO, 2000). The share of small ruminant to the total milk output is estimated at 16.7% with the major production coming from goat (ILCA, 1991).

Ethiopia has huge livestock genetic resource and leading African country and ranks 9^{th} in the world in livestock population (FAO, 2005). The livestock sub-sector accounts for about 40% of the agriculture GDP and 20% of the total GDP (Aklilu, 2002) which include an estimated annual production of 288,000 tons of meat, 938,000 tons of milk, without considering the contribution of livestock in terms of manure, draught power, and transport services.

In the Tropics, small ruminants play a significant role in financing and risk aversion (Kosgey et al., 2004). Moreover, the primary reason for selling livestock in the highlands of Ethiopia is to generate income to meet emergency expenses of the family. According to EARO (2000) sale of live animals are taken as a last resort and animals are generally sold when they are old, culled, or barren, which reflect the poor quality of animals supplied to markets.

2.1.3 Small ruminant marketing in Ethiopia

Sheep in the Tropics are a form of investment that is a quick source of cash, especially in the predominantly minimal-input traditional production system (Lebbeie and Ramsay, 1994). However, in Ethiopia the majority of sheep sent to market for slaughter are unfinished milk tooth lambs with live weight ranging from 10kg to 18 kg (Galal et al., 1979) which results in low meat yield as well low income to farmers.

Besides, price fluctuation is one of livestock marketing problems facing the market participants including farmers. Accordingly, Ayele et al. (2004) found significant differences in prices between seasons and markets. Seasons in which farmers faced severe cash shortages exhibited the lowest adjusted prices for animals they sold, indicating that although livestock may provide a fallback position for cash in times of crisis, terms of trade may be worst when farmers need cash the most. Furthermore, according to Berhanu et al. (2007) several problems were reported from farmers, such as lack of market information and low price due to poor body condition during the dry periods. Largely prices depend on supply and demand, which is heavily influenced by the season of the year and the occurrence of religious and cultural festivals or occurrence of drought and weather shocks.

Therefore, Seleka (2001) discussed that appropriate market incentives are necessary to drive for major genetic improvement. Moreover, improving of marketing facilities would enable farmers to get better prices for their animals more than what they are getting currently.

For that reason, Solomon et al. (2004) also discussed that the economic benefit of sheep production could be enhanced by introduction of finishing technology, selling animals after attaining optimum desired market weight which will have positive effect on improving the standard of living of poor farmers and increase export earnings.

2.2 Production and functional traits of Menz and Horro sheep

2.2.1 Production traits

Menz sheep is indigenous to the highlands of Ethiopia, with thin-fat-tail, medium-size (30-35kg), predominantly black, brown or white in plain and patchy coat color pattern, and raised for its meat and coarse wool (Mason, 1996). Horro sheep breed is also adapted to Ethiopian highlands, with long-fat-tail, uniform in colour, mostly solid tan and raised for its meat production (DAGRIS, 2007).

On-farm productivity of small ruminants in the subsistence oriented smallholder production systems in Ethiopia is low (Tembley, 1998) and the estimated off-take rate (percentage of animals slaughtered of all the population) for sheep is below 37% (FAO, 1999). With average carcass yield of about 10 kg per animal (FAO, 1999), the low off-take rate indicate that low productivity at farm and national level. Accordingly, FAO (1991) stated that the annual off-take rate for sheep is estimated to be 40 % with an average carcass weight of about 10 kg which is the second lowest among the Sub-Saharan African countries.

Carcass quality is poorly defined in Ethiopia, while proportion of fat in the carcass and lean to bone ratio are of major importance if animals to be sold to more affluent urban and export markets (Ermias et al., 2006). Dressing percentage could be also an important tool to evaluate carcass merit and estimate of dressing percentage for Menz and Horro lambs were 49.1% and 48.0 %, respectively (Awgichew, 2000).

Furthermore, according to Awgichew (2000) on-station study Menz and Horro lambs did not differ significantly both in pre-weaning and post-weaning average daily gain. However, Horro and Menz lambs gained 26.21 and 26.24 g between birth and 180 days of age, respectively. Furthermore, lambs born in the wet season had a slightly better pre-weaning growth rate compared to those born into the dry season which indicates seasonal influence on growth performance. Moreover, birth type, dam parity and season of birth significantly influenced pre-weaning average daily weight gain.

Aklilu (2005) reported that sheep export from the highland area is limited due to darkening of the meat after slaughter. However, Ermias et al. (2006) conclude that favorable proportion of carcass fat, higher carcass lean yield and lean to bone ratio in Horro and Menz breed as well as lower non-carcass components in the Menz breed indicate sustainability for export of mutton. Moreover, Negussie et al. (2004) state that growth and carcass composition in Horro and Menz breed are significantly affected by genotype, growth phase and season of birth.

Growth rate in indigenous Ethiopian sheep breeds is slow and this result in limiting the profitability. However, growth in lambs is influenced by breed, sex of lamb, litter size and season of birth as reflection of seasonal fluctuation in feed availability and milk yield of the dam. Because of seasonal fluctuation in feed availability, animals lose weight during dry season and gain weight during wet season, deposit fat during the later season and mobilize during unfavorable season (Negussie et al., 2004; Ermias et al., 2002).

According to Awgichew (2000) birth weight of Horro and Menz lambs were 2.43kg and 2.17 kg, respectively. Furthermore, Horro sheep had significantly larger live body weight at all ages than the Menz by as much as 6 to 18%. In both breeds, lambs born single were significantly heavier than those born as twins or triplets. In all age categories and both breeds, males were consistently heavier and larger in size than females (Tibbo et al., 2004).

2.2.2 Functional traits

Reproductive performances like litter size, lambing interval and age at first lambing are economically important traits in sheep production enterprises. Both biological and economic efficiency of sheep production enterprises are improved with high levels of flock reproduction rate (Dickerson 1978). Increased reproduction rate spreads the high fixed energy input cost of maintaining the breeding ewe flock and replacements over more sales of offspring.

Conception and lambing rates in Horro ewes were found to increase with ewe parity and ewe weight at mating to a certain limit (extremely high ewe weights at mating and advanced age ewes have shown a decline in conception rates). Very low weight of ewes at mating affected conception negatively. Conception rate also declined with advanced age (Solomon, 2002). Accordingly the finding result low heritability for litter size which indicates there would be low genetic improvement from direct selection of this trait.

Studies reported age at first lambing for Menz breed: 16.5 months (Gautsch, 1987), 17.06 months (Niftalem, 1990) and 15-22 months (Abebe, 1999). Furthermore, Tesfaye (2008) and Zewdu (2008) recently reported age at first lambing of 470 and 400 days respectively, for Menz and Horro sheep.

Moreover, Niftalem (1990) and Abebe (1999) Finding conducted on-farm and on-station show that lambing interval for Menz sheep is 381-409 days and 229-273 days respectively. In addition to this, according to Tesfaye (2008) and Zewdu (2008) on-farm study lambing interval for Menz and Horro sheep is 255 and 234 days, respectively.

Litter size for Menz breed 1.14 (Agyemang et al., 1985), 1.08 (Gautsch, 1987), 1.02 (Niftalem, 1990) as well as for Horro breed 1.34 (Solomon and Gemeda, 2000) was reported. largely, litter size of Ethiopian sheep breeds like Menz sheep breeds is low (Abebe, 1999) which is almost close to one lamb per lambing while breeds like Horro is more prolific with litter size of 1.35 and 1.34 (FAO, 1991; Solomon, 2002). Furthermore, Zewdu (2008) reported twining rate of 39.8% for Horro sheep.

Overall, Berhan and Van Arendonk (2006) conclude Menz ewes have more acceptable reproductive performance compared to Horro ewes under controlled breeding. Though, the authors recommended for better characterization of those sheep breeds to do the same experiment in the area where Horro breed originated.

According to Awgichew (2000) sex, birth type, and dam parity also influence lamb birth weight. Lambs born at the end of the rainy season tend to be heavier at birth compared to those born at the beginning of the rainy season. Furthermore, the study concludes that, this could be due to the provision of qualitatively better forage for the ewes during the wet season which covers the later part of the gestation period.

The number of lambs born and surviving to marketing is very important to sheep production farms, Mukasa-Mugerwa et al. (2000) reported lamb mortality was higher in Horro breed compare to the Menz breed due to low birth weight and non-parasitic disease. The authors conclude that improving animal health is necessary. However, on farm study by Gemeda et al. (2005) showed that survival rate of Horro lambs to 12 month of age was 86.5%.

Lamb survival is a low heritable trait; use of breeds with low litter size in difficult tropical environment can be effective means of reducing lamb mortality in parallel with farm management and health routines (Tibbo, 2006).

Furthermore, Awgichew (2000) reported survival rate between birth and weaning (90 days) for Menz lambs with 89%. This was significantly higher than that for the Horro with 76%. The study also indicated that Menz lambs had much better post-weaning survival rate from birth to 180, 270 and 365 days of age (81, 71 and 62%) compared to Horro (51, 39 and 37%), respectively.

Tibbo (2006) reported a pre-weaning mortality of 33.1% for Horro and 19.2% for Menz sheep. This difference in pre-weaning mortality could be attributed to breed differences.

Moreover, Berhan and Van Arendonk (2006) found an overall mortality rate for Menz and Horro breed of 13.5% and 27%, respectively in an on-station experiment.

Tibbo (2006) says that there is adequate within and between breed genetic variation for growth and survival, which can be exploited through selective breeding for permanent improvement of the breeds. In addition to this, Solomon et al. (2007) show that there is substantial additive genetic variation in the population of Menz breed which can lead to significant genetic improvement through selective breeding.

The survival of lamb up to weaning is affected by the age of the ewe, type of birth (single, twin or triple born), season of birth (wet or dry season) and birth weight of the lamb (Sulieman et al., 1990). Litter size and mortality are positively correlated and the higher the litter size the higher the mortality rate. This could be mainly due to the fact that twins have lower body weight compared to single lambs.

Accordingly, Gemeda et al. (2005) found that survival rate for Horro breed was significantly affected by birth weight of lambs. The lightest lambs generally had the highest mortality rate. Moreover, Niftalem (1990) reported that lambs born from heavier dams had a significantly higher survival rate at all level of the specified age, than those from lighter ewes.

2.3 Genetic diversity and conservation priority of Ethiopian indigenous sheep breeds

The term animal genetic resource is used to include all animal populations, species, breeds and strains including wild relatives which are of economic, scientific, traditional and cultural interest to humankind in terms of food and agriculture production for the present or future (Rege and Gibson 2003). Furthermore, those indigenous animal genetic resources, a majority of which are found in developing countries, are believed to conserve much of the current global genetic diversity with millions of people directly depending on them for their livelihood. Breed differences arise from adaptation to environmental circumstances. Further differences are caused by random drift, migration, mutation, natural selection or targeted selection. Therefore, the population structure of sheep in Ethiopia is strongly associated to historical patterns of sheep migration, geographic isolation and interbreeding; while morphological diversity follow ecological pattern (Solomon et al., 2007).

According to Solomon et al. (2007) 14 sheep population can be classified into six breed groups and nine breeds. The study showed that there is significantly low genetic differentiation among the sheep populations. Maximum genetic diversity can be conserved by maintaining minimum within and between breeds genetic relationship (Solomon et al., 2008). This created genetic diversity among breeds can be also exploited in a structured breeding system designed for a specific production-marketing situation (Leymaster, 2002).

Characterization of animal genetic resources is a pre-requisite for designing conservation-based utilization programs. Characterization of animal genetic resources includes a clear definition of genetic attributes of an animal genetic resource and the environments to which it is adapted, physical description, reproduction and adaptations, uses, prevalent breeding system, population size, typical features, predominant production system, description of environments in which it is predominantly found and an indication of performance levels (FAO, 2000; Rege and Okeyo, 2006; Workneh et al., 2004).

