ASSESSMENT OF SMALL RUMINANT PRODUCTION SYSTEMS AND ON-FARM EVALUATION OF UREA TREATED WHEAT STRAW AND CONCENTRATE FEEDING ON SHEEP BODY WEIGHT CHANGE IN BURIE WOREDA, WEST GOJJAM

M.Sc. Thesis

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By
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As Thesis Research advisor, I here by certify that I have read and evaluated this thesis prepared under my guidance, by Yenesew Abebe, entitled: **Assessment of Small Ruminant Production Systems and On-farm Evaluation of Urea Treated Wheat Straw and Concentrate Feeding on Sheep Body Weight Change in Burie Woreda, West Gojjam**. I recommend that it be submitted as fulfilling the thesis requirement.

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As members of the Board of Examiners of the Msc thesis open defense examination, we certify that we have read, evaluated the thesis prepared by **Yenesew Abebe** and examined the candidate. We recommend that the thesis be accepted as fulfilling the Thesis requirement for the Degree of Master of Science in Agriculture (**Animal Nutrition**).

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Dedication

I dedicate this thesis to my beloved parents: Abebe Desta and Shashie Ewenetu

STATEMENT OF THE AUTHOR

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ABBREVIATIONS

ADF	Acid Detergent Fiber
ADL	Acid detergent lignin
AUA	Alemaya University of Agriculture
ADG	Average daily gain
BOA	Bureau of Agriculture
BOARD	Bureau of Agriculture and Rural Development
BOFED	Bureau of Finance and Economic Development
BW	Body weight
CP	Crude protein
DM	Dry matter
EARO	Ethiopian Agricultural Research Organization
EE	Ether extract
EPLAUA	Environmental Protection, Land Administration and Use Authority
g	Gram
GNC	Groundnut cake
HH	Household
ID	Identification number
ILCA	International Livestock centre for Africa
ILRI	International Livestock Research Institute
IPMS	Improving Productivity and Market Success of Ethiopian Farmers
IVOMD	*In vitro* organic matter digestibility
kg	Kilogram
m	Meter
masl	meters above sea level
mg	milligram
ml	milliliter
OM	Organic matter
n	Number of observation
NDF	Neutral Detergent Fiber
NSC	Noug seed cake

ABBREVIATIONS (*Continued*)

SD	Standard deviation
SPSS	Statistical package for social sciences
TDN	Total digestible nutrients
TLU	Tropical livestock unit
WB	Wheat bran
Wt	Weight

BIOGRAPHICAL SKETCK

The author was born in 1974 in Gozemin woreda, East Gojjam zone, Amhara National Regional State. He attended his elementary, junior high school and senior secondary school in Debre Markos at Abema Elementary School, Tekele Haymanot Junior Secondary School and Debre Markos Comprehensive Senior Secondary School, respectively. After completing his secondary school education he joined the then Alemaya University of Agriculture (AUA) in September 1995 and graduated from the same university in Animal Sciences in BSc degree in July 1999.

After graduation the author was employed by Delanta Dawent Woreda Agricultural Office, North Wollo Zone, as an expert and served there for 1 year. He was then employed by EARO (Ethiopian Agricultural Research Organization) in 2001and served at Debre Zeit and Pawe Agricultural Research Centers as a Junior Researcher. The author then transferred to ARARI (Amhara Regional Agricultural Research Institute) in 2003 and joined Andassa Livestock Research Center as a Junior Researcher. The author served at Andassa Livestock Research Center for almost three years and he then joined Haramaya University in September 2006 to resume his MSc degree study in Animal nutrition.

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ASSESSMENT OF SMALL RUMINANTS PRODUCTION SYSTEMS AND ON-FARM EVALUATION OF UREA TREATED WHEAT STRAW AND GROUNDNUT CAKE AND WHEAT BRAN MIX FEEDING ON SHEEP BODY WEIGHT CHANGE

ABSTRACT

Assessment of the small ruminants production systems was conducted in four selected representative rural kebeles, namely, Woheni Durebetie, Woyenema Ambaye, Denbun and Boko Tabo in Burie Woreda to assess the farmers' traditional small ruminants management practices, to identify and prioritize the constraints of the small ruminants production systems. The study was carried out through informal and formal surveys in the selected kebeles. The farmers interviewed in the informal survey were selected purposively and for the formal survey, by systematic random sampling method. In addition, sheep/ goat flocks in the grazing fields were selected randomly and body weight (BW) (using hanging scale), sex and age (by dentition) of the animals were measured and recorded. Farmers in the study area rear sheep for two main purposes, for cash income and home slaughter on festivals. On average, one household had 3.7±2.46 heads of sheep (n = 127). There were two sheep breeds in the study kebeles, Washera and Horro. The mean body weight of sheep in the flock was 21.6±9.34 kg (n = 1211). From the current survey result, it was evident that there were more Washera sheep (98%) in Woheni Durebetie Kebele and more Horro sheep (92%) in Boko Tabo Kebele in Burie Woreda. As farmers in the study area sell, castrate and slaughter males at a very young age, there is a possibility of inbreeding in the sheep flocks. The main feed resources for sheep in the area are natural pasture and stubble grazing. In addition, most farmers supplement salt and *atella* (a local beer (*tela*) residue) to their animals. There is feed shortage problem both during the dry and rainy seasons in the highland kebeles. Based on calculation of feed requirement for the existing livestock per household, there is a deficit of 0.7 ton DM feed per household per year in the highland kebeles. One household in the area sold on average 1.1±1.40 heads of sheep (n = 127) per year. Farmers mainly sell sheep during Easter, New Year and Christmas. Sheep from the woreda and neighbouring woredas and even neighbouring region enters into the woreda for marketing. Among the constraints

identified in sheep production, sheep diseases, lack of adequate veterinary service and feed and nutrient shortage are the main ones. To bring improvements in sheep production in Burie Woreda, these constraints should be given more emphasis in research and development activities that are going to be undertaken in the area. The goat production system in the study area is similar in several respects to the sheep production system.

Two on-farm feeding trials were conducted in Arebesi, Tiya Tiya and Sertekez kebeles in Burie Woreda. The objectives of the trials were to evaluate the weight change performance of the lambs when they were fed urea treated wheat straw and concentrates, to estimate the economic feasibility and to assess farmers evaluation of these feeding practices. The lambs used in the trial were all local breeds (Washera, Horro and crossbreds) and of male sex. The animals used in the grazing and wheat straw feeding trial had an initial body weight of 20.8±3.88 kg (n = 18) and 23.3±4.37 kg (n = 32) and an initial age of 8.7±1.68 months (n = 18) and 10.2±1.84 months (n = 32), respectively. The wheat straw that was used for the trial was treated with 5% urea. The following treatments were used in the trials. In the grazing trial, farmers' traditional fattening practices and grazing plus 200 g concentrate mix supplement. In the wheat straw feeding trial, untreated wheat straw plus 200 g concentrate mix and urea treated wheat straw plus 200 g concentrate mix supplement. The concentrate mix consisted of 75% groundnut cake (150 g) and 25% wheat bran (50 g). A completely randomized design was employed for the on-farm feeding trials. At the end of the feeding trials, farmers' were interviewed individually and in a group to evaluate the results of the feeding trials. Economic analysis was done using partial budget analysis. The trials were conducted for 86 days. The experimental animals consumed almost all the concentrate feed mix offered to them during the trials. The animals' consumption of urea treated and untreated wheat straw was very low, 52.8 g and 7.4 g per day, respectively. There was no difference ($P>0.05$) on final BW and daily BW gain between the treatments in the wheat straw feeding trial. But, in the grazing trial, there was a difference ($P<0.05$) on final BW and daily BW gain between the treatments. The animals in the concentrate supplemented treatment and the control group had a mean final BW of 24.6 kg and 21.9 kg and a mean daily BW gain of 43.6 g and 12.9 g per day, respectively. Supplementation of groundnut cake and wheat bran mix to grazing sheep was feasible based on partial budget analysis also. Furthermore, this treatment was selected to be the best by farmers' evaluation and has a potential for adoption by farmers. Hence, this feeding practice can be scaled up to be widely used in the study area.

1. INTRODUCTION

Smallholder farmers predominate in developing countries and they are entirely dependent on agriculture for their livelihoods (Dixon *et al.,* 2001). About 76% of the poor in developing countries live in rural areas and two-thirds of the rural people in these countries keep livestock (Owen *et al*., 2005). In Ethiopia, more than 80% of the human population depends on agriculture for their livelihoods (Azage, 2005) and usually keep livestock as pastoralists or in mixed crop livestock systems.