Furthermore, to assess the genetic variation and to set conservation priorities genetic and molecular characterization of different species of farm animals is necessary beside to breed's bio-geographical distribution and census at breed level (IBC, 2004).

According to FAO (1999) the demand for livestock products in the developing world will be doubled over the next 20 years, due to population growth, urbanization and rising income. So in order to meet the growing demand better utilization and conservation priorities of the diversified animal genetic resource is necessary.

The world watch list for domestic Animal Diversity indicates that 30% of the world's domestic animal breeds are at risk of extinction (FAO, 1999). Moreover, Solomon et al. (2008) found five threatened sheep breeds of the 14 Ethiopian indigenous sheep which needs prior conservation. These were Simien, Gumz, Afar, Menz and Black head Somali (BHS).

The reasons for the high rate of extinction and loss of genetic diversity within and between breed are various and interconnected, including: the intensification and industrialization of agriculture and animal production, low productivity of the local breeds, neglect the potential of good indigenous breeds and lack of well defined breeding objectives. Beside to this, use of uniform high-yielding breeds and cross-breeding, policies and developments that disadvantage ethnic minorities, conflict and wars, natural disasters, disease outbreaks and inappropriate development aid focusing on short-term benefits contribute to the loss of animal genetic resource and livestock diversity (Rege and Gibson, 2003; Tisdell, 2003).

2.4 Genetic improvement of Menz and Horro sheep

The value of indigenous breeds is often under-estimated mostly due to their low productivity. Consequently, developing countries in most cases go for exotic breeds to increase productivity through crossbreeding or breed substitution without properly investigating the production potential of the indigenous breeds in the existing climatic condition (Hodges, 1990). Furthermore, introduction of exotic breeds to achieve genetic improvement without even adequately investigating the merits of local breeds resulted in the reduction of the population of the indigenous breeds and in endangering the existence of the local genetic material.

Therefore, since indigenous sheep genetic resources have developed specific adaptations to survive, produce and reproduce under climatic stresses, poor quality feed, seasonal feed and water shortage, endemic disease and parasite challenge which make them suitable for use in the subsistence-oriented traditional and low-input production system (IBC, 2004). It is important to consider all those features while setting up conservation priorities and breeding schemes.

In Ethiopia, in spite of the large population of sheep and the great role of sheep both to the livelihood of resource-poor farmers and the national economy at large; the current level of on farm productivity in the smallholder production system is low. Their productivity is limited due to various factors involving biological and environmental aspects as well as socioeconomic factors. In the recent two decades a national sheep breeding program was carried out, which didn't result in major genetic improvement in sheep population. Reasons therefore could be poor involvement of the livestock owners in decision making and implementing of breeding programs, lack of infrastructure and lack of well defined breeding objectives which are most frequently cited constraints in the Tropics (Sölkner et al., 1998; Kosgey et al., 2006; Philipsson et al., 2006; Tibbo et al., 2006).

2.5 Definition of breeding objectives and economic values

According to Fewson (1993) the breeding objective is defined as "developing vital animals which will ensure that profit as high as possible under future commercial conditions of production". However, Baker and Rege (1994) discussed that defining breeding objectives in those comprehensive economic terms (i.e. revenue minus production costs) is difficult enough in temperate agriculture and much more difficult in the Tropics.

Besides, Valle Zarate (1995) defines the breeding objective for marginal regions in the Tropics and Sub-tropics as "breeding activities are aimed to support small subsistence farmers to develop cost and resource-saving production methods and to become more market-oriented, in order to provide for their families and stay on the land. Animal products should be produced efficiently, taking in to account specific environmental conditions with sever climatic and feed restrictions and seasonal fluctuations, as well as minimum investment opportunities".

A breeding objective is an important part of a breeding program. It is important to have a close connection with the target group and to consider interest and wish of the farmers while defining breeding objectives. However, in most cases it has been missing while designing breeding programs (Sölkner et al., 1998).

In the selection index theory, the aggregate genotype (i.e. the breeding goal) is usually defined as a linear function of traits to be improved, each multiplied by its economic value, which is the value of a unit change in the trait while keeping the other traits in the aggregate genotype constant (Hazel, 1943). Animal breeding is largely concerned with selection of animals based on well-defined breeding goal, which should fit the future farm production and market requirement. Moreover, the breeding goal provides the basis for breeding programs, which can be defined within the context of economic theory (Amer et al., 1998).

Breeding goal traits should be easy to measure, heritable, variable and not too many. In addition to this, those traits should be included in the aggregate genotype according to their economic importance (Hazel, 1943). In order to do this, the economic value of each trait should be known beforehand.

Subsistence farmer unlike commercial ones, tend to keep animals for family need rather than purely as economic enterprise. They keep multi-purpose animals which produce meat, milk, wool, skin beside their transport and draught service. For that reason, it is important to consider all tangible and intangible roles of the breed, when defining breeding objectives at breed level (Kosgey et al., 2004). Furthermore, definition of breeding objectives, identification of the existing structure, institution, production system and indigenous breeding practice are first steps to establish sustainable breeding programs (Sölkner et al., 1998; Kosgey and Okeyo, 2007).

Estimation of economic value for important traits is needed to establish an economic total merit index. However, in the Tropics detailed assessments of costs and revenues are scarce as well as estimates of economic values for important traits are rare, which could be due to lack of recording, farmers illiteracy and small flock sizes (Kosgey et al., 2003). Furthermore, Baker and Rege (1994) discussed that defining breeding objectives in the Tropics in comprehensive economic terms (i.e. revenue minus production costs) could be much more difficult.

Economic values are key in the definition of breeding objectives and criteria for livestock improvement programs and estimation of economic values require proper methodologies in terms of models, including physiology modeling of animal production, farm economics and appropriate assumptions of future production circumstances (Groen et al., 1997).

Rewe et al. (2006) reported economic values for production and functional traits of the Kenyan Boran cattle. Moreover, the authors recommended further estimation of economic value for disease resistance traits. Besides, economic values for fertility, prolificacy, milk yield and longevity traits of the Spain dairy sheep breeds were reported by Legarra et al. (2007).

Overall, a genetic improvement program requires definition of comprehensive breeding goal traits incorporating with need and social circumstances of the farmers as well as ecological constraints. Besides, local communities should participate in definition of breeding objective and support the direction of change (Sölkner et al., 1998; Kosgey and Okeyo, 2007).

3. MATERIALS AND METHODS

3.1 Breed and study site description

Of the four ICARDA-ILRI-BOKU community based sheep breeding schemes, Menz and Shambu were selected for this study. Reasons therefore included better accessibility and documented literature regarding the production and reproduction data compared to sheep breeds of the other two sites. In both of the study areas Agricultural production is characterized by a mixed crop-livestock production system where sheep production has traditionally been an integral part. Farmers mainly keep sheep as a primary investment and as immediately available source of capital.

3.1.1 Menz

Menz is a small breed with a short-fat-tail (Solomon et al., 2007) and course wool which is adapted to high altitude precipitous terrain with scarcity of feed and limited production of crop due to extreme low temperatures. This breed is mainly kept for meat production and located in the Debre-Birhan area which is found in the highlands of Ethiopia.

The survey was conducted in the Menz area of the Amhara regional state, particularly in Molale, which is located 280 km north of the capital city Addis Ababa. The altitude ranges from 2600-3000 m.a.s.l. with a minimum and maximum temperature of 6.8 ^{o}C and17.6 ^{o}C, respectively. The long rainy season occurs from June to September and while an erratic unreliable short rainy season may occur in February to March.

The production system in this area is characterized by a mixed crop-livestock system which is limited to sheep-barley production in very high altitude areas. Natural pasture is the main source of feed. Supplementation is rare except if farmers plan to fatten their castrated rams to sell them during holidays.

3.1.2 Horro

Horro is a long-fat-tail (Solomon et al., 2007) hair-type breed and is the most prolific and largest breed among indigenous Ethiopian sheep breeds. This breed is mainly used for meat production and is located in the Bako-Shambu areas of the western mid-highland region of Ethiopia.

The survey was conducted in Shambu area of Oromia regional state, which is located 310 km west of the capital city Addis Ababa and is believed to be the closer epicenter of Horro sheep. The maximum and minimum temperatures of the Shambu area are 26 ^{o}C and 18 ^{o}C, the altitude ranges from 1800 to 2835 m.a.s.l. Its main rainy season occurs between May and September and the dry season lasts from October to April.

Farming in this area is dominated by mixed crop-livestock system andnatural pasture is the main source of feed. Supplementation is rare except in case farmers plan to fatten their castrated rams. The breed is used for meat and highly demanded for local markets.

3.2 Data collection

Data were collected from October 01, 2008 to January 10, 2009 in both Menz and Shambu area. A set of structured questionnaires were developed (see appendices 8.3.1) for smallholder farmers in order to collect information on input parameters (production costs) and important output parameters (revenues). Furthermore, additional information was derived from previous work.

3.2.1 Input parameters (production costs)

Input parameters such as feed costs, costs for housing (barn cost), labor costs and health management costs were gathered by interviewing farmers and informal discussions with representatives of animal health centers. In addition, data regarding ewe age structure, lambing frequency and culling criteria were gathered through questionnaire with farmer.

3.2.2 Output parameters (revenues)

Output parameters such as revenues from selling animals and manure were collected by interviewing farmers. Additionally, information about revenue from wool was gathered for Menz sheep. Farmers and traders were also interviewed in the market areas (see Appendices 8.3.2) to collect data about prices of sold sheep categories (ewe lamb, ram lamb, breeding ram, breeding ewe and fattened sheep).

3.2.3 Secondary data

Secondary source data regarding production and reproduction potential of breeds were utilized in order to optimize the computer model. Besides, genetic parameters were taken from literature to calculate genetic standard deviation.

3.3 Data analysis

3.3.1 Herd structure and Model description

For the derivation of economic values for the important traits, a computer program based on a so called bio-economic model was used. It was originally designed to optimize management-related decisions in cattle farms (Amer et al., 1996) and was then modified for the estimation of economic values in cattle (Miesenberger, 1997) and further in sheep (Fuerst-Waltl and Baumung, 2009). The underlying herd model is based on a deterministic approach. A meat sheep herd with lamb fattening and rearing of young sheep for replacement was simulated in a steady state over an infinite planning term according to Miesenberger (1997).

The assumption for the description of the age structure in the model is based on analyses of the data from the questionnaire and is presented in Tables 1 and 2 for Menz and Horro sheep, respectively. The age structure results from different probabilities of disposals (voluntary, involuntary, infertile). Most of the voluntary culling was done in the 2nd and 3rd lactation. A detailed description of the model and herd structure is presented in appendices 8.1. Time of disposal for different reasons and conception rates in different lactations are presented in Tables 3 and 4.