The livestock population of Ethiopia is currently estimated at 43.1 million cattle, 23.6 million sheep, 18.6 million goats, 1.7 million horses, 0.3 million mules and 4.5 million donkeys excluding nomadic areas (CSA, 2008) and is diverse genetically. Small ruminant productivity in Ethiopia is low compared with the apparent potential (EARO, 2001a). Generally, technical and non-technical constraints limit animal productivity in Ethiopia (EARO, 2001d). Among the technical constraints, poor nutrition both in quantity and quality, diseases and low genetic potential for higher production hinder animal productivity in the country. Currently, feed is the main constraint limiting livestock productivity in the country (Alemayehu, 2005). There is seasonal fluctuation in feed supply both in quantity and quality. Feed shortage and nutrient deficiency are common during the dry season both in the highlands and the lowlands of the country (Alemayehu, 2005).

Various factors contribute to the low feed supply to livestock. Grazing lands are decreasing in area (Alemayehu, 2005). Poor soil fertility and unreliable and seasonal rainfall limit the amount of feed obtained from these areas (EARO, 2001a). Crop residues are also low in nutritive value. The use of improved forages by smallholder farmers is not common. Utilization of agro-industrial by-products is limited to urban and peri-urban areas.

Currently, livestock depend on natural pasture and crop residues as their main feed resource in the country (Alemayehu, 2005). The quality and quantity of feed produced from the natural pasture is low (EARO, 2001b). According to this source, a mean annual yield of 4.2 ton DM per hectare can be obtained from the natural pasture. In addition, the

critical nutrient lacking in natural pasture was noted to be CP during the dry season. The same source reported that in January the CP content of the natural pasture was about 3.2% which is below maintenance requirement for ruminant animals. Owing to this, up to 20% body weight (BW) loss has been recorded in cattle kept entirely on natural pasture (EARO, 2001b). It is also observed that BW gains during the rainy season are lost during the dry season. Currently, with increasing human population and demand for crop production, grazing lands are shrinking and livestock are kept in low potential lands that are not suitable for crop production and other purposes (Alemayehu, 2005). This condition is evident in the mixed farming systems of the highlands and mid altitude zones of Ethiopia.

According to EARO (2001b), based on the 1990 E.C. crop yield data, about 14 million ton DM crop residues is estimated to be produced in the country annually. From this amount, cereals contribute about 95% and the rest is the contribution of legume residues. Crop residues are low in CP, vitamins, minerals and digestibility (EARO, 2001b). Lignin content of crop residues is also high. Generally, unsupplemented crop residue based diets do not maintain BW of ruminant animals. According to Abule (1994), a BW loss of up to 75 g per day was observed in young calves fed sole diet of *tef* straw. In another study, sheep fed on sole untreated wheat straw lost 33.9 g per day (Getahun, 2006). But sheep fed on sole urea treated straw gained 10.7 g per day. Hence, supplementation and urea treatment of crop residues are necessary to efficiently utilize the available crop residues in the country.

Urea treatment improves the nutritive value of crop residues in several ways. Generally, it increases the nitrogen content, intake and digestibility of crop residues (Tingshuang *et al.*, 2002). According to the same source, urea treatment also improves palatability of these feed materials. Above all, urea is easy to handle and cheaper to purchase than any other material available for crop residue treatment (Preston, 1986). Other than improving the nutritive value of crop residues, urea treatment has several other advantages such as killing harmful microbes, pests and weed seeds. Hence, it enhances crop production. It also retards mold growth and destroys parasite eggs (Tingshuang *et al.*, 2002).

Small ruminant population of Ethiopia is one of the largest in Africa (IBC, 2007). Most of the small ruminants population of the country is kept by smallholder farmers and small

ruminants production in the country is traditional (EARO, 2001a). Improvement in small ruminants productivity can be achieved through identification of production constraints and introduction of new technologies or by refining existing practices in the system. In Ethiopia, the small ruminant production system in different agro-ecological zones is not studied fully and farmers' needs and production constraints have not been identified (EARO, 2001a). Assessment of the small ruminants production system and identification and prioritization of the constraints of production is a prerequisite to bring improvement in small ruminants productivity in the country. Prioritization of the production constraints is essential as it helps to use the scarce resources efficiently. Understanding the production system helps to design appropriate technologies which are compatible with the system. On-farm testing of new and improved practices is also important as solutions to constraints are location specific and several factors affect the adoption of these practices in the system (ILCA, 1990). In addition, various income sources for farmers should be assessed as they affect production and productivity (Low, 1989). In general, assessment of the production system is important to plan development and research activities and bring improvements in productivity. In Burie Woreda, small ruminants production and marketing systems are not studied and precisely known and constraints are not identified and prioritized. In addition, improved animal feeding practices and their biological, social and economic feasibility to be adopted by smallholder farmers have not been tested in the woreda. Hence, assessment of the small ruminants production and marketing systems and testing of new and improved feeding practices are necessary in the woreda in order to achieve improvements in small ruminants productivity. Therefore, this study was conducted with the following objectives.

Objectives:

1. To assess the small ruminants production and marketing systems and to identify and prioritize the constraints in Burie Woreda,
2. To evaluate the effect of feeding urea treated wheat straw and groundnut cake and wheat bran mix supplementation on BW change of lambs,
3. To estimate the economic feasibility and to assess farmers evaluation of these feeding practices
4. To assess the on-farm birth weight and growth performance and mortality and causes of mortality of lambs.

2. LITERATURE REVIEW

2.1. Farming Systems Assessment

Several decades ago the performance of livestock in Africa was poor (ILCA, 1990). Many factors have contributed for the poor performance of livestock in Africa. Among the factors, failure to understand the situation of small scale farmers is included. It is believed that farming systems research will provide such knowledge. According to Low (1989), farming systems is a new approach to developing technologies that will be widely adopted by small scale farmers in developing countries. A farming systems research was developed because technologies developed on-station in developing countries were not adopted by small scale farmers (Low, 1989). Lack of adoption of technologies was that they were developed without adequate knowledge of the small scale farmers' circumstances. Farmers' circumstances are determined by both physical and social factors. According to Low (1996), knowledge of farmer circumstances and objectives is essential to evaluate and design appropriate technologies to small scale farmers.

Livestock systems research has several phases (ILCA, 1990). It includes the descriptive/ diagnostic phase, the design phase, the testing phase and the extension phase. In the descriptive phase, the production system of each identified target group is described using secondary data and informal survey. In this phase, target groups for which intervention is needed and factors which limit production and income will be identified. Generally, constraints are identified through secondary data and informal surveys. Sometimes, further in-depth studies are necessary using formal surveys.

To begin agricultural research activities adequate knowledge of the farming system is necessary (Roeleveld and Broek, 1996). At the beginning knowledge of farmers, farming conditions and constraints faced by farmers is crucial. To achieve this result, information must be collected and analyzed. The process of description, analysis and research planning is commonly known as the diagnostic phase (Roeleveld and Broek, 1996). This phase includes secondary data collection and analysis, informal and formal surveys.

According to Roeleveld and Broek (1996), the informal survey is used to confirm and complement the initial understanding of the system developed based on secondary data. Informal surveys are conducted through direct observations and interviews with farm families and key informants. The main technique in informal surveys is the open ended interview with farm families and key informants using a checklist. Formal surveys provide a quantitative basis for conclusions drawn during earlier phases. In addition, it is used to redefine target groups (recommendation domains) and to test hypotheses about relationships (Roeleveld and Broek, 1996). The main technique in formal surveys is structured interview using a questionnaire.

The success of the Green revolution in South East Asia led many people to believe that it can be repeated in tropical areas (Mettrick, 1993). The failure to produce further Green revolutions provoked the question why it was not possible to many researchers. According to Mettrick (1993), reviewing past research results, it is believed that even though the improved technologies that were generated were technically sound, they were not relevant to the objectives and socio-economic circumstances of small-scale farmers. In addition, in some cases, they were not appropriate to the agro-climatic conditions of the area. Technologies were inappropriate to farmers' circumstances because researchers had inadequate knowledge or even interest in the circumstances of small scale farmers (Mettrick, 1993). Researchers were technology oriented rather than problem oriented. In addition, fragmentation of research and disciplinary isolation led researchers only to look at small parts of the farming system without taking into account linkages in the system. Furthermore, researchers blanket recommendation is inappropriate as it does not take into account the diversity of farmer circumstances.