Table 1: Proportions (in %) of ewe classes by lactation and fate for the reference herd of Menz sheep

	Lactation								
	1	2	3	4	5	6	7	8	9
Involuntary	1.11	0.55	0.36	0.11	0.11	0.31	0.39	0.63	7.76
Fertility	0.99	0.55	0.27	0.11	0.11	0.23	0.39	0.56	0.00
Voluntary	0.00	0.69	0.36	0.22	0.11	0.00	0.00	0.00	0.00
Survivor	13.8	12.01	11.02	10.58	10.26	9.72	8.94	7.76	0.00
Total	15.91	13.80	12.01	11.02	10.58	10.26	9.72	8.94	7.76

Table 2: Proportions (in %) of ewe classes by lactation and fate for the reference herd of Horro sheep

	Lactation								
	1	2	3	4	5	6	7	8	9
Involuntary	1.10	0.54	0.36	0.11	0.11	0.31	0.39	0.63	7.81
Fertility	0.98	0.54	0.27	0.11	0.11	0.23	0.39	0.56	0.00
Voluntary	0.00	0.41	0.36	0.22	0.11	0.00	0.00	0.00	0.00
survivor	13.58	12.09	11.09	10.65	10.33	9.79	9.00	7.81	0.00
Total	15.66	13.58	12.09	11.09	10.65	10.33	9.79	9.00	7.81

Table 3: Herd leaving time for different reasons for Menz and Horro sheep

	Time of disposal(days)		
Breed	Involuntary Culling	Infertility Culling	Voluntary culling
Menz	120	270	120
Horro	120	270	120

Table 4: Conception rates in different lactations for Menz and Horro sheep

	LS	Lactation								
Breed		Young	1	2	3	4	5	6	7	8
Menz	130	0.75	0.75	0.80	0.85	0.90	0.90	0.85	0.80	0.75
Horro	130	0.75	0.75	0.80	0.85	0.90	0.90	0.85	0.80	0.75

LS= time between lambing and 1st service

Table 5: Distribution of singles, twins and triples for Horro and Menz sheep

	Proportion in %		
Breed	Singles	Twins	Triples
Menz	98	2	0
Horro	60	36	4

Milk production and requirements

An average milk yield of 18.4 liters for Menz and Horro was assumed for the first lactation (standard lactation 112 days). For the calculation of the milk yield in higher lactations, the average milk yield of the first lactation was multiplied by aging factors. Highest milk yields were observed for the 4th lactation with an ageing factor of 1.39 while the lowest milk yield was observed in the highest lactations (Table 6). The functions of Wood (1967) and Gompertz (Fitzhugh, 1976) were used to estimate daily milk, fat and protein yield and live weight and daily gain, respectively (see Appendices 8.1).

For Menz lambs it was assumed that milk from the dam can cover the energy and protein requirements. However, due to the higher twining rate in Horro, the milk from the dam may not fit the protein and energy requirements of the lambs. Therefore milk extension was considered for the first 7 weeks of the lambs.

Table 6: Milk yield in kg for the 1st lactation and age factors for computation of milk production potential of higher lactations

			Aging factors							
Breed	Standard-lactation (days)	Yield/1st lactation	2	3	4	5	6	7	8	9
Menz/Horro	112	18.4	1.27	1.36	1.39	1.36	1.30	1.19	1.14	1.12

The growth rates and live weights of different sheep categories were calculated according to Miesenberger (1997). Energy and protein requirements, and energy deficit was calculated according to AFRC (1993), GfE (1996, 2001) and Kichgessner (2004). A linear planning algorithm was used to select a least cost ration meeting the protein and energy requirement (Press et al., 1986) for each day. Difference in requirements because of live weight changes (growth and mobilization of body reserves) and gestation was taken into account. More details of the model are described in Appendices 8.1.

3.3.2 Assumptions

The economic values were derived by calculating the difference in herd profit before (reference scenario) and after change in genetic merit. For these purpose daily results weighted by the proportion of the respective ewe class were summarized over the lambing interval or until culling. The proportion of ewes in different lactations depended on the percentage of culling for fertility, involuntary or voluntary reasons. Within scenario, it was assumed that the herd distribution stayed constant over time with same flock size which will not be the case in practice since farmers keep in small flock with fluctuating numbers.

It was assumed that all carcasses have the same grade and different cuts of the carcass have the same price. Even though, there is seasonal variation on sheep price, feed availability and feed price (Ayele et al., 2004) seasonal variation was ignored by assuming that all sheep in the same age category has the same price and feed stuffs have the same price overall the year. Revenue from wool and manure was not included in the study. It was also assumed that sheep are kept in the same house in winter and summer time even though farmers may have different sheep houses for the dry and wet season. For this study only the housing for the wet season was considered. It was assumed that infertile females were culled at 270 days of age while farmers tend to keep fertile females longer in the herd.

Farmers use to fatten castrated rams at the age of more than 2 years. However, in this study it was assumed that fattening of 180 days old lambs was practiced to optimize the situation. It was assumed that farmers deworm, vaccinate and spray fattening lambs once per fattening period, which costs (€) 0.07, 0.03 and 0.03 per treatment and lamb, respectively. Thus, health management activities were also applied for replacement sheep once in a year. Furthermore, different kinds of feed stuffs were used which may not be affordable by farmers. Costs per kg of dry matter and protein, energy and fiber content are present in Table 7 and Table 8 for Menz and Horro sheep.

Table 7: Costs per kg of dry matter (€/kg DM) and protein, energy (MJ ME) and fiber content for the assumed feed stuffs for Menz sheep

Feed stuff	€/kg DM	Crude protein (g)	MJ ME	Fiber (%)
Natural pasture hay	0.07	84.7	20	40
Barley grain	0.35	93.9	30.6	23
Pea grain	0.35	295	22.4	20
Vetch	0.35	255	23.9	19
Local beer by product (Atella)	0.02	184	10.52	20

Table 8: Costs per kg of dry matter (€/kg DM) and protein, energy (MJ ME) and fiber content for the assumed feed stuffs for Horro sheep

Feed stuff	€/kg DM	Crude protein (g)	MJ ME	Fiber (%)
Barley straw	0.1	23.5	20	50
Maize grain	0.28	295	22.4	20
Beans grain	0.24	59.3	34.7	20
Barley grain	0.28	93.9	30.6	23
Local beer by product (Atella)	0.02	184	10.52	20

Feed restrictions were applied for both breeds, in case of Menz the ration contained a maximum of 80% concentrate, a minimum of 12% fiber, a maximum of 50% pea and 90% vetch. For Horro, the maximum of concentrate was 80%, the minimum of fiber 12%, the maximum of beans 50% and the maximum of maize 90%. All relevant revenues and costs were calculated per day. Revenues resulted from selling fattened lambs and animals for replacement. Furthermore, all costs were treated as variable.

Lambing occurred at any time of the year as uncontrolled matting was predominant in both areas. Furthermore, all lambings were considered as easy for both breeds so that costs related to lambing were not considered. Ten % of Menz and 20% of Horro male lambs were considered as breeding rams and sold at an age of 300 days with 20€ and 21€ per ram, respectively. To account for costs of breeding rams, insemination costs were assumed so that farmers have to pay 0.07€ per insemination per ewe even though artificial insemination is not practiced in Ethiopia. Horro lambs were supplemented with milk extension (in this case cow milk) for the first 7 weeks and from the 7th week onwards lambs were fed according to their energy and protein requirements using feed stuffs shown in Table 8.

Table 9: Assortment of assumptions for Menz and Horro sheep

Traits (unit)	Values	
	Menz	Horro
Standard lactation (days)	112	112
Age at first lambing (days)	470	400
Minimum days dry (days)	55	55
Proportion of singles/twins/triples (%)	98/2/0	60/36/4
Still birth rate (%)	2	2
Proportion of breeding ram sold (%)	10	20
Fattening period (kg)	15-20	15-22
Fattening period (days)	90	90
Ewe mature weight (kg)	25	28
Lamb survival to 12 month (%)	78	80

For the computation of the costs for each fattening animal the costs of the lamb feeding (phase), barn costs, feeding costs, veterinary costs, labor costs and the other costs were considered. A fraction of prices and revenues considered are stated for both breeds in Table 10.

Table 10: Assortment of revenues and prices for Menz and Horro sheep

Traits (unit)	Breed	
	Menz	Horro
Ewe carcass weight (€/kg)	1.5	1.5
Price per kg of carcass weight (€/kg)	4	4
Labor cost (€/hr)	0.144	0.144
Breeding ram price (€/ram)	20	21
Veterinary cost per lamb fattened/replacement (€)	0.13/0.13	0.13/0.13
Cost per insemination (€)	0.07	0.07
Barn unit costs (€ per ewe/year)	0.11	0.24
Barn cost (€ per fattening lamb/day)	0.0003	0.00067
Barn unit costs (€ per replacement stock/year)	0.084	0.183

All results were expressed per average ewe place and year. To avoid double counting (Dempfle, 1992) economic values were derived separately for each trait keeping all other traits constant. For each trait the results were expressed as marginal utility in € referring to an improvement of a trait by one unit (e.g. 1% lamb survival, 1g of daily gain) and as economic value in € per genetic standard deviation (s_a).

Table 11: Description of lamb fattening in the reference situation for Menz and Horro sheep

Traits	Unit	Values	
		Menz	Horro
Daily gain	G	74	80.5
Fattening starting age	days	180	180
Dressing percentage	%	45	45
Price/kg of carcass	€	4	4
Live weight after fattening	kg	20	22
Carcass weight of fattened lambs	kg	9	10

3.4 Trait complexes

3.4.1 Fattening and live weight traits

Daily gain: daily gain (DG) is an important trait in lamb fattening enterprises. Improved performance of daily gain (live mass/age at slaughter) results in a shortened fattening period enabling the derivation of economic values. To increase daily gain, the parameters of the Gompertz curve (Fitzhugh, 1976) were changed in lambs (see appendices 8.2) without changing adult ewe size. With constant proceeds for each fattening lamb the marginal utilities could be derived directly from the profit difference with two different performance levels.

Mature ewe live weight: ewe mature live weight was also considered in this study and the economic values were calculated by increasing ewe mature weight by one unit (see appendices 8.2)

3.4.2 Functional traits

Length of productive life: length of productive life is defined by the age of the ewe when it leaves the flock and is affected by culling policies. To derive economic values for length of productive life of ewe the probability of involuntary culling was decreased by one percent in all lactations. This resulted in a change of the herd distribution and thus in a different profit per ewe place and year (see appendices 8.2).

Lambing interval: The economic value for lambing interval was derived by reducing days to first service. Since lambing interval affects the herd life of the ewe, marginal utilities were calculated by correcting for the marginal utility of length of productive life for each breed (see appendices 8.2).

Litter size: litter size is a categorical trait. Thus the economic values were calculated assuming a standard normal distribution with single, twin and triple bearers and the proportion of ewes in these categories are shown in Table 7. Class limits (u-values) were assigned for the reference scenario and subsequently by shifting approximately one genetic standard deviation towards the desired proportions (twins and triples) resulting in new u-values and thus new class ratios. Both, u-values and class ratios may be found in the u-table for standard normal distribution (e.g. Essl, 1987). From the original and new ratios weighted means for litter size and price were calculated. The differences between original and new mean prices enabled the calculation of approximated marginal utilities (see appendices 8.2).

Stillbirth rate: marginal utilities and economic values for stillbirth rate were calculated by changing the rate of stillbirth by one percent towards the desired and undesired direction respectively, resulting in a different profit per ewe place and year (see appendices 8.2).

Lamb survival: survival of lambs between born alive and mating was considered. Since lamb survival is an important trait; it largely affects the total profit of the farm. Marginal utilities and economic values of lamb survival were calculated changing the survival rate of lambs towards the desired and unfavorable direction by one unit (1%), resulting in a different profit per ewe place and year (see appendices 8.2).

3.5 Genetic parameters

Tables 12 and 13 show the genetic parameters used to derive economic values for important traits of Menz and Horro. All genetic parameters were taken from secondary sources. Genetic parameters for ewe mature weight, daily gain, lamb survival and litter size were available for both breeds form Solomon et al. (2007), Solomon (2002), Hassen et al. (2003) and Berhan (2001). However, genetic parameters for length of productive life, stillbirth and lambing interval were not available for the breeds or other Ethiopian sheep breeds. Therefore, those parameters were taken from other meat sheep populations (e.g. Fuerst-Waltl et al., 2006) to calculate the genetic standard deviation (s_a).