According to Mettrick (1993), small farmers do not have the capacity to identify and communicate their needs to the researchers. Hence, it makes necessary to assess the farming system by researchers. If researchers failed to do these activities; farmers' aspirations, management practices and constraints to production will be based on common sense of the researchers rather than analysis of the farming system. This eventually leads to the generation of technologies which are not appropriate to the small scale farmers. This practice expends the financial budget resources of a country in vain.

According to Low (1989), in addition to farm activities attention should also be given to non-farm non-market production (investment and consumption) as they indirectly affect farm production. It was observed in some African countries that farmers preferred to adopt the less labour demanding practices even though they understand that additional labour input using practices increased productivity and income. In some cases farmers valued leisure more than the gains they could get from improved practices with additional labour input. Studies highlighted that household members in rural areas spend their time for non-farm non-market production activities especially women (Low, 1989). Hence, the significance of technologies will decrease if they compete for the time of household members who are responsible to do such activities. According to Low (1989), off-farm employment opportunities in an area have a significant impact on on-farm productivity. It is believed that neighbouring farmers with differing off-farm employment opportunities will have differing inclinations on on-farm activities and productivity.

2.2. Livestock Population, Production Systems and Productivity in Ethiopia

Ethiopia has an estimated sheep and goat population of 20.73 and 16.3 million, respectively (CSA, 2006). From the total number of sheep about 74% are females and 26% males. From the total number of goats, about 70% are females and 30% males. According to Teferra and Abaye (1995), about 70% of the livestock population of the country is found in the highlands and the rest, 30% is found in the lowlands. Ethiopia's contribution of livestock and livestock products to the world market is low. This is mainly due to the low productivity of almost all livestock species in the country (Seyoum and Zinash, 1989).

There are 3 livestock production systems in the country (Teferra and Abaye, 1995). These are crop-related livestock production system, pastoralist production system and private and commercial oriented parastatal production system. The latter production system covers only a minor portion of the production system. Native pasture, crop residues and stubble grazing are the main feed resources in the crop-related livestock production system. In the highland mixed crop-livestock sub-system, the land is intensively cultivated (EARO, 2001a). Average landholding in these areas is small. In addition, sheep and goats are kept

in small to medium sized flocks. Small ruminants in these areas are largely scavengers. They depend on natural pasture, stubble or crop residues as their feed resources.

In Ethiopia, the small ruminant production system in different agro-ecological zones is not studied fully and farmers' needs and production constraints have not been identified (EARO, 2001a). According to Markos (2006), there are two sheep production systems in the country. These are the traditional smallholder management system and the private commercial and parastatal production system. Under the traditional subsistence smallhoder management system, there are three sub-systems. These are sheep-barley or sheep production system, mixed crop-livestock system and pastoral production system. The traditional subsistence smallholder management system is the most common one in the country. But the parastatal and commercial production system represents a minor portion of the sheep production system in the country. The sheep production in the country is based mainly on indigenous breeds. There are several sheep production constraints in the country. These include feed scarcity, inadequate utilization of indigenous sheep breeds, transport and infrastructural problems, paucity of market information and lack of trained personnel and absence of recording (Markos, 2006).

2.3. The Concept of Marketing and Livestock Marketing Constraints in Ethiopia

Marketing includes all activities from the producer to the final consumer (ILRI, 1995). It also includes processing and distribution systems. Smallholder producers in Africa are producers as well as consumers of their own produce. According to the above source, producers will be some distance away from consumers. Producers may also be highly dispersed. The produce from these smallholder producers needs to be assembled and transported to the consumers. The nature of producers affects the nature of marketing and distribution processes. Without markets, areas must maintain diversified activities to produce their own basic needs and other materials (ILRI, 1995). In the presence of a market an individual can specialize in one activity and sell the surplus in order to purchase his basic needs and other materials. A region should specialize on the basis of a comparative advantage. A comparative advantage exists when a region can produce a good, relative to the price of other goods, more cheaply than another region. In livestock production, comparative advantage is a result of agro-ecological conditions particular to

that region making it suitable to certain specialized activities (ILRI, 1995). In this case, those regions with a given agro-ecological base will produce that good more cheaply than another region.

Markets for a given commodity can be categorized by the number of sellers and buyers in a market (Muturi *et al.*, 2001). The theoretical extremes are perfect competition (many sellers and many buyers) to monopsony/ monopoly. In perfect competition a single buyer or seller can not influence the price of a commodity. According to Muturi *et al.* (2001), the assumptions for a perfect market never hold true in the real world. The assumptions for a perfect market include many buyers, many sellers and perfect information freely available to sellers and buyers. To assess the efficiency of a marketing system, the typical approach is the structure, conduct and performance analysis (Muturi *et al*., 2001). Structure refers the number of players; conduct, the degree of competition and performance, the margins involved in the marketing process. To assess the marketing system efficiency, it is necessary to study the market chain of a given commodity from production to the final consumption.

The difference between the price a producer receives and the price the consumer pays for a commodity is termed the marketing margin (Muturi *et al*., 2001). Margins are a measure of the efficiency of a marketing system. According to Muturi *et al*. (2001), all things equal, the smaller the margin the more efficient the marketing machinery. In the absence of processing, cost for transport, cost of storage, loss in transport and storage and trader's margin (return to his management, labour and capital) affect the marketing margin. The trader's margin is affected by the degree of competition on market and the efficiency of market information flow. The less competition there is and the less transparent the market due to less information flow the higher the chances are the trader to increase his margin (Muturi *et al*., 2001). This is achieved by paying less to the sellers and demanding higher prices from consumers, or both these two actions. Information is expensive and its flow is not perfect.

According to Amir and Knipscheer (1989), selling animals on market where there are several buyers is advantageous to the producers. Competitive bidding among buyers assures the producers of getting the best price for their animals. Unless the results of increased animal production can be marketed successfully, a new animal production

technology will not be useful to the producers (Amir and Knipscheer, 1989). Famers evaluate production in terms of the costs and labour needed to sell their goods. Successful animal production technologies are those that increase production and increase profit. Farmers may fail to adopt new technologies due to market problems. Production and marketing should be considered together. That means one becomes the incentive to enhance and promote the other. According to Muturi *et al.* (2001), there is a positive relationship between increased productivity of agricultural production and the development of an adequate marketing system for the agricultural products.

Ethiopia's huge livestock population, proximity to the export markets and other conducive conditions gave the country a comparative advantage in livestock trade (Belachew and Jemberu, 2003). There are several livestock trading constraints in Ethiopia. According Belachew and Jemberu (2003), inadequate market infrastructure, absence of market information system, absence of market oriented livestock production system, inadequate number of exporting firms with low level of capacities, inadequate knowledge of international trade, low level of quarantine facilities and procedures, prevalence of various diseases, repeated bans, excessive cross-border illegal trade and stiff competition are the major challenges that hinder the smooth livestock trade in Ethiopia. Due to lack of market information, the available livestock markets in the country are loosely integrated. Lack of market information may also increase the marketing cost. The lowland pastoral areas in the country are the major source of export animals due to surplus output and preferability of the breeds in the Middle East Countries. The highland areas in the country are livestock deficit due to higher population density (Belachew and Jemberu, 2003). Livestock especially cattle are supplied from pastoral areas to the highland areas in the country. The Ethiopian cattle, sheep and goat are the preferred livestock types in the Middle East Countries. This is due to the meat produced from this animals is organic in nature and the meat is of good taste (Belachew and Jemberu, 2003).

2.4. Feed Resources in Ethiopia and Their Nutritive Value

There are several feed resources for livestock in Ethiopia. The type and quantity of feed resources in any area depends on environmental conditions and other factors. Currently, according to Alemayehu (2005), natural grazing and browse, crop residues, improved

pasture, forage crops and agro-industrial by-products are the main feed resources in the country. According to the above source, improved pasture and forage production as well as the utilization of agro-industrial by-products is restricted only to urban and peri-urban intensive farms. Currently, crop residues and natural pasture are the main feed resources in the country. Generally, forage quantity and quality fluctuates from season to season in the country. Feed shortage and nutrient deficiencies are prevalent both in the highlands and lowlands of the country during the dry season (Teferra and Abaye, 1995). It is estimated that there is about 40 million ha pasture land in the country (EARO, 2001b).