Table 12: Means per average ewe place (reference situation), genetic standard deviation (s_a) and heritability (h^2) for all important traits in Menz sheep

Traits (unit)	Mean	h^2	s_p	s_a
Daily gain (g)	74	0.25	14.88	7.44
Length of productive life (days)	1653	0.12	866	304
Stillbirth (%)	2	0.02	14.14	2
Litter size (no. of lambs)	1.02	0.12	0.14	0.05
Lambing interval (days)	284	0.05	74.5	16.5
Ewe mature weight (kg)	25	0.4	3.49	2.20
Lamb survival (%)	78	0.05	37.9	8.3

Table 13: Means per average ewe place (reference situation), genetic standard deviation (s_a) and heritability (h^2) for all important traits in Horro sheep

Traits (unit)	Mean	h^2	s_p	s_a
Daily gain (g)	80.5	0.15	35.7	13.83
Length of productive life (days)	1679	0.12	866	304
Stillbirth (%)	2	0.02	14.14	2
Litter size(no. of lambs)	1.44	0.12	0.56	0.20
Lambing interval (days)	284	0.05	74.5	16.5
Ewe mature weight (kg)	28	0.33	7.08	4.07
Lamb survival (%)	80	0.02	66	9.3

4. RESULTS AND DISCUSSION

4.1 Reference situation

Table 14 provides an overview of the reference situation. A profit of € 2.02 and 11.77 per average ewe place and year was achieved for Menz and Horro sheep, respectively. Thus, a higher profit per average ewe place and year was achieved in Horro sheep; which could be due to the higher twining rate and better growth potential of the breed compared to Menz.

Revenues for Menz and Horro resulted from selling of fattened lambs (€ 36.1 and € 39.7), female replacements (€ 18) and breeding rams (€ 20 and € 21), respectively. Main costs were costs for concentrate feed stuffs. Housing and labor costs had a limited effect in both breeds indicating the traditional and small animal husbandry system at farmer level. In the reference situation the average herd life was 4.53 and 4.60 years for Menz and Horro sheep, respectively.

Table 14: Results for the reference situation (per average ewe place)

Traits	Unit	Results in reference situation	
		Menz	Horro
Results per lambing cycle			
Cycle length*	day	263	263
Revenue from ewes sold	€	4.57	5.02
Feed cost	€	14.54	13.63
Concentrates	kg DM	44.3	56.8
Barn cost	€	0.0022	0.005
Insemination cost	€	0.06	0.06
Cost for lambing	€	0.00	0.00
Proportionate costs (sales)			
- Lamb fattened	€	10.96	12.2
- Replacement	€	3.2	5.0
- Ewe	€	20.37	23.91
- Ram	€	11.2	12.5
Proportionate revenues (sales)			
- Lamb fattened	€	36.1	39.7
- Replacement	€	18	18
- Ewe	€	21.83	32.41
- Ram	€	20	21
Revenue total	€	100.5	115.5
Cost total	€	60.33	67.31
Profit	€	40.2	48.2
Results per year			
Revenue total	€	30.28	44.89
Cost total	€	28.25	33.12
Profit	€	2.02	11.77

*Shorter than lambing interval as culling is considered

DM = dry matter

4.2 Derivation of economic values

All presented marginal utilities in Table 15 and Table 16 refer to an improvement of a trait by one unit and are expressed per average ewe place and year, respectively. Economic values were estimated by multiplying the marginal utilities by the genetic standard deviations of the traits presented in Table 14 and Table 15. Therefore, economic values are expressed per ewe place and year and genetic standard deviation. To avoid double counting, economic values were derived for each trait separately while keeping all other traits constant.

Fattening traits: A positive marginal utility of € 0.084 and 0.097 per g of increase in daily gain was achieved per average ewe place and year for Menz and Horro, respectively. The economic values were calculated by multiplying the obtained marginal utilities with the assumed genetic standard deviations of 7.44g and 13.83g, respectively, resulting in economic values of € 0.63 and 1.35 per genetic standard deviation. For multipurpose Slovakian sheep positive marginal economic value (€ 0.032) for daily gain from birth to weaning were also reported by Wolfova et al. (2009). The authors presented their results in marginal economic values because reliable genetic parameters for the traits considered were not available to calculate economic values. Besides, Miesenberger et al. (1997) reported positive economic values for Simmental dual purpose cattle in Austria.

Live weight traits: Negative marginal utilities of € -0.35 and -0.31 per unit of increase in live weight per average ewe place and year were achieved for Menz and Horro, respectively. Multiplying by the genetic standard deviation of 2.20 and 4.07 kg respectively, resulted in negative economic values of € 0.77 and 1.26 per genetic standard deviation. This negative economic value is due to heavier ewes requiring more feed for maintenance and growth which results in increase of feed cost and reduces revenues from sell of culling ewes. This result was in agreement with Kosgey et al. (2003) who obtained a slightly negative economic value (€0.03) per ewe place per year in the base situation. Additionally, Conington et al. (2004) also reported negative economic values for the mature weight of U.K. hill meat sheep in different hill farming systems. However, this result was in contrast with Haghdoost et al. (2008) who found a positive economic value of mature ewe live weight per average ewe place and year in Arabic sheep. On the other hand, negative and positive economic values of doe live weight were also reported for Kenyan dual purpose goats by Bett et al. (2007) in three different production systems.

Functional traits: the functional trait with the highest economic value for Menz sheep was lamb survival (€2.20, see Table 15), while in Horro sheep litter size was the trait with the highest economic value among functional traits (€3.67, see Table 16). The corresponding marginal utilities were € 0.26 per unit (1%) improvement of the trait and € 18.62 per lamb born for lamb survival and litter size, respectively.

For Menz sheep lambing interval was the second most important functional trait with a marginal utility of € 0.095 per day. Assuming a genetic standard deviation of 16.5 days resulted in an economic value of € 1.57 per genetic standard deviation. Furthermore, for Horro a marginal utility of € 0.12 per day was obtained for lambing interval. Assuming a genetic standard deviation of 16.5 days resulted in an economic value of € 1.98 per genetic standard deviation. A positive economic value (€ 5.35) for lambing interval was also reported by Fuerst-Waltl and Baumung (2009) for dairy sheep in Austria.

In Horro sheep lamb survival was the second most important functional trait with a marginal utility of 0.35 per unit (1%), resulting in an economic value of € 3.25 per genetic standard deviation. This positive result shows that improvement of lamb survival results in increase of fattening lambs and replacement stocks which positively affects the flock profit. Haghdoost et al. (2008) reported positive economic values for pre-weaning and post-weaning lamb survival in Arabic sheep. Besides, Wolfova et al. (2009) also found a positive marginal economic value (€ 0.0040) for the survival rate of lambs from 24 h after birth until weaning in multi-purpose Slovakian sheep. Besides, Bett et al. (2007) estimated positive economic values for pre-weaning and post-weaning survival rate in Kenyan dual purpose goats. However, Kosgey et al. (2003) reported no or low economic values of $0.0 and $0.1 per ewe place per year in the base situation in the tropic meat sheep for pre-weaning and post-weaning lamb survival, respectively.

Economic values for litter size were derived independently from other traits to avoid double counting (Dempfle, 1992). Thus, a possible correlated increase in milk yield due to higher litter size is not included in the economic value. For Menz sheep a marginal utility of € 20 per lamb born was obtained, assuming a genetic standard deviation of 0.05 resulted in an economic value of 0.98 per genetic standard deviation. A marginal economic value of € 0.20 per 0.01 lamb born for litter size was also reported by Wolfova et al. (2009) as well as Haghdoost et al. (2008) reported positive economic value for Arabic sheep. Moreover, Kosgey et al. (2003) found positive economic values of $ 12.94 and 15.04 for litter size under fixed feed resource and setting feed costs to zero situations, respectively for the Tropic meat sheep. However, Kosgey et al. (2003) reported a negative economic value of € 0.53 in the base situation.

Marginal utilities of € 0.205 and 0.28 per one unit improvement of stillbirth per average ewe place and year were obtained for Menz and Horro, respectively. The values resulted in economic values of € 0.41 and 0.56, respectively. Positive economic values of € 1.77 were also reported in Austrian dairy sheep (Fuerst-Waltl and Baumung, 2009). Besides, Miesenberger et al. (1997) found a positive economic value for stillbirth for Simmental dual purpose cattle in Austria.

A negative marginal utility of € -0.0032 per day is obtained for length of productive life in Menz while in Horro the marginal utility is € -0.0038, the respective economic values are € -0.97 and -1.15 (see Table 15 and Table 16). The negative economic values obtained for length of productive life may have been caused by reduced fertility (conception rate, see Table 4) of ewes at higher age, resulting in increased lambing intervals and smaller number of lambs available for fattening as well as for breeding. In addition, as the fertility of ewes at higher age is reduced, more female replacements are required which results in an increase of rearing costs. Besides, milk production declines at the higher age as observed in Table 6 and thus more feed is needed to rear lambs resulting in higher feed cost. Fuerst-Waltl and Baumung (2009) also reported a slightly negative economic value (€ -0.28) and marginal utility of € -0.0015 per day of length of productive life for dairy sheep in Austria. However, Wolfova et al. (2009) reported a positive marginal economic value (€ 11.1) for length of productive life for multi-purpose sheep in Slovakia. Furthermore, Conington et al. (2004) also found a positive economic value for longevity in U.K. hill sheep.

4.2.1 Relative economic values

Table 15 and Table 16 also show absolute economic and relative economic values, the latter setting length of productive life and mature ewe live weight to zero. Among the traits considered, functional traits have the highest relative economic value (89% and 87.5%) for Menz and Horro sheep, respectively. Furthermore, average daily gain has positive relative economic value of 11% and 12.5% for Menz and Horro sheep, respectively.

Table 15: Marginal utilities (€/unit), economic values (€/genetic standard deviation s_a) and relative economic values (setting economic value for functional longevity and mature ewe live weight 0) for all important traits and trait groups considered for Menz sheep.

Traits (unit)	Marginal utility in €	Economic value in €/s_a	Relative economic value (%)	Relative economic value for trait complex (%)
				Fattening
Average daily gain (g)	0.084	0.63	11	11.00
Mature ewe live weight (kg)	-0.35	-0.77	0.00	
Length of productive life (d)	-0.0032	-0.97	0.00	
Lambing interval (d)	0.095	1.57	27	Functional
Stillbirth (%)	0.205	0.41	7.0	89.0
Litter size (no. of lambs)	20	0.98	17	
Lamb survival (%)	0.26	2.20	38	

Table 16: Marginal utilities (€/unit), economic values (€/genetic standard deviation s_a) and relative economic values (setting economic value for functional longevity and mature ewe live weight 0) for all important traits and trait groups considered for Horro sheep.

Traits (unit)	Marginal utility in €	Economic value in €/s_a	Relative economic value (%)	Relative economic value for trait complex (%)
				Fattening
Average daily gain (g)	0.097	1.35	12.5	12.5
Mature ewe live weight (kg)	-0.31	-1.25	0.00	
Length of productive life (d)	-0.0038	-1.15	0.00	
Lambing interval (d)	0.12	1.98	18.3	Functional
Stillbirth (%)	0.28	0.56	5.2	87.5
Litter size (no. of lambs)	18.62	3.67	34	
Lamb survival (%)	0.35	3.25	30	

4.3 Sensitivity analysis

Sensitivity of economic values to different price levels gives information on the likely direction of future genetic improvement, which has important implications for practical breeding programs. Therefore, in Table 17 and Table 18 economic values for the traits considered and their sensitivity to the price level of production inputs and price of breeding rams respectively, for Menz and Horro are presented. Production inputs considered for sensitivity analysis were feed (only for concentrate feed stuffs) and labor cost.

Table 17: Economic values (€ per ewe per year) for the reference situation with changes in price levels of breeding ram price, feed and labor costs for Menz sheep

Scenarios	Price level	Daily gain	Mature ewe live weight	Lamb survival	Lambing interval	Length of productive life	Litter size	Stillbirth
Breeding ram price	+100%	0.62	-0.78	2.28	1.57	-1.00	0.98	0.45
Feed cost	+20%	0.68	-0.76	2.16	1.49	-0.94	0.98	0.41
	-20%	0.56	-0.78	2.24	1.57	-0.97	0.98	0.43
Labor cost	+20%	0.63	-0.77	2.25	1.57	-0.97	0.98	0.41
	-20%	0.63	-0.78	2.25	1.49	-0.97	0.82	0.41

Table 18: Economic values (€ per ewe per year) for the reference situation with changes in price levels of breeding ram price, feed and labor costs for Horro sheep

Scenarios	Price level	Daily gain	Mature ewe live weight	Lamb survival	Lambing interval	Length of productive life	Litter size	Stillbirth
Breeding ram price	+100%	1.36	-1.22	3.57	2.12	-1.20	4.13	0.62
Feed cost	+20%	1.44	-1.30	3.16	1.80	-1.15	3.60	0.54
	-20%	1.25	-1.20	3.25	2.00	-1.15	3.69	0.56
Labor cost	+20%	1.38	-1.25	3.20	1.90	-1.15	3.67	0.55
	-20%	1.38	-1.22	3.20	2.00	-1.15	3.68	0.55

The sensitivities are discussed relative to the reference situation. For both breeds most of the traits, economic values increase with increasing breeding ram price. The economic values of lamb survival and stillbirth rate were sensitive to breeding ram price by € 0.08 and 0.04 for Menz, respectively. Litter size, lamb survival, lambing interval and stillbirth rate for Horro were sensitive to breeding ram price by € 0.46, 0.32, 0.14 and 0.06 respectively. This shows that an increasing value of breeding rams may have a positive impact on the future market circumstances of male breeding animals. Overall, economic values of functional traits were improved when breeding ram price increase.

Increasing feed costs by 20% for Menz results in decreasing economic value for most of the considered traits except for litter size and stillbirth which stayed more or less stable. However, economic values for average daily gain is increased with increasing feed cost; this could be due to increasing the intake of fiber feed stuffs which are cheaper in price than concentrate feed stuffs, resulting in lower feed cost. When decreasing concentrate feed cost by 20% an economic value of lamb survival increases by € 0.04 and while the economic value of average daily gain decreases by € 0.07, this could be due to increase intake of concentrate than fiber feed stuff when feed gets cheaper, resulting in higher feed cost. Other traits stayed more or less stable.

In Horro, increased concentrate costs result in a small decrease of the economic values of € 0.18, 0.09, 0.07 and 0.02 for lambing interval, lamb survival, litter size and stillbirth, respectively. The results for average daily gain are in accordance to Menz sheep which can be explained with the same reason. However, decreasing costs of concentrates result in improving economic value of litter size and lambing interval while lamb survival and stillbirth stayed more or less stable.

For most of the considered traits economic values are not sensitive for changed price levels of labor in both breeds; this could be due to small time allocation for management by farmers and relatively cheap labor cost. However, the economic values of lambing interval and daily gain increase by € 0.02 and 0.03 respectively, in Horro sheep, while in Menz the economic value for lamb survival increases by 0.05, when labor gets cheaper.

5. CONCLUSIONS

Estimation of economic values is a pre-requisite to establish the economic total merit index and to include traits according to their economic relevance in the aggregate genotype. Thus, economic values were derived for some important traits of two Ethiopian sheep breeds.

The results showed that functional traits have the highest absolute and relative economic values in both breeds setting economic value of length of productive life and mature ewe live weight to zero. In agreement with Kosgey et al. (2003) and Haghdoost et al. (2008) litter size was one of the most economically important traits. This shows that not only production traits but also functional traits have to be considered when defining breeding goal traits even if their heritability is rather low. However, for length of productive life and ewe mature live weight negative economic values were obtained, this could be due to reduction in reproduction and production potential of ewes as their age increases while higher feed requirements for heavier ewes resulted in high feed cost, respectively.

The economic value estimates were fairly robust to changes in price of feed and labor. However, economic values of functional traits were improved when increasing the price of breeding rams. Therefore, this indicates that smallholders should give a higher value to breeding rams rather than fattened sheep, since a breeding ram is genetically valuable as parent for the next generation.

Overall, the results of this study showed that litter size, lambing interval and lamb survival were the most economically important traits followed by daily gain and stillbirth. Therefore, including those traits in the breeding goal and selection for those traits can increase the profit of the flock. However, selection for medium size breeding ewes is necessary even if farmers are interested for ewes with larger body size. Besides, culling measurement at smallholder level is necessary not to keep unproductive ewes for longer time in the herd.

Since there is scarcity of information on economic evaluation in Ethiopia, some interest and creativity is required to identify important traits and derive their economic values. Furthermore, economic values may change overtime they should be recalculated in regular time intervals. This study presented economic values for some important traits but further derivation of economic value for other traits like adaptation and wool traits is also advisable. Besides, refinement of the model to smallholder' situation is required.

6. SUMMARY

Economic values for some important traits were derived for Menz and Horro, which are indigenous sheep breeds of Ethiopia. A bio-economic model based on a deterministic approach was adapted. A meat sheep herd with lamb fattening and rearing of young sheep for replacement was simulated in a steady state over an infinite planning term and with constant number of ewes.

The traits considered were daily gain, mature ewe live weight, length of productive life, lambing interval, litter size, still birth and lamb survival. The economic value of a trait was derived by calculating the difference in herd profit before (reference situation) and after a genetic change. To avoid double counting, economic values were derived separately for each trait keeping all other traits constant. Results were expressed as marginal utilities in € referring to an improvement of a trait by one unit and as economic values in € per genetic standard deviation (s_a). The main source of revenue was from selling of fattened lambs, young replacements and breeding rams.

Positive economic values were achieved for daily gain, litter size, lambing interval, stillbirth and lamb survival. However, negative economic values were obtained for length of productive life and mature ewe live weight. The study showed that functional traits had highest relative economic values followed by daily gain. Furthermore, economic values of litter size, lambing interval and lamb survival were improved when the price of breeding rams increases. As daily gain, litter size, lamb survival and lambing interval had positive economic values, they should be considered in genetic improvement programs.

7. REFERENCES

Abebe, M. 1999. Husbandry practice and productivity of sheep in Lallo- mama Midir woreda of central Ethiopia. An M.Sc Thesis presented to the school of Graduate Studies of Alemaya University of Agriculture, Dire Dawa, Ethiopia.

AFRC (Agricultural Food and Research Council), 1993. Energy and protein requirements of ruminants. An advisory manual prepared by the AFRC Technical Committee on Responses to Nutrients. CAB International, Wallingford, UK.

Agyemang, K., Negussie, A. Voorthuize, A. and Anderson, F.M. 1985. A rapid survey of sheep production in the traditional sector of Debre Berhan, Ethiopian Highlands. In: R.T. Wilson and D. Bourzat (eds). Proceeding of Small Ruminants in African Agriculture. ILCA (International Livestock Center for Africa) Addis Ababa, Ethiopia.

Aklilu, Y. 2002. An audit of the livestock marketing status in Kenya, Ethiopia and Sudan. Issue and proposed measures. Volume II. Community-based Animal health and participatory Epidemology unit. Pan Africa Programme for the Control of Epizotics (PACE). Organizations of African unity/interafrican bureau for animal resources. (http://www.eldis.org/fulltext/cape/Aklilu Marketing_vol_2.pdf)

Aklilu, Y., Hawkes, P., King, A. and Sullivan, G. 2005. Sanitary and Phytosanitary Standards (SPS) and livestock-meat marketing assessment for Ethiopia. Consultancy Report for a project funded under the RAISE IQC for Sanitary and Phytosanitary Standards (SPS) of USAID in Washingiton, D.C USAID/Ethiopia and EGAT office of USAID/Washingiton.

Amer, P.R., Mpofu, N. and Bondoc, O. 1998. Definition of breeding objectives for sustainable production system. 6th World Congress on Genetics Applied Livestock Production. 27:470-478.

Amer, P.R., Kaufmann, A. and Kuenzi, N. 1996. Breed choice and pricing system implications for farmers and political institutions from a Swiss cattle farm model. In: J.B. Dent, M.J. Mcgregor and A.R. Sibbald (ed.) livestock farming systems. Research, development, socio-economics and the land manager. EAAP Publ. no. 79, Wageningen Acadamic puplisher, Wageningen, The Netherlands.

Asfaw, N. and Jabbar,M. 2008. Livestock ownership, commercial off-take rates and their determinants in Ethiopia. Research Report 9. ILRI (International Livestock Research Institute), Nairobi, Kenya.

Awgichew, K. 2000. Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding conditions. M.Sc., thesis, University of Wales, UK.

Ayele, G., Jabbar, M.A., Teklewold H., Mulugeta, E., and Kebede, G. 2004. Seasonal and inter-market differences in prices of small ruminants in Ethiopia. Journal of Food Products and Marketing. 12: 59-77.

Baker, R.L. and Rege, J.E.O. 1994. Genetic resistance to disease and other stresses in improvement of ruminant livestock in the Tropics.World 5th Congress on Genetics Applied to Livestock Production. 20:405-412.

Berhan, A. 2001. Comparison of reproductive performance, mortality rate And productivity of Menz and Horro sheep breeds of Ethiopia. M.Sc., Thesis, Wageningen University, The Netherlands.

Berhan, A. and Van Arendonk, J. 2006. Reproductive performance and mortality rate in Menz and Horro sheep following controlled breeding in Ethiopia. Small Ruminant Research. 63:297-303.

Berhanu, G, Hoekstra, D. and Samson, J. 2007. Heading towards commercialization? The case of live animal marketing in Ethiopia. Improving Productivity and Market Success

(IPMS) of Ethiopian Farmers Project Working Paper 5. ILRI (International Livestock Research Institute), Nairobi, Kenya.

Bett, R.C., Kosgey, I.S., Bebe, B.O. and Kahi, A.K. 2007. Breeding goal for the Kenya Dual Purpose Goat. II. Estimation of economic values for production and functional traits. Tropics Animal Health and Production. 39:467-475.

Conington, J., Bishop, S.C., Waterhouse, A. and Simm, G. 2004. A bioeconomic approach to derive economic values for Pasture-based sheep genetic improvement programs. Journal of Animal Science. 18:1290-1304.

CSA (Central Statistics Authority), 2007. Agricultural sample survey, 2004/05 (1997 E.C). Volume II, report on livestock and livestock characteristics. Statistical bulletin, 331, Addis Ababa, Ethiopia.

DAGRIS, 2007. Domestic Animal Genetic Resources Information System. (eds. J.E.O. Rege, O. Hanotte, Y. Mamo, B. Asrat and T. Dessie). International Livestock Research Institute, Addis Ababa, Ethiopia. http://dagris.ilri.cgiar.org

Dempfle, L. 1992. Berücksichtigung von Fruchtbarkeit und Eutergesundheit in der Rinderzüchtung. Züchtungskunde. 64:447-457.

Dickerson, G. E. 1978. Animal size and efficiency: basic concepts. Animal Production. 27:267–379.

EARO (Ethiopian Agricultural Research Organization), 2000. National Small Ruminants Research Strategy Document. EARO, Addis Ababa, Ethiopia.

EPA, 2002. Ethiopian Privatisation Agency. Available at web: http://www.telecom.net.et/~epa/Sectors/leather.html

Erimias, E., Yami, A. and Rege, J.E.O. 2006. Slaughter characteristics of Menz and Horro sheep. Small Ruminant Research. 64:10-15.

Ermias, E., Yami, A., and Rege, J.E.O. 2002. Fat deposition in tropical sheep as adaptive attribute to periodic feed fluctuation. Journal of Animal Breeding and Genetics. 119:235-246.

Essl, A. 1987. Statistische Methoden in der Tierproduktion. Österr. Agrarverlag, Wien, Austria.

FAO (Food and Agricultural Organization), 1991. Small ruminant production and small ruminant genetic resource in Africa. Animal Production and Health Paper. No. 88. FAO, Rome, Italy.

FAO (Food and Agricultural Organization), 1999. The Global Strategy for the Management of Farm Animal Genetic Resources- Executive Brief. FAO, Rome, Italy.