About 14 million ton DM crop residue is produced in Ethiopia (EARO, 2001b). Among crop residues sorghum stover, *tef* straw and maize stover account for 27, 27 and 22%, respectively of the total crop residues yield in the country. Crop residues are high in lignin content and are low in nutritive value (McDonald *et al*., 2002). Crop residues are low in CP content and low digestibility (Ranjhan, 1997). This characteristic of crop residues affects intake and animal productivity. Generally, there is variation in chemical composition and digestibility between and within crop residues. According to Ranjhan (1997), crop residues are poor in minerals and vitamins content. As crop residues are low in nutritive value, growth performance, milk production and reproduction of animals based on these feed materials will be low. Hence supplementation of CP, readily fermentable energy sources and minerals is essential to bring better animal performance using crop residue based diets (EARO, 2001b).

According to EARO (2001c), Ethiopia is the second largest producer of wheat. According to the same source, wheat is one of the cereal crops grown between 1500 to 3200 masl. The most suitable area falls between 1900 to 2700 masl. Wheat ranks 5th in area of production in the country after tef, maize, barley and sorghum and in total grain production, it ranks 4th after maize, tef and sorghum (EARO, 2001c). In productivity per hectare, wheat ranks 2nd following maize. Wheat is one of the cereal crops which are believed to contribute for the country's food grain self-sufficiency. Gojjam is one of the important bread and durum wheat growing areas in the country.

Wheat is the second major crop grown in Burie Woreda after maize (IPMS, 2007). Bread wheat is a recently introduced crop in the woreda. Its production is expanding year to year both in area coverage and amount of grain production. Farmers in Burie Woreda grow one

improved variety of bread wheat called kubsa (HAR 1685). This variety is preferred by the farmers in the area as this variety has white grain colour, yields better and fetches good prices on market. According to IPMS (2007), out of the total area devoted for cereal crop production in 2005/6 production year (28,881 ha), 6,514 ha was devoted for wheat production in rain-fed crop production in Burie Woreda. This figure puts wheat in the second rank in area of production following maize (12,175 ha). According to the above source, wheat grain production is second in amount following maize grain production. As wheat is widely grown in the woreda, wheat straw production is also high in the woreda. Wheat straw is poor in nutritive value. It has low CP content and low digestibility. According to McDonald *et al*. (2002), the nutritive value of wheat straw is very poor but the digestibility of wheat straw can be improved through chemical treatment. As the amount of wheat straw produced in the highland kebeles of Burie Woreda is comparable with maize stover production, wheat straw was selected and used in the on-farm feeding trial.

2.5. Nutrient Requirements and Recommended Rations for Sheep Fattening

Fattening is the deposition of unused energy in the form of fat within the body of the animal (Perry *et al*., 2003). The objective of fattening is to make the meat tender, juicy and of good flavour. Fattening increases the requirement for protein to promote good digestion. Fattening animals are usually full fed because the energy which is beyond the maintenance requirement is available for fattening. In general, growth is a much cheaper form of gain than fattening. Body weight gain in growth is in the form of protein and bone while in fattening it is in the form of fat. About 2.25 times as much net energy is required to form a kg of body fat as is required to form a kg of body protein (Perry *et al*., 2003). Young animals make more efficient and less expensive gains than older animals since their gain is in the form of growth. On the other hand, older animals are fattened more easily than younger animals. In older animals a larger part of the energy consumption is available for fattening. To get rapid gains, surplus supply of nutrients beyond maintenance requirement is needed by fattening animals. But nutrient requirement for fattening depends on the age of the animals. Young animals require more protein, vitamins and minerals than mature animals during fattening (Perry *et al*., 2003). More supply of nutrients is important

to get rapid gains. In addition, rapid gains shorten the fattening period and so it decreases the cost of labour and other expenses.

According to Ranjhan (1997), growing lambs (15 – 30 kg) consume 73.7 g/ kg $W^{0.75}$. For lamb fattening of 30 kg BW, to get 150 g gain per day, 10.9 g CP and 60% TDN is needed. In addition, 2.16 Mcal ME, 6.0% DCP and 0.22% Ca is required. It is also reported that a lamb of 30 kg BW consumes 1350 g DM per day. According to Pond *et al.* (1995), a lamb weighing 30 kg and gaining 295 g per day requires 0.94 kg TDN and 191 g CP. In addition, the animal is assumed to consume DM at 4.3% of its BW per day amounting 1.3 kg DM per day of feed. Moreover, 6.6 g Ca and 3.2 g P is needed by such animals. These recommendations are based on exotic sheep breeds abroad.

According to Solomon *et al.* (2005), an on-farm fattening study carried out in west Wollega using 49.5% ground maize, 49.5% noug seed cake and 1.0% common salt, revealed that finished rams were 16.3% (4.0 kg) heavier than the control group. In addition, it was observed that the supplemented group gained approximately 49 g/ day. A net return of Birr 40.24 / head / 84 day was estimated to be obtained in this study. Generally, authors concluded that supplementation of yearling Horro rams at a rate of 400 g/ head / day for three months as profitable if finishing is done at an appropriate time.

In another study, sheep respond well to noug seed cake and/ or wheat bran supplementation. Fentie and Solomon (2008) reported a daily BW gain in the range of 70.11 – 82.44 g/ day when *Farta* sheep were supplemented with wheat bran and/ or noug seed cake mix. Un-supplemented sheep (those fed hay alone) lost 9.11g per day during the study. The authors concluded that supplementation of wheat bran, noug seed cake or their mix improved feed conversion efficiency, total DM intake and growth performance. Based on partial budget analysis, supplementation of 300 g (201 g NSC + 99 g WB) per day was recommended as profitable when there is capital scarcity or 300 g noug seed cake per day, when there is no capital scarcity for the producers.

A study conducted to evaluate the fattening performance of goats using varying hay to concentrate ratios (groundnut cake, brewer's dried grain and wheat bran) revealed encouraging results in supplementing goats with concentrates (Asnakew, 2005). According to the above source, goats supplemented with concentrates showed significant final and average daily BW gain than the control group (hay alone). Based on the economic analysis of the feeding practice, 50% concentrate level was recommended as profitable if capital is not a constraint. Generally, based on the fattening performance, carcass characteristics and economic analysis of the feeding practice, the diet containing 20% concentrate level was recommended as the optimum for feedlot fattening of goats.

According to Simret (2005), a study conducted to evaluate the effect of wheat bran and groundnut cake on performance of Somali goats, final and average daily BW gain of the concentrate supplemented groups was significantly higher ($P<0.05$) than the control group. On average, the concentrate supplemented groups gained in the range of 39.9 – 44.7 g/ day. On the other hand, the goats in the control group on average lost 30.2 g/ day. In this study, the author recommended 200 g concentrate mix (25% wheat bran and 75% groundnut cake on Dm basis) as economical. In general, based on previous research, there is a recommended level of concentrate supplementation to sheep fattening. The studies were done on growth performance of Horro sheep. From these on station studies, supplementation of 300 – 400 g/ day of maize grain and noug cake in a 50:50 mix is recommended (EARO, 2001a).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

Burie Woreda is located between 10˚15′N and 10˚42′29″N and between 36˚52′1″E and 37˚7′9″E in Amhara National Regional State, Ethiopia. It has an estimated area of 838.9 square kilometers with altitude range of 713 – 2604 masl (BOFED, 2008; IPMS, 2007). The rainy season in Burie is from May to September with a monomodal pattern and a mean annual rainfall of 1386 – 1757 mm (IPMS, 2007). According to IPMS (2007), the long term annual temperature of Burie ranges from 14 ºC to 24 ºC. As the woreda has different ecological settings, it is suitable for different crops and livestock species production. The farming system, livestock production and livestock population of the woreda is adequately described in IPMS (2007).