FAO (Food and Agricultural Organization), 2000. World watch list for domestic diversity, 3rd ed. FAO, Rome, Italy.

FAO (Food and Agricultural Organization), 2005. Global Information and Early Warning System on Food and Agriculture World Food Programme. FAO, Rome, Italy.

Fewson, D., 1993. Design of livestock breeding programs. Animal Genetics and Breeding Unit (AGBU), p.53-58, Armidale, Australia.

Fitzhugh, H.A. 1976. Analysis of growth curves and strategies for altering their shape. Journal of Animal Science. 42:1036-1051.

Fuerst-Waltl, B., and Baumung, R. 2009. Economic values for performance and functional traits in dairy sheep. Italian Journal of Animal Science. (accepted).

Fuerst-Waltl, B., Willam, A. and Baumung, R. 2006. Entwicklung nationaler Zuchtprogramme für Schafrassen in Österreich. Abschlussbericht des Projektes 1330 im Auftrag des BM für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft und des Österreichischen Bundesverbandes für Schafe und Ziegen. Vienna, Austria.

Galal, E.S., Kassahun, A., Beyene, K., Yohannes, G. and Odonovan, P.B. 1979. A study on fattening Ethiopian sheep. 1. Performance of highland lambs under feedlot conditions. Ethiopian Journal of Agriculture Science. 1:93-98.

Gautsch, K.D. 1987. Comparative productivity of indigenous sheep in the highlands of Ethiopia and Rwanda.Working document, No.14. ILCA (International Livestock Center for Africa), Addis Ababa, Ethiopia

Gemeda, D., Kumsa, T., Galmessa, U., Abegaz, S. and Gebreyohannes, G. 2005. Mortality rate and major clinical signs in Horro sheep at smallholder farms in East Wollegga and West Shoa zones, West Oromia, Ethiopia. Ethiopian Journal of Animal Production. 5:33-42.

GfE (Gesellschaft für Ernährungsphysiologie - Ausschuss für Bedarfsnormen), 1996. Energiebedarf von Schafen. Proc. Soc. Nutr. Physiol. 5:149-152

GfE (Gesellschaft für Ernährungsphysiologie - Ausschuss für Bedarfsnormen), 2001. Energie-Nährstoffbedarf landwirtschaftlicher Nutztiere Nr. 8: Empfehlungen zur Energie-und Nährstoffversorgung der Milchkühe und Aufzuchtrinder. DLG-Verlag, Frankfurt, Germany.

Groen, A.F., Steine, T., Colleau, J.J., Pedersen, J., Pribyl, J. and Reinsch, N. 1997a. Economic values in dairy cattle breeding, with special reference to functional traits. Report of an EAAP working group. Livestock Production Science. 49:1-21.

Haghdoost, A., Shadparvar, A.A., Nasiri, M.T.B. and Fayazi, J. 2008. Estimates of economic values for traits of Arabic sheep in Village system. Small Ruminant Research. 80:91-94.

Hassen, Y., Fuerst-Waltl, B. and Sölkner, J. 2003. Genetic parameter estimates for birth weight, weaning weight and average daily gain in pure and crossbred sheep in Ethiopia. Journal of Animal Breeding and Genetics. 120:29-38.

Hazel, L.N. 1943. The genetic basis for constructing selection indexes. Genetics. 28:476-490.

Hodges, J. 1990. Genetic improvement of livestock in developing countries using the open nucleus breeding system. Animal Science Papers and Reports 6, Polish Academy of

Sciences, Institute of Genetics and Animal Breeding, Jastrzebiec, Proceedings of the FAO Conference on Open Nucleus Breeding Systems, Białobrzegi. Poland.

IBC (Institute of Biodiversity Conservation), 2004. The State of Ethiopia's Farm Animal Genetic Resources: Country Report. A Contribution to the First Report on the State of the World's Animal Genetic Resources. Addis Ababa, Ethiopia.

ILCA (International Livestock Center for Africa), 1991. A hand Book of African Livestock Statistics. Working Document No. 15. Addis Ababa, Ethiopia.

ILCA (International livestock center for Africa), 1993. Handbook of Africa Livestock Statstics. ILCA, Addis Ababa, Ethiopia.

Kebede, Z. 1995. Skin and hides production and marketing in Ethiopia. In: proceeding of the 2nd annual conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia.

Kirchgessner, M. 2004. Tierernährung. DLG-Verlag, Auflage, Germany

Kosgey, I.S, Van Arendonk, J.A.M. and Baker, R.L. 2003. Economic values for traits of meat sheep in medium to high production potential areas of the Tropics. Small Ruminant Research. 50:187-202.

Kosgey, I.S, Van Arendonk, J.A.M. and Baker, R.L. 2004. Economic values for traits in breeding objectives for sheep in Tropics: Impact of tangible and intangible benefits. Livestock Production Science. 88:143-160.

Kosgey, I.S., Baker, R.L., Udo, H.M.J. and Van Arendonk, J.A.M. 2006. Successes and failures of small ruminant breeding programmes in the Tropics: a review. Small Ruminant Research. 61:13–28.

Kosgey, I.S. and Okeyo, A.M. 2007. Genetic improvement of small ruminants in low-input, smallholder production systems: Technical and infrastructural issues. Small Ruminant Research. 70:76–88.

Lebbiea S.H.B. and Ramsay, K. 1994. A perspective on conservation and management of small ruminant genetic resources in the Sub-Saharan Africa. Small Ruminant Research. 34:231-247.

Legarra, A., Ramon, M., Ugarte, E. and Perez–Guzman M.D. 2007. Economic weights of fertility, prolificacy, milk yield and longevity in dairy sheep. Animal.1:193-203.

Lemma S. 2002. Phenotypic classification and description of indigenous sheep types in the Amhara national regional state of Ethiopia. M.Sc thesis. University of Natal, Pietermaritzburg, South Africa.

Leymaster, K.A. 2002. Fundamental aspect of cross breeding of sheep: Use of breed diversity to improve efficiency of meat production. Sheep and Goat Research Journal. 17(3):50-59.

Mason, I.L. 1996. A World Dictionary of Livestock Breeds, Types and Varieties. 2nd ed. Common Wealth Agricultural Bureau, Farnham Royal.

Mengistu, A. 2000. Country pasture/forage resource profile, Ethiopia. Available on web; http://www.fao.org/waicent/faoinfo/agricult/agpc/doc/pasture/pasture.htm).

Miesenberger, J. 1997. Zuchtzieldefinition und Indexselektion für die österreichische Rinderzucht. Dissertation, Universität für Bodenkultur, Wien, Austria.

Miesenberger, J., Soelkner, J. and Essl, A. 1997. Economic weights for fertility and reproduction traits relative to other traits and effects of including functional traits into a total merit index. Interbull Bulletin. 18:78-84.

MOA (Ministry of agriculture), 1998. Agro-ecological zones of Ethiopia. Addis Ababa, Ethiopia

MOA (Ministry of agriculture), 2000. Forage extension manual. Animal and fishery resource department, Addis Ababa, Ethiopia.

Mukasa-Mugerwa, E. and Lahlou-Kassi, A. 1995. Reproductive performance and productivity of Menz sheep in the Ethiopian highlands. Small Ruminant Research. 17:167-177.

Mukasa-Mugerwa, E., Lahlou-Kassi, A., Rege, J.E.O., Tembely, S., Tibbo, M. and Baker, R.L. 2000. Between and within bred variation in lamb survival and risk factors associated with major causes of mortality in indigenous Horro and Menz sheep in Ethiopia. Small Ruminant Research. 37:1-12

Negussie, E., Rottmann, O.J., Pirchner, F. and Rege, J.E.O. 2004. Growth and carcass composition of Tropical fat-tailed Menz and Horro sheep breeds. Animal Science. 78:245-252.

Niftalem, D. 1990. On farm study of reproductive and growth performance of Menz sheep around Debre Brahan area. M.Sc Thesis, Alemaya University, Dire Dawa, Ethiopia.

Philipsson, J., Rege, J.E.O. and Mwai, O. 2006. Sustainable breeding programmes for Tropical farming systems. In: ILRI-SLU. Animal Genetics Training Resource, CD- Version 2, eds J.M. Ojango, B. Malmfors and O. Mwai. ILRI (International Livestock Research Institute), Nairobi, Kenya, and SLU (Swedish University of Agricultural Sciences), Uppsala, Sweden.

Press, W.H., Flannery, B.P., Teukolsky, S.A. and Vetterling, W.T. 1986. Numerical Recipies: The art of scientific computing. Cambridge University Press. Cambridge, UK.

Rege, J.E.O. and Gibson, J.P. 2003. Animal genetic resources and economic development: issues in relation to economic valuation. Ecological Economics. 45:319–330.

Rege, J.E.O. and Okeyo, A.M. 2006. Improving our knowledge of Tropical indigenous animal genetics resources. In: ILRI-SLU. Animal Genetics Training Resource, CD- Version 2, eds J.M. Ojango, B. Malmfors and O. Mwai. ILRI (International Livestock Research Institute), Nairobi, Kenya, and SLU (Swedish University of Agricultural Sciences), Uppsala, Sweden.

Rewe, T.O., Indetie, D., Ojango, J.M.K. and Kahi, A.K. 2006. Economic values for production and functional traits and assessment of their influence on genetic improvement in the Boran cattle in Kenya. Journal of Animal Breeding and Genetics.123:23-36.

Seleka, T.B. 2001. Determinants of short-run supply of small ruminants in Botswana. Small Ruminant Research. 40:203-214.

Sölkner, J., Nakimbugwe, H. and Valle Zarate, A. 1998. Analysis of determinants for success and failure of village breeding programs. World 6th Congress on Genetics Applied to Livestock Production, vol. 25, Armidale, NSW, Australia.

Solomon, A. 2002. Genetic evaluation of production, reproduction and survival in a flock of Ethiopian Horro sheep. PhD thesis, University of the Free State, South Africa.

Solomon, A. and Gemeda, D. 2000. Genetic and phenotypic parameters of growth, reproduction, and survival performance of Horro sheep at Bako Agric. Res. Center. Research Report. International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia.

Solomon, A., Gemeda, D., Kumsa, T., Soboka, B. Bacha, D., Mideksa, B., Dubiso, F., Galmessa, U. and Feleke, B. 2004. Proceedings of the 12th annual conference of the Ethiopian Society of Animal Production (ESAP) Addis Ababa, Ethiopia.

Solomon, G., Komen, H., Windig, J.J., Hanotte, O. and Van Arendonk, J.A.M. 2008. Conservation priorities for Ethiopian sheep breeds combining threats status, breed merits and contribution to genetic diversity. Genetic Selection Evaluation, PhD. Thesis, Wageningen University, The Netherlands.

Solomon, G., Sisay, L., Komen, H. and Van Arendonk, J.A.M. 2007. Estimate of genetic parameters and genetic trends for live weight and fleece traits in Menz sheep. Small Ruminant Research. 70:145-153.

Solomon, G., Van Arendonk, J.A.M., Komen, H., Windig, J.J. and Hanotte, O. 2007. Population structure, genetic variation, and morphological diversity in indigenous sheep of Ethiopia. Animal Genetics. 38:621-628.

Suileman, A.H., Sayers, A.R. and Wilson, R.T. 1990. Evaluation of Shugor, Dubasi, and Watish sub types of Sudan sheep at El-Hunda National sheep research station, Gezera province. ILCA Research report 18, Addis Ababa, Ethiopia.

Tembley, S. 1998. Small ruminant production in Ethiopia: prospects for improving productivity. Proceedings of the 5th National Conference of Ethiopian Society of Animal Production. Addis Ababa, Ethiopia.

Tesfaye, G. 2008. Characterization of Menz and Afar indigenous sheep breeds of smallholders and pastoralists for designing community-based breeding strategies in Ethiopia. M.Sc. thesis, Haramaya University, Ethiopia.