Agro-ecologically, the woreda is classified into two sub agro-ecological zones (M1-4 and M2-5) (Appendix Figure 3; Appendix Table 1). The coverage of M1- 4 in the woreda is 51.5% and the coverage of M2-5 in the woreda is 48.5% (BOFED, 2008). According to MOA (2000), the M2-5 (tepid to cool moist mountains and plateau) has a high potential for rain-fed and irrigated agriculture and livestock production. The major constraints in agriculture in this zone are believed to be soil erosion and deforestation. The M1-4 (hot to warm moist gorges) zone has a potential for afforestation, incense and bamboo harvesting. The major constraints in agriculture in this area are believed to be topography, soil erosion and deforestation. There are three soil types in Burie Woreda (IPMS, 2007). These are Humic Nitosols (63%), Eutric Cambisols (20%) and Eutric Vertisols (17%) (Appendix Figure 8). The land use pattern in the woreda consists of about 46.6% cultivated land, 16.3% wasteland, 14.8% shrub, 8.4% natural forest, 6% construction (roads and houses), 1% perennial crops and 0.3% water bodies (OoARD, 2007) (Appendix Figure 6).

According to OoARD (2007), in Burie Woreda about 46.6% of the total area is cultivated and average household cultivated landholding is about 1.6 ha. Human population of the woreda is estimated at 174,957, of which 143,558 (82%) live in rural areas (BOFED, 2008) organized into 22 rural kebeles and 2 town associations (Appendix Figure 2). The main cereal crops grown in the woreda include maize, wheat, *tef*, finger millet and barley.

3.2. Assessment of Small Ruminants Production System

3.2.1. Informal survey

Before beginning the informal survey, secondary data were collected from Burie Woreda IPMS Office, Burie Woreda Agricultural and Rural Development Office, Amhara Region Agricultural and Rural Development Bureau (BOARD), Bureau of Finance and Economic Development (BOFED) and Environmental Protection Land Administration and Use Authority (EPLAUA). Data regarding livestock production, human population, agro-ecology, agro-climatic zones, area of the woreda, crop production and other basic data about the woreda were collected from these sources. Based on the secondary data, rural and urban kebeles of the woreda were identified and criteria were set to select the kebeles for the study. Urban kebeles of the woreda were excluded from the selection. Based on the secondary data and participation of woreda livestock and crop experts, 4 representative rural kebeles were selected for the study. The criteria used for selection of the study kebeles are agro-climatic and agro-ecological zone of the kebele, sheep and goat population and density, accessibility by vehicle and non-adjacent kebeles to one another. The selected kebeles were Woheni Durebetie (Dega), Woyenema Ambaye (Woina Dega), Denbun (Woina Dega) and Boko Tabo (Kolla). Small ruminant population, human population and area of these kebeles are given in Appendix Tables 4, 5 and 6. To calculate the feed balance in the study area the mean number of livestock species owned by a HH was converted into TLU (ILCA, 1990) (Appendix Table 11). One TLU is the equivalent of one bovine animal of 250 kg BW.

Farmers for the interview were selected purposively from the selected kebeles (Woheni Durebetie, Woyenema Ambaye, Denbun and Boko Tabo). For key informant interviews, kebele administrators and religious leaders were selected and interviewed. For individual interviews, farmers who are involved in sheep production and from various economic statuses (poor, medium and rich (based on resident farmers' evaluation)) were selected and interviewed. During key and individual interview selection, those farmers who lived in the area for several years were selected and interviewed. For the group interview, farmers from different age, economic status and gender were included.

For the informal survey, checklist covering breeds and breeding, feeds and feeding, disease and disease control and production constraints and solutions to the constraints identified as perceived by the farmers was prepared for the study (Appendix 3). The interviews were done by a group of interviewers. One person conducted the interview and the others took notes based on the response of the farmer(s). During the interviews, clarification was asked by the interviewer and the note takers on points which were not clear and those points which needed further clarification. At the end of the interviews constraints to sheep production were first listed down. After that priorities were set using pair-wise ranking method for each kebele and single list ordinal ranking method for the woreda (ARARI, 2005). In addition, solutions for the problems identified were asked from the producers. Generally, interviews for sheep and goat production were done separately. That is different individual, key informant and group interviews were conducted to study the two production systems (Appendix Tables 2 and 3). This was done because there was a difference in sheep and goat production and ownership in the study area. At the end of the field work, during the evenings, notes taken during the day time were summarized in a group by the field team group discussion. Based on the data taken during the field work, the real farmers' responses were recorded in the summaries, which were later discussed with a group of farmers to confirm the correctness of the information. Based on the group response, corrections to the summaries were made and the initial final report was prepared based on these processes.

To assess the nature of the flock structure, data were collected from each kebele during the informal survey field work. Flocks in each kebele were randomly selected in the grazing fields and each and every animal in the flock was caught, measured and the data were recorded. Data on sex, age, heart girth, BW and breed (not applicable for goats) of each sheep/ goat was taken and recorded. Body weight of the animals was measured using hanging scale. Age of the animals was estimated based on observation of their dentition (Girma and Alemu, 2008).

During the informal survey process, observations were made in the selected study kebeles. Observations were made on randomly selected households and communally owned resources (grazing lands, water sources, etc). In each randomly selected farm, in the presence of the owner, sheep houses, their cleaning, tethering of animals and the materials

from which they were constructed from were observed and recorded. In communally held resources, observations were made together with development agents (DAs) in the kebeles and the nature and condition of the grazing lands, water resources and herding of animals. In addition, photographs were taken and discussions with the farmers in their respective areas were undertaken and the data were recorded.

3.2.2. Formal survey

Based on the informal survey result, questionnaire was prepared and pretested (Appendix 4). For the goat production formal survey, the sheep production questionnaire was used with minor modifications. The formal survey was conducted on the same kebeles that were used for the informal survey study. Farmers interviewed were selected from the kebele list by systematic random sampling method. Enumerators from each kebele were selected and trained on data collection. The constraints for sheep production were prioritized using single list weighted category based ranking method (ARARI, 2005).

3.2.3. Marketing of small ruminants

Data on reason for sheep/ goat sale, disposal outlets and frequency, age and sex of disposed animals and time of disposal were collected. Market linkages were assessed through secondary data and informal survey. In addition, three markets namely Derequa, Burie and Kuche (Appendix Figure 21) were selected and used for the study in the woreda. From the selected markets, price of sheep/ goat traded was recorded on the basis of size and sex group on selected market days. Sample sheep/ goats were selected from each class (age and sex group) and were weighed. Origin, destination and mode of transport were also recorded. In addition, on the selected market places informal interviews were conducted to assess the nature of sheep and goat sellers and buyers in these market places. Based on these data, questionnaires were developed for sheep/ goat sellers and buyers (Appendix 5 and 6). On the selected market places and on selected market days, sellers and buyers were selected randomly from the market and were interviewed. In addition, traders in each market place were selected and interviewed

during the study at what price they bought sheep/ goat in one market, in which market place they sold the animals and at what price they sold the animals at these market places.

3.3. On-farm Feeding Trial on Sheep Using Urea Treated Wheat Straw and Concentrates

3.3.1. Selection of kebeles

As wheat production was not the dominant crop in selected kebeles used for the survey other kebeles were selected for the on-farm feeding trials. Three kebeles, namely, Arebesi, Tiya Tiya and Sertekez kebeles were selected based on availability of wheat straw, sheep population, climate and accessibility (Appendix Figure 2). All the kebeles selected fall in the Woina Dega agro-climatic zone of the woreda.

3.3.2. Selection of households and animals

Before selecting participating farmers, the residents of each selected kebele who had sheep and wheat straw were gathered for a brief orientation about the trial. Farmers who were willing to participate, representative of the area and fulfill the criteria set (ownership of adequate experimental animals, wheat straw, willingness to participate in the data collection until the end of the experiment, etc) were selected to participate in the on-farm feeding trial. The concentrate feed supplements, animal health care fees, urea and other materials required for urea treatment (plastic sheet, watering can, etc) and the feeding trial were provided by ALRC (Andassa Livestock Research Center), whereas experimental sheep, wheat straw and labour for urea treatment were provided by the participating farmers. In addition, at the beginning of the study, farmers were trained how to manage and feed the animals during the trial period. The animals selected and used from the participating farmers were local breeds and of male sex. In the grazing trial, there were 12 Washera, 4 Horro and 2 crossbred sheep. In the wheat straw feeding trial, there were 28 Washera, 2 Horro and 2 crossbred sheep. The lambs used in the grazing and wheat straw feeding trials had an initial age of 8.7 months (n = 18, SD = 1.68) and 10.2 months (n =

32, SD = 1.84), respectively. The initial BW of the animals is given in Tables 42 and 43. Those animals which were in good health and body condition were selected and used in the trial.