Tibbo, M. 2006. Productivity and health of indigenous sheep breeds and crossbreds in the central Ethiopian highlands. PhD dissertation. Department of Animal Breeding and Genetics, Faculty of Veterinary Medicine and Animal Sciences, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden.

Tibbo, M., Ayalew, W., Awgichew, K., Ermias, E. and Rege, J.E.O. 2004. On-station characterization of indigenous Menz and Horro sheep breeds in the central highlands of Ethiopia. FAO/UNEP Animal Genetic Resources Information. 35:61-74.

Tibbo, M., Philipsson, J. and Ayalew, W. 2006. Sustainable sheep breeding programmes in the Tropics: Framework for Ethiopia. Conference on International Agriculture Research for Development University of Bonn, Germany

Tisdell, C. 2003. Socioeconomic causes of loss of animal genetic diversity: analysis and assessment. Ecological Economics. 45(3):365–376.

Valle Zarate, A. 1995. Züchtungsstrategien für marginale Standortbedingungen der Tropen und Subtropen. Archive of Animal Breeding. 38:461-478.

Wilson, R.T. 1989. Reproductive performance of African indigenous small ruminants under various management systems. A Review. Animal Reproduction Science. 20:265-286.

Wolfova, M., Wolf, J., Krupova, Z. and Margetin, M. 2009. Estimates of economic values for traits of dairy sheep: II. Model application to a production system with one lambing per year. Journal of Dairy Science. 92:2195-2203.

Wood, P.D.P. 1967. Algebraic Model of the Lactation Curve in Cattle. Nature (London). 216:164-165.

Workneh, A., Ephrem, G., Tibbo, M., Yetnayet M. and Rege J.E.O. 2004. Current State of Knowledge on Characterisation of Farm Animal Genetic Resources in Ethiopia. Proceedings of the 11th Annual conference of the Ethiopian Society of Animal Production. Addis Ababa, Ethiopia

Workneh, A. 2006. Getting the Incentives Right: Concerns Associated with Expansion of Cattle Export Markets in Ethiopia. Ethiopian Journal of Animal production. 6:99-103.

Zelalem, A. and Fletcher, I. 1991. Small ruminant productivity in the central Ethiopia mixed farming system. Proceeding of the 14th National Livestock Improvement Conference, Institute of Agricultural Research, Addis Ababa, Ethiopia.

Zewdu, E. 2008. Characterization of Bonga and Horro indigenous sheep breeds of smallholders for designing community-based breeding strategies in Ethiopia. M.Sc. thesis, Haramaya University, Ethiopia.

8. APPENDECIS

8.1 Model description (Miesenberger, 1997)

For the simulation of a meat sheep herd (Menz and Horro) in a steady state over an infinite planning term the maximum number of lactation (n) and the number of reasons for disposal (k) needs to be known. Accordingly, the number of different ewe classes is calculated by n(k+1). For this simulation n=9 and k=3 (culling for infertility, for voluntary and for involuntary reasons) were assumed resulting in 36 different ewe classes. In lactation number 9 all ewes were disposed for involuntary reasons.

Probabilities for different reasons for disposal ($c_{(i,j)}$)in the reference scenario for Menz sheep

	Lactation							
Reason for culling	1	2	3	4	5	6	7	8
Involuntary culling	0.07	0.04	0.03	0.01	0.01	0.03	0.04	0.07
Infertile culling	0.06	0.04	0.02	0.01	0.01	0.02	0.04	0.06
Voluntary culling	0.00	0.05	0.03	0.02	0.01	0.00	0.00	0.00

Probabilities for different reasons for disposal ($c_{(i,j)}$)in the reference scenario for Horro sheep

	Lactation							
Reason for culling	1	2	3	4	5	6	7	8
Involuntary culling	0.07	0.04	0.03	0.01	0.01	0.03	0.04	0.07
Infertile culling	0.06	0.04	0.02	0.01	0.01	0.02	0.04	0.06
Voluntary culling	0.00	0.03	0.03	0.02	0.01	0.00	0.00	0.00

For all classes the probability of realization $P_{(i,j)}$, defined by the maximum number of lactations and the probability of disposals $C_{(i,j)}$ may be calculated with i=lactation number and j=fate of a ewe within lactation. The sum of all $P_{(i,j)}$ is 1.

The probability of a ewe to reach lactation 1 is denoted by P_i. In the first lactation, p_i=1, in higher lactations pi is calculated by

(1) $P_{(i+1)} = pi - \sum_{j=1}^{k} p_{(i)} \cdot c_{(i,j)}$ i= 1,2,…n-1 j= 1,2,……,k

The proportion in each lactation (p_i) is therefore calculated by

(2) $P_{(i)} = p_{(i)} / \sum_{i=1}^{n} p_{(i)}$ i=1,2,……n

By multiplication with the respective probabilities for disposal c(i,j) the proportions of ewe classes by lactation and fate for the reference herd are calculated.

(3) $P_{(i,j)} = p_{(i)} \cdot c_{(i,j)}$ i=1,2,….n j=1,2,……,k

For particular values of i and j the following formulas are applied

(4) $P_{(i,j)} = P_{(i+1)}$ for i= 1,2,…….n j= k+1

(5) $P_{(i,j)} = 0$ for i= n j= k+1

Calculation of milk yield and live mass

Daily milk yield and milk contents were calculated by the exponential function described by Wood (1967):

(6) $Y_t = a.t^b \cdot e^{c.t}$

With y_t being milk, fat or protein performance on day t, where a, b, and c are constants that specify the shape of the lactation curve. The parameter a is calculated by the given milk production potential (MP) and the shape of the lactation curve:

(7) $$a = \frac{MP}{\sum_{t=1}^{240} tb \cdot e^{c.t}}$$

Parameters of the wood curve for meat sheep in first, second and higher (3+) lactations

	Carrier yield		Fat percentage		Protein percentage	
Lactation	b	c	b	c	b	c
1	0.180	-0.0087	-0.0469	0.00120	-0.09862	0.00133
2	0.167	-0.0108	-0.0536	0.00210	-0.11732	0.00156
3+	0.116	-0.0930	-0.1893	0.00370	-0.13098	0.00171

The average milk production of the second and higher lactations is calculated by applying multiplication factors describing the relative production level in different lactations due to the ageing process.

The live mass of a female animal is described by the function

(8) $LM_t = MM - (MM - BM).\ e^{-.0056t}$

With LM, MM, and BM denoting the live and mature (MM = 25kg and 28kg for Menz and Horro, respectively) and birth mass, respectively, and t being the age in days. For breeding rams the exponential parameter was changed to 0.004 with an assumed mature mass of 36 kg and 38 kg for Menz and Horro, respectively.

For fattening animals LM on day t was defined according to the Gompertz function (Fitzhugh, 1976):

(9) $LM_t = a\ .\ e^{-be^{-kt}}$

with a being the asymptote, while b and k denotes slope and point of inflexion, respectively.

Parameters of the Gompertz function for fattening lambs of Menz sheep for the reference situation and for deriving economic weights

Gompertz parameters		
a	b	k
36.6128[1]	2.1928	0.00477
36.6128	2.1428	0.00527
36.6128	2.0928	0.00577
36.6128	2.0428	0.00617

[1]reference situation

Parameters of the Gompertz function for fattening lambs of Horro sheep for the reference situation and for deriving economic weights

Gompertz parameters		
a	b	k
36.3078[1]	2.3501	0.00566
36.3078	2.3001	0.00616
36.3078	2.2501	0.00666
36.3078	2.2001	0.00716

[1]reference situation

Energy and protein requirements, energy deficit (AFRC, 1993; GfE 1996, 2001; Kirchgessner, 2004)

Model calculations were based on the following requirements (LM = live mass (kg), BM = birth mass (kg), LMZ = gain live mass (g/d)):

- **Energy requirement:**

Maintenance:

(10) 0.43 MJ ME / kg LM $^{0.75}$ including medium movement and wool growth

Milk production:

Energy content of milk (LE) is calculated by

(11) LE (MJ/kg) = 0.38 fat% + 0.21 protein% + 0.95

Efficiency factor for calculation of requirement = 0.60

Gestation:

Energy content of the gravid uterus (CE)

(12) CE (MJ/d) = 0.25 x BM . (10^x) x 0.07372 x e $^{-0.00643t}$ with

X = 3,322 – 4,979 x $e^{(-0.00643 .t)}$ with t = day of gestation

Efficiency factor for calculation of requirements = 0.20.

Growth:

(13) MEg = 0.141 x LM + 0.0273 x LMZ + 0.0001 x (LM x LMZ)

- **Protein requirement:**

Maintenance:

(14) Maintenance requirement (g XP/d) = 3.0 kg $LM^{0.75}$ + 15 including medium wool growth

Milk production:

(15) Milk production protein requirements (g XP) = (protein per kg milk in g)/0.42

Gestation:

Protein requirements during gestation

(16) (g XP) = (10.5/0.83) x (energy requirements for maintenance and gestation)

Growth:

Protein requirements for growth (g XP/d) = 1.708 x LM + 0.4316 x LMZ

A possible energy deficit is defined by the difference between energy requirements and maximum energy consumption. The maximum loss of live mass was assumed to be 8% at the maximum rate of 7.77 g per kg LM $^{0.75}$. For a possible additional energy deficit the milk production was reduced accordingly. A linear weight gain at the same maximum rate was modeled until the next lambing as soon as the energy balance for maintenance, production and gestation was positive.

8.2 Tables for trait complexes and their parameters to derive economic values

Gompertz curve parameters for fattening lambs and marginal utilities of reference situation for Menz breed

a	b	c	DG (g)	Δ DG	Profit (€)	Δ Profit(€)	Marginal utilities
[1]36.6128	2.1928	0.00477	74	9.2	2.02	1.01	0.11
36.6128	2.1428	0.00527	83.2	9.6	3.03	0.79	0.082
36.6128	2.0928	0.00577	92.8	10	3.82	0.6	0.06
36.6128	2.0428	0.00627	102.8		4.42		

[1]reference situation, DG = daily gain

Gompertz curve parameters for fattening lambs and marginal utilities of reference situation for Horro sheep.

a	b	c	DG (g)	Δ DG	Profit (€)	Δ Profit (€)	Marginal utilities
[1]36.3078	2.3501	0.00566	80.5	8.3	11.77	1	0.12
36.3078	2.3001	0.00616	88.8	8.7	12.76	0.83	0.095
36.3078	2.2501	0.00666	97.5	8.9	13.59	0.68	0.076
36.3078	2.2001	0.00716	106.4		14.26		

[1]reference situation, DG = daily gain

Ewe mature live weight, profit per ewe place per year and marginal utilities per unit of weight increase for Menz sheep

Mature weight (kg)	Δ Weight (kg)	Profit	Δ Profit	Marginal utilities
[1]25	1	2.02	-0.35	-0.35
26	1	1.67	-0.36	-0.36
27		1.32		

[1]reference situation

Ewe mature live weight, profit per ewe place per year and marginal utilities per unit of weight increase for Horro sheep

Mature weight (kg)	Δ Weight (kg)	Profit	Δ Profit	Marginal utilities
[1]28	1	11.77	-0.31	-0.31
29	1	11.46	-0.30	-0.30
30		11.16		

[1]reference situation

Probabilities of involuntary culling, length of productive life and marginal utilities of length of productive life for Menz sheep

	Productive Life time (days)	Δ Productive life time (days)	Profit	Δ Profit	Marginal utility
[1]0.00	1653	72	2.02	-0.23	-0.0032
-0.01	1725	74	1.79	-0.23	-0.0031
-0.02	1799		1.56		

[1]reference situation

Probabilities of involuntary culling, length of productive life and marginal utilities of length of productive life for Horro sheep

	Productive Life time (days)	Δ Productive life time (days)	Profit	Δ Profit	Marginal Utilities
[1]0.00	1679	73	11.77	-0.29	-0.0039
-0.01	1752	80	11.48	-0.29	-0.0036
-0.02	1832		11.19		

[1]reference situation

Days of first service and marginal utilities per day to derive economic value of lambing interval for Menz sheep

Productive life (days)	ΔProductive life (days)	Time between lambing & 1st service (days)	Profit	ΔProfit	Marginal utilities	
[1]1654	6	130	2.02	0.08	-0.0032*6= -0.02	0.08-(-0.02)= 0.1
1648	5	129	2.10	0.07	-0.0032*5= -0.02	0.07-(0.02)= 0.09
1643		128	2.17			

[1]reference situation

Days of first service and marginal utilities per day to derive economic values of lambing interval for Horro sheep

Productive life (days)	ΔProductive life (days)	Time between lambing 1st service (days)	Profit	ΔProfit	Marginal utilities	
[1]1683	6	130	11.77	0.1	- 0.0037*6= -0.02	0.1 -(-0.02)= 0.12
1677	5	129	11.87	0.1	- 0.0037*5= -0.02	0.1 -(-0.02)= 0.12
1672		128	11.96			

[1]reference situation

Proportion of single, twin and triple, average liter size and marginal utilities per lamb born for Menz sheep

Proportion of singles and twins	Liter size	ΔLitter size	Profit	ΔProfit	Marginal utilities
[1]98%, 2%	1.02	0.003	2.02	0.06	0.06/0.003=20
97.7%, 2.3%	1.023		2.08		

[1]reference situation

Proportion of single, twin and triple, average liter size and marginal utilities per lamb born for Horro sheep

Proportion of singles, twins and triples	Liter size	ΔLitter size	Profit	ΔProfit	Marginal utility
[1]60%, 36%, 4%	1.44	0.16	11.77	2.98	2.98/0.16=18.62
46%, 48%, 6%	1.60		14.75		

[1]reference situation

Stillbirth rate and marginal utilities of Menz sheep

Stillbirth rate (%)	ΔStillbirth rate (%)	Profit	Δ Profit	Marginal utilities
3%	1	1.82	0.20	0.20
[1]2%	1	2.02	0.21	0.21
1%		2.23		

[1]reference situation

Stillbirth rate and marginal utilities for Horro sheep

Stillbirth rate (%)	ΔStillbirth rate (%)	Profit	Δ Profit	Marginal utilities
3%	1	11.49	0.28	0.28
[1]2%	1	11.77	0.28	0.28
1%		12.05		

[1]reference situation

Lamb survival rate and marginal utilities Menz sheep

Lamb survival rate (%)	ΔLamb survival rate (%)	Profit	Δ Profit	Marginal utilities
77%	1	1.76	0.26	0.26
[1]78%	1	2.02	0.27	0.27
79%		2.29		

[1]reference situation

Lamb survival rate and marginal utilities for Horro sheep

Lamb survival rate (%)	ΔLamb Survival rate (%)	Profit	Δ Profit	Marginal utilities
79%	1	11.49	0.28	0.28
[1]80%	1	11.77	0.28	0.28
81%		12.05		

[1]reference situation

8.3 Questionnaire

8.3.1 Questionnaire prepared for farmers for farmer

Questionnaire prepared for the study on derivation of economic value for important traits for sheep breeders in Menz and Shambu areas.

Introduce yourself very gently and explain to the respondent that, this questionnaire is prepared to generate data for the study on derivation of economic value for important traits for sheep breeders in Menz and shambu area, conducted by University of Natural Resource and Applied Life Science (BOKU), Austria in collaboration with International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia and the International Center for Agricultural Research in the Dry Areas (ICARDA) project. The output of this study will be used as input to establish the economic total merit index (TMI) to design community-based sheep breeding scheme for Menz and Hroo breeds in their local production environment.

Thank you very much for your willingness to discuss with us!!

General information

1. Date ___________________________ (DD/MM/YY)

2. Interviewer's/respondent code ________________________________

3. Age of the respondent ______________

4. Education level of the respondent

a. illiterate b. Writing and reading

c. Elementary school d. Secondary school

e. above secondary school f. Spiritual education

1. How many sheep do you have? _______________________________

2. Do you have private grazing land for your sheep?
   a) Yes ________________ b) No _________________

   2.1 If yes, how large (area) is the grazing land? _________________________ hectare

   2.2 Do you practice harvesting feed from your grazing land?
   a) Yes _____________ b) No ______________

   2.3 If yes, how often do you harvest feed for your sheep from the grazing land?
   ____

   2.4 How much kg of feed do you get in a time? ______________________

3. Do you fatten sheep?

a) Yes ____________ b) No _____________

3.1 If yes, how long is the fattening period? ___________________________ Months

4. Do you offer supplementary feed for your sheep?
a) Yes ________________ b) No ________________

4.1 If yes, fill the following table carefully?

For which sheep do you offer supplementary feed	Type of supplementary feed	For how long (month)	Amount of supplement feed (Kg/day)	Cost/kg of feed (Birr)
Fattening animals				
Breeding ewes				
Breeding rams				
Pregnant ewes				

5. Do you practice hand-rearing?

a) Yes _________________ b) No ________________

5.1 If yes, fill the following table carefully

which lambs do you hand-rear	Feed stuff	For how long	Amount of feed (kg/lamb/day)	Cost of feed/kg (Birr)
Single born				
Twin born				
Triple born				

6. Where do you keep your sheep?

a) In sheep house _______________ b) With the family _____________________

6.1 If they live in sheep house, do you have different sheep house for your lambs and adult sheep?

a) Yes _____________________ b) no _______________________

6.2 If yes, please fill the following table carefully?

sheep	**Area of the house (measure the stable)**	**Cost to build the house (Birr)**	**Duration used (years)**
lambs			
Adult sheep			

6.3 If you keep both lamb and adult sheep in the same sheep house, please fill the following table carefully?

sheep	**Area of the house (measure the stable)**	**Cost to build the house (Birr)**	**Duration used (years)**
For all sheep			

7. Please fill the table carefully for the activity you perform?

Farm activities		Sources of labor		Working hours/laborer/day	Cost/laborer/activity/hour (Birr)
		Family member	Hired laborer		
Farm cleaning (manure collecting)					
Herding/head of sheep					
feeding					
Feed harvesting					
Shearing/head of sheep					
Sheep transport to market area	trekking				
	trucking				
Sheepskin transport					

Manure transport				

7.1 How far is the sheep and sheepskin marketing area from your place? ________________________Km

8. Which of the following management activities and how often do you perform? How much do you pay per treatment per sheep?

activities	**For which group of sheep**	**Cost of treatment/sheep (birr)**	**activities**	**For which group of sheep**	**Cost/treatment/sheep (Birr)**
Dehorning			Drenching		
Docking			Dipping		
Castration			Deworming		
Spraying			Foot trimming		

9. Do you use drugs (e.g Albendazol for fattening animal)?

a) Yes _____________ b) No _______________________

- If yes, please mention for which sheep you use the drugs and how much do you pay per unit of drug? How often do you use the drug?

Drug	**For which sheep**	**How often**	**Cost/unit of drug (Birr)**

10. Have you experience selling sheep?
a) Yes b) no

- If yes, please complete the following table

Which sheep category do you sell	**How often do you sell?**	**Age of the sheep**	**No. of shep you sell at a time**	**Average income/lamb (in Birr)**
Ewe lamb				
Ram lamb				

Breeding ewe				
Breeding ram				
Fattened sheep				

11. Do you pay for the middleman during sheep marketing?

    a) Yes __________ b) No ____________________

    - If yes, how much do you pay for the middleman per marketing per sheep? _____________ Birr

    11.1 Have you ever experienced seasonal variation for price when you sell your sheep?

    a) Yes _______________ b) No ___________________

    _ If you have experienced it, in which season do you prefer to sell your lambs, fattened sheep and breeding sheep respectively?
    ____

12. What other product of your sheep do you sell? Please fill the following table carefully

Sheep product		How often do you collect	For what purpose do you use it		Where do you sell it		How far is the market from you farm (Km)	How much income/kg of product (sheepskin) (Birr)
			Source of income	For home use	Farm get	Market area		
manure								
Sheepskin	raw							
	Semi-processed							
wool								

12.1 How much kg of manure do you get from your sheep every morning? __________kg

12.2 In which season do you prefer to sell manure and sheepskin?

____________________________sheepskin ________________________ manure

13. Which sheep do you shear? And how much gram of wool do you get per each sheep/shearing?

    a) Fattening animals before slaughter ______________________ gram of wool

    b) Breeding ewe ___________ gram of wool

c) Breeding ram______________ gram of wool

d) Replacement sheep ____________gram of wool

e) Lamb ___________ gram of wool

13.1 Is there seasonal variation in price for wool?

a) Yes ___________ b) No ____________

- If yes, in which seasons do you get more and less income from wool?

More income in ______________ Season

Less income in ______________ season

14. Do you purchase replacement sheep?

a) Yes ___________ b) No ______________

- If you purchase, which of the following sheep do you purchase and how much does it cost to buy each replacement sheep?

Replacement sheep	**How often do you purchase**	**Average cost/sheep (Birr)**
Ewe lamb		
Ram lamb		
Breeding ewe		
Breeding ram		

15. Have you culled animals involuntarily (due to bad performance)?

a) Yes ____________ b) No ________________________

15.1 If yes, which criteria do you use to cull sheep involuntarily

____

____

____

15.2 When do you make the culling decision (age of the culled sheep)?

____________ Months

15.3 Do you sell involuntarily culled female sheep immediately after culling decision or after fattening? How much do you get per each condition per sheep?

______________ Birr immediately after culling decision ______________ Birr after fattening

16. Do you cull ewes voluntarily?

a) Yes ____________ b) No _______________

16.1 If yes, how often do you cull ewes voluntarily? _________________________________

16.2 For what reason do you cull ewes voluntarily?

____

17. What is the age and weight of lambs at weaning? __________ months _________ Kg

17.1 What proportion of born lambs survives to weaning? ___________________

17.2 What proportion of weaned lambs survives to yearling? _________________

18. please, fill the following table based on your ewe age structure and parity

Age	Number of ewes	parity
1 year old		
2 years old		
3 years old		
4 years old		
5 years old		
6 years old		
7 years old		
8 years old		

19. What is the marketing age and weight of the fattened sheep for;

a) Female _________________ month ______________ kg

b) Male ____________________ month ____________________ kg

20. In which month does lambing frequently occur? (PRA-key informants)

20.1 January _____________
20.2 February _____________
20.3 March _____________
20.4 April ________________
20.5 May _______________
20.6 June _____________
20.7 July _______________
20.8 August ______________
20.9 September ____________
20.10 October _________
20.11 November ________
20.12 December ________

8.3.2 Questionnaire for market areas

Questionnaire for market areas

Name of the market ____________________ Interviewer's/respondent code ________________

Main occupation of the respondent _____________________ Education level of the respondent ____________________

Note: explain clearly the purpose of this questionnaire to the respondent and fill the table based on the following.

Sheep type: breeding ram, breeding ewe, ewe lamb, ram lamb, fattened sheep foe slaughter

Origin of the sheep; from where is the sheep brought**Age of the sheep**; in months or years

Body size; large or small **Coat color**; white, black, brown, dark brown or mixed

Tail type; fat or thin tail **Horn status**; horned or polled

Libido; active or passive **Mothering ability**; attached to the lamb or not

Lambing interval: Once per year or what? **Twining rate**: Single bearer or twin bearer

Price, how much did the buyer pay?

Table1. For ram (male)

Sheep type	Origin	Age	Body size	Coat color	Tail type	Horn status	libido	price

Table2. For ewe (female)

Sheep type	Origin	Age	Body size	Coat color	Tail type	Horn status	Mothering ability	Lambing interval	Twining rate	price