3.3.3. Urea treatment method

The wheat straw was treated with 5% urea. To treat 100 kg wheat straw, 5 kg urea and 80 liters of water was used (Preston, 1986: Chenost and Kayouli, 1997; Tinshuang *et al*., 2002). After applying the urea solution to the wheat straw and thorough mixing, the straw was placed in a pit with a dimension of 1.5 m^3 (1 m X 1.5 m X1 m; width, length and depth). The floor, walls and top of the pit were covered with plastic sheets and a thin layer of crop residue and soil was applied at the top. The urea treatment was done in February 2008. The pit was left undisturbed for two months. After two months, the pit was opened and the daily feed offer (urea treated wheat straw) was taken out daily from the pit and allowed to ventilate (about 12 hours) to disperse the free ammonia and was fed to the experimental animals. Due to the presence of rain, the urea treated straw was put out of the pit and were put into large plastic bags, compressed, made air tight by binding the mouth of the plastic bags with a string and put into the house of the farmer and were fed to the animals.

3.3.4. Treatments and experimental design

There were two experiments per each kebele. In each selected kebele (except Sertekez kebele, as it was difficult to get farmers with adequate resources for the trials), 8 farmers having two intact rams were selected for each experiment. All the selected animals for the experiment were weighed with hanging scale and heart girth measured at the beginning of the preliminary period. A completely randomized design was employed for the two on-farm trials. Treatments were allocated to the experimental units randomly using a lottery method. At the beginning, based on random allocation of treatments, farmers were informed to which animal to supplement the experimental feed during the trial (Grazing experiment). There were 8 replicates per treatment in each kebele (except Sertekez kebele). The treatments are the following:

A. Grazing experiment

T1. Farmers practice (Grazing plus farmers' traditional fattening practice (Supplementation of food leftover, *atella* and maize grain every three/ four day's interval))

T2. Grazing + 200 g concentrate mix (75% groundnut cake (GNC) + 25% wheat bran (WB))

B. Wheat straw feeding experiment

T1. Untreated wheat straw + 200 g concentrate mix (75% GNC + 25% WB)

T2. Urea treated wheat straw + 200 g concentrate mix (75% GNC + 25% WB)

3.3.5. Animal management

The rams used for the trial were treated for internal parasites (Albendazole (300 mg/ head) and Fasinex (250 mg/ head)) and were vaccinated against three locally common diseases (Anthrax (0.5 ml/ head), pasteurellosis (1 ml/ head) and enterotoxaemia (1 ml/ head)) at the beginning of the trial. They were not treated for external parasites as the problem was not common in the area. Other management practices were the same as farmers' traditional practices in the area. But the management practice of farmers during the trial was observed and recorded during the trial. The experimental animals were offered groundnut cake and wheat bran mix daily according to the treatments. They were offered 200 g concentrate feed (75% GNC + 25% WB) per head per day during the trial period. The concentrate feed consisted of 75% groundnut cake (150 g) and 25% wheat bran (50 g) based on the results of Getnet (1998). The concentrate feeds were purchased from the local market. The animals were fed concentrate feeds individually. The experimental sheep in the wheat straw feeding trial were offered 500 g wheat straw per head per day based on their initial body weight. All the experimental sheep were also offered water and common salt *ad libitum*.

3.3.6. Feed intake and body weight measurement

The feeding trials were conducted for 86 days after 14 days of adaptation to the treatment feeds. The trials were conducted from May to August 2008. Feed offered and feed refusal of wheat straw and concentrate supplement mix were weighed and recorded every week by the data collectors in each kebele throughout the trial period. Daily average feed intake was estimated as the difference between the amount of feed offered less the feed refusal based on the data that were collected every week. The BW of the experimental sheep was measured every week and recorded.

3.3.7. Sampling of feeds and laboratory analysis

Samples of feed offered were collected (urea treated and untreated wheat straw) every week from each participating farmer. Samples of concentrates were collected from the concentrate feed distributed to the farmers. The samples collected were saved in plastic bags. Feed samples (wheat straw) for each treatment from each kebele were mixed thoroughly to reduce the chemical analysis cost and sub-samples were taken for laboratory analysis at the end of the trial. The samples were sun dried, ground (Osuji *et al*., 1993) and laboratory analysis was done. Samples were analyzed for DM, ash and CP according to AOAC (1980). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed according to Van Soest and Robertson (1985). *In vitro* digestibility of the feed samples was also done (Tilley and Terry, 1963).

3.3.8. Farmers' assessment of the feeding practices

At the end of the feeding trial, farmers' were interviewed individually and in a group to evaluate the results of the feeding trial. Farmers were asked on their opinion about animal performance, future adoption of the feeding practice using their own resources, constraints encountered during the trial and their selection of the best treatments. In the group interviews, non-participating farmers who were neighbours of the on-farm feeding trial participating farmers were included in the discussion.

3.3.9. Economic analysis of the feeding trials

Economic analysis was done using partial budget analysis (Upton, 1979). Price of concentrate feed mix, estimated buying and selling market prices of animals, price of urea and labour cost for urea treatment were recorded and used for the analysis. For labour cost, first the average of each kebele was calculated and then the average of the three kebeles was calculated and used for the analysis. From the data collected, net income (NI) and marginal rate of return (MRR) were calculated using the following formulas.

1. $NI = TR - TVC$
2. $\Delta NI = \Delta TR - \Delta TVC$
3. $MRR = \Delta NI / \Delta TVC * 100$

3.4. Monitoring Sheep Reproduction, Lamb Growth and Mortality

The study was conducted for 6 months in three representative kebeles of the woreda, namely, Woheni Durebeite, Woyenema Ambaye and Boko Tabo. One kebele was excluded due to the illness and absence of the data collector from the area. From each kebele 20 farmers having 5 or more breeding ewes were selected randomly. Breeding females in each selected kebele and household were identified and recorded in a data recording format including their colour, sex, age and breed together with their owner's data (name, sex, age, etc) and they were given ID numbers. In the selected farms, animals born, date of birth, their sex and type of birth were recorded and the animals born were identified by their own colour, sex, breed and their dams ID and their owner's data. The BW of lambs born was taken in the first 24 hours after birth and after that at 2 weeks interval during the study. Mortality of lambs and causes of mortality were recorded. In addition, the total number of sheep present in each household every week, sheep loses, causes of sheep loses, purchasing practices and feeding, disease control and housing practices of each farmer were recorded by data collectors every week in each kebele.

3.5. Statistical Analysis

The data collected from the formal survey of the four kebeles, on-farm trials and the market data were analyzed through descriptive statistics (landholding per HH, sheep number per HH, percentages, etc) and analysis of variance (land holding per HH, mean livestock holding per HH, body weight of animals, number of animals offered for sale per one market day per market place, price of animals per head/ kg, number of animals brought for sale per one seller per market day, ADG, birth weight, growth rate, feed intake and number of sheep lose per HH) using SPSS statistical software (SPSS 12.0, 2003). For the on-farm trials, initial BW was used as a covariate in the analysis of variance. The following models were used for the data analysis (Desta, 2001; Montgomery, 2001):

1. Assessment of the production system:

$Y_{ij} = \mu + t_i + \varepsilon_{ij,}$ where

Y_{ij} = the response of the j^{th} HH in the i^{th} kebele

μ = grand mean

t_i = effect due to the i^{th} kebele

ε_{ij} = random error effect

2. Marketing of small ruminants

   $Y_{ij} = \mu + t_i + \varepsilon_{ij,}$ where

   Y_{ij} = the response of the j^{th} sheep in the i^{th} market

   μ = grand mean

   t_i = effect due to the i^{th} market

   ε_{ij} = random error effect

3. On-fam feeding trial

   a. Grazing experiment

$Y_{ij} = \mu + \beta(x_{ij} - x..) + t_i + \varepsilon_{ij,}$ where

Y_{ij} = the response of the j^{th} sheep receiving the i^{th} treatment

μ = grand mean

t_i = effect due to the i^{th} treatment

β = linear regression coefficient

x_{ij} = measurement of covariate

x.. = mean of xij values

ε_{ij} = random error effect

b. Wheat straw feeding experiment

$Y_{ijk} = \mu + \beta(x_{ij} - x..) + t_i + b_j + (tb)_{ij} + \varepsilon_{ijk,}$ where

Y_{ijk} = the response of the k^{th} sheep receiving the i^{th} urea treatment and j^{th} wheat variety

μ = grand mean

β = linear regression coefficient

x_{ij} = measurement of covariate

x.. = mean of x_{ij} values

t_i = effect due to urea treatment

b_j = effect due to wheat variety

$(tb)_{ij}$ = interaction effect

ε_{ij} = random error effect

4. Monitoring of sheep reproduction, mortality and growth

$Y_{ij} = \mu + t_i + \varepsilon_{ij}$, where

Y_{ij} = the response of the j^{th} lamb in the i^{th} kebele

μ = grand mean

t_i = effect due to the i^{th} kebele

ε_{ij} = random error effect

4. RESULTS AND DISCUSSION

4.1. Households and Farm Characteristics in the Study Area

The study area is characterized by mixed crop/ livestock system. Even though the system is mixed crop/ livestock system, the farmers give more emphasis to crop production in the study area. Most of the farmers in the area have land for crop production. On average, land holding per household in the area is 1.3 ha (n = 126, SD = 1.05). This figure is lower than that reported in North and West Shoa Zone (Agajie *et al.*, 2002) and that reported by IPMS (2007) for Burie Woreda. Farmers in the lowland kebele (Boko Tabo) have more ($P<0.05$) land per household than those farmers found in the highland kebeles (Woheni Durebetie, Woyenema Ambaye and Denbun) (Table 1). There is land scarcity in the study area for crop production, especially in the highland kebeles. From the informal survey result (Appendix Tables 2 and 3), it is evident that land holding per household is declining as human population in the area is increasing and as households are giving land to their mature and landless siblings. Most of the area in the lowland kebele is not suitable for crop production even though the area is large compared with the available human population (Appendix Table 4 and Appendix Figure 6).

Renting land and share cropping of land are common in the area. Those farmers who have no oxen, female headed households, sick farmers and those farmers who are old-aged either rent or share crop their land. Most of the youth (newly established households) in the area are landless. Share cropping is more common than renting land in the area. Landless farmers who rear livestock are disadvantaged in the area. There is feed scarcity in the area as the grazing land especially in the highland kebeles is very small in area and is overgrazed (Appendix Table 4; Appendix Figures 12 and 13). The land owning people have private grazing lands (29%) to feed and supplement their animals during feed scarcity periods (during the rainy season). But the landless farmers have no opportunity to practice this.

Table 1. Mean landholding, family size and literate household members per household in the study kebeles in Burie Woreda

Variable	Woheni Durebetie Mean±SE N = 38	Woyenema Ambaye Mean±SE N = 39	Denbun Mean±SE N = 30	Boko Tabo Mean±SE N = 20
Land holding per HH (ha)	0.9^{b}±0.04	0.9^{b}±0.08	1.2^{b}±0.11	3.0^{a}±0.34
Total family size	5.1^{a}±0.28	5.4^{a}±0.27	5.7^{a}±0.33	5.4^{a}±0.47
Literate family members	2.5^{a}±0.25	3.0^{a}±0.25	2.9^{a}±0.31	2.6^{a}±0.46

SE =Standard error; N = Number of respondents; Means with different superscript letters within a row are significantly different ($P<0.05$)

Almost all the area of the landholding, especially in the highland kebeles is devoted to crop production, but some farmers have a small area of private grazing land (0.04 ha) from their own landholdings. Fallowing of land is not practiced in the area, especially in the highland kebeles as there is land scarcity. But farmers practice crop rotation each year. In the lowland kebele, those farmers who have more land practice fallowing the land usually for one year only. The following crops are grown in each kebele in descending order of importance. Maize, finger millet, barley, tef and wheat in Woheni Durebetie kebele; Maize, finger millet, tef, barley and wheat in Woyenema Ambaye kebele; Maize, wheat, finger millet, beans and tef in Denbun kebele; Maize, sesame, pepper, tef and haricot bean in Boko Tabo kebele.

There are several constraints in crop production. Pests and diseases are the main ones. There is pest problem on maize, finger millet, tef, beans, potato, pepper in the highland kebeles and sesame in the lowland kebele. In addition, there are diseases on wheat, maize and beans. Low soil fertility and rain shortage in some cases are also common problems. In Woheni Durebetie kebele farmers were beneficial by growing potato. Currently, as the crop is being affected by disease/ pest (the root of the plant), growing potato in the area is decreasing. Lack of improved seeds and fertilizers are also common problems in the study area. Farmers grow improved varieties of maize, wheat and pepper in the area. The maize varieties they use in the highland (BH-660) and in the lowland (BH-540) kebeles are different. Among the improved crops grown in the study area, maize is widely grown and expanding.

Soil fertility is declining in the area. The soil is being eroded every year by rain water. In addition, there is no fallowing and the land is cultivated and cropped every year. Manure addition on the crop land has also decreased in the area due to fear of theft of cattle during the night in the rainy season. So, farmers carry manure from their home and apply it on their own crop land. Farmers apply both chemical fertilizer and manure (compost) to keep the fertility of the soil. They also practice physical ways of soil fertility maintenance.

The farmers in the study kebeles rear different types of livestock. Cattle, sheep, goat, horse, donkey, mule and chicken rearing is common in the area. Farmers also keep bee colonies. The livestock population in each study kebele and average livestock holding per household is given in Tables 2 and 3. Based on the informal survey result, there is a decreasing trend in cattle productivity in the study area. The number of each livestock species per kebele has increased compared with the number a decade or so earlier. Milk yield in cattle has decreased due to feed shortage in all areas. It is said that body size has decreased in cattle but calving interval in cattle has increased in recent decades. But the same case is not true in sheep. The performance of sheep in the area is the same as before. Generally, feed shortage is blamed for the entire decline in cattle productivity.

Table 2. Livestock population in the study kebeles in Burie Woreda

Livestock species reared	Woheni Durebetie	Woyenema Ambaye	Denbun	Boko Tabo
Cattle	3068	9569	4879	3772
Sheep	2394	4455	1101	1566
Goat	242	463	292	2460
Horse	70	15	0	0
Mule	1	5	7	0
Donkey	145	250	512	264
Chicken	1797	12735	2600	694

Source: IPMS (2008)

There are communal and private grazing lands in the study kebeles. The area of the communal grazing lands differs from kebele to kebele and even it differs within one kebele (Appendix Table 4). The area of the private grazing lands is very small. On average, one household has 0.04 ha of private grazing land. In addition, from the total households in the study kebeles only 29% of the households have private grazing lands. Assuming that the communal grazing lands are equally utilized by all the households found in the area and these lands being distributed to the households equally, one household in the study area will have 0.2 ha of communal grazing land.

Most of the farmers in the area rear sheep especially in the highland kebeles. Both land owners and landless farmers rear sheep in the area. Most of the farmers want to increase

Table 3. Mean livestock and bee colonies holdings per household in the study kebeles in Burie Woreda

Livestock species reared	Woheni Durebetie Mean±SE N = 38	Woyenema Ambaye Mean±SE N = 39	Denbun Mean±SE N = 30	Boko Tabo Mean±SE N = 20
Cattle	4.1[a]±0.50	3.8[a]±0.51	5.2[a]±0.57	4.6[a]±0.71
Sheep	3.2[a]±0.31	3.9[a]±0.45	4.1[a]±0.38	3.5[a]±0.69
Goat	0.3±0.14	0.5±0.25	0	1.7±0.51
Horse	0.1±0.05	0.03±0.03	0	0
Donkey	0.5[a]±0.11	0.3[a]±0.09	0.6[a]±0.11	0.2[a]±0.12
Chicken	1.7[b]±0.41	2.1[b]±0.69	4.8[a]±0.77	3.4[ab]±0.61
Bee colonies	0.4[a]±0.15	1.5[a]±0.56	0.3[a]±0.21	0.1[a]±0.10

SE = Standard error of the mean; Means with different superscript letters within a row are significantly different ($P<0.05$)

their sheep number per household so as to increase their income. As the area is favourable for sheep production and as the soil fertility and landholding per household is decreasing in the highland kebeles of the study area, farmers want to increase their sheep number per household and increase their income. But sheep diseases, feed shortage, labour shortage and lack of financial resources, especially to the poor to purchase and rear sheep are hindering its expansion. Farmers say that they lose several heads of sheep per year due to diseases, feed shortage (new born lambs) and predators in the study area. About 94% of the famers got their starting sheep flock by purchasing from the market. Some of the farmers (3%) got them as a gift from parents/ relatives. Most of the farmers own the sheep

they rear and some farmers rear other farmer's sheep (*temado*) to get benefits from sheep rearing.

Generally, livestock production is one of the main activities in the area. There are several constraints in livestock production in the area. In all the study kebeles livestock diseases, feed shortage and lack of adequate veterinary service are the main constraints. In addition, water shortage especially in the lowland kebele, labour shortage as children spend most of their time at school and financial shortage and lack of modern knowledge to rear animals are also the constraints in the area in a decreasing priority. In all the selected and study kebeles there is no veterinary clinic available so farmers go to neighbouring kebeles to get their sick animals treated.

In relative terms (based on the residence farmers evaluation), farmers can be grouped into poor, medium and rich farmers based on their resources. This categorization is important as there is a difference in sheep management between the poor and the rich farmers (sheep fattening, sheep sale, housing, etc). The main resources which determine these categories are the size of land and the number of livestock owned. A farmer who is considered rich in the highlands will not meet the criteria of a rich man in the lowland. For instance, a rich man in the highland kebeles may not have the same area of land of a rich man in the lowland kebele. The lowland farmers have more land per household than the highland farmers (Table 1). Farmers get cash income from grain, livestock and livestock products sale. In addition, trees (eucalyptus, in the highlands) and vegetables are also minor cash income sources in the area. Farmers spend the cash income for basic needs purchase, purchase of seed and fertilizer, oxen, breeding animals and for paying the rent for their land. Small-scale trading in livestock and hired labour work within the kebele and in towns are the main off-farm activities in the area.

4.2. Sheep Production System

4.2.1. Breeds and breeding of sheep

Farmers in the area rear sheep for two main purposes. They rear sheep mainly to get cash income and for home slaughter on festivals. This is also true in most parts of Ethiopia (EARO, 2001b; Alganesh *et al*., 2004). Farmers in the study area on average had 3.7 heads of sheep (n = 127, SD = 2.46) per household. From this total number per

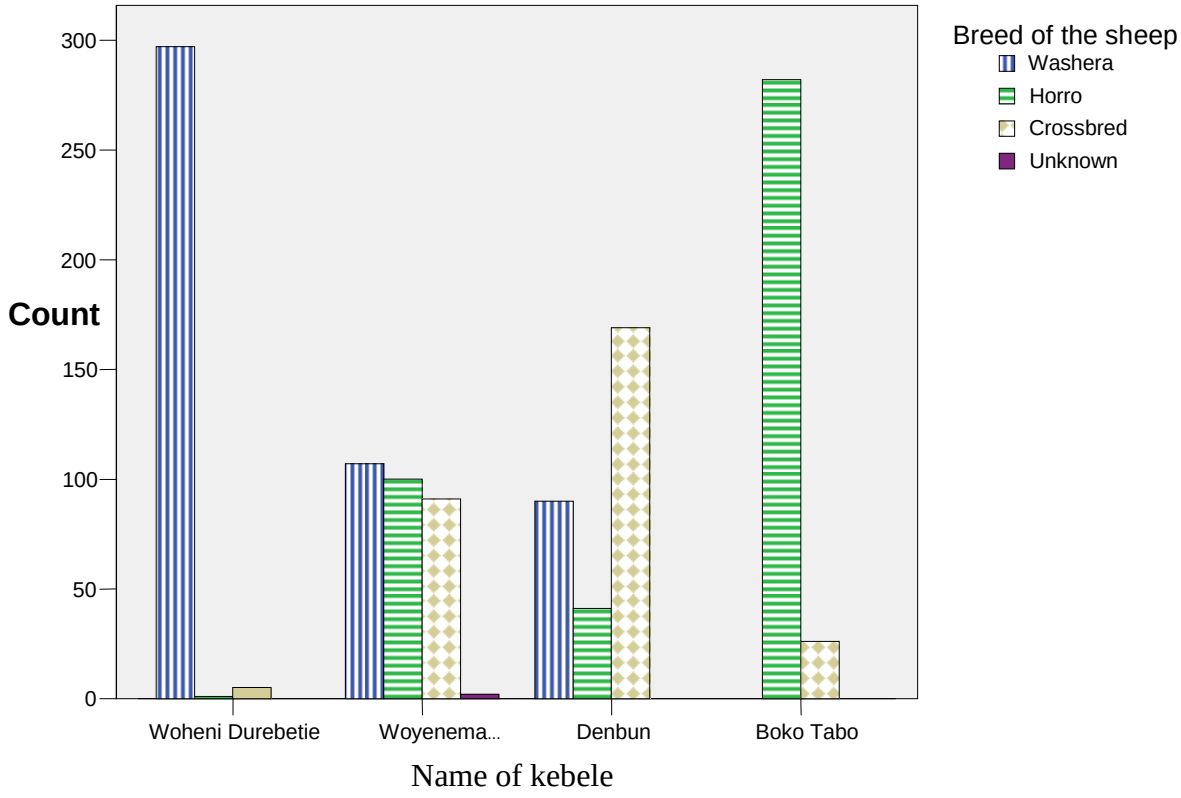


Figure 1. Proportion of sheep breeds in the study kebeles of Burie Woreda

household, 0.9 heads are males and 2.6 heads are females. There are two sheep breeds in the study kebeles of the woreda. These are Horro and Washera (Appendix Figures 9 and 10). The two breeds are believed to exist in the study woreda (EARO, 2001b; Sisay,

2002). According to Solomon (2008), these two breeds of sheep are the main sheep breeds found in Ethiopia among the 9 breeds of sheep classified in the country. There are more Washera sheep (98.0%) in the Dega kebele (Woheni Durebetie) and more Horro sheep (91.6%) in the Kolla kebele (Boko Tabo) (Table 4 and Figure 1). The proportion of the breeds in each study kebele is different (χ^2 = 1031.9, P<0.05) (Table 4). Currently, Horro breed is being introduced to the highland kebeles and Washera breed to the Kolla kebele. In addition, there is a sheep type which is a crossbred between Horro and Washera in the study kebeles of the woreda (Appendix Figure 11). The sheep breeds in the Woina Dega kebeles (Woyenema Ambaye and Denbun) are a mix of Horro, Washera and crossbreds. The proportion of the sheep breeds in each kebele is given in Figure 1 and Table 4. Originally, there was Washera breed in Woheni Durebetie and Woyenema Ambaye kebeles; and Horro, in Boko Tabo kebele.

Farmers say that Horro breed is more disease and feed shortage resistant than Washera breed. About 59% of the respondents said that Horro sheep is more disease resistant than Washera and the crossbred sheep found in the area. But Horro breed is less preferable on market compared to Washera breed by farmers in the highland kebeles and hence fetches lower market prices for their owners. Farmers say that Horro breed has more meat per head than Washera breed. Horro breed also reproduces more frequently than Washera breed (lambing interval is short). Horro sheep give birth to twins usually and triplets occasionally. But Washera sheep give birth to one lamb at a time. Farmers in the highland kebeles prefer to rear Washera sheep. The more preferable sheep breed, Washera, in the highland kebeles of the woreda is becoming more susceptible to diseases recently and death rate for the breed is high. So, the farmers practice crossbreeding Washera with Horro breed and get a local crossbred sheep called *Anfet* in Amharic (Appendix Figure 11). They use male Washera and female Horro sheep to get the local crossbred animals. The crossbred animals are more disease and feed shortage resistant and better in reproduction than Washera breed. In addition, they are intermediate in phenotypic characteristics to Washera and Horro and hence they are more preferable compared to Horro breed. In the next generation, farmers get the crossbred females (ewes) mate with Washera rams and get the third generation animals. These third generation animals are more similar to Washera. The Farmers intention by crossbreeding is to make their animals

disease resistant and to get more preferable animals on market (Washera) and home consumption purposes. It is believed that disease resistance in animals is strongly

Table 4. Proportion of different sheep breeds and expected count in the study kebeles of Burie Woreda

Name of Kebele		Breed of sheep			Total
		Washera	Horro	Crossbred	
Woheni	Count	297	1	5	303
Durebetie	Expected count	123.8	106.3	72.9	303.0
	% within the kebele	98.0%	.3%	1.7%	100.0%
Woyenema	Count	107	100	91	298
Ambaye	Expected count	121.8	104.5	71.7	298.0
	% within the kebele	35.9%	33.6%	30.5%	100.0%
Denbun	Count	90	41	169	300
	Expected count	122.6	105.2	72.2	300.0
	% within the kebele	30.0%	13.7%	56.3%	100.0%
Boko Tabo	Count	0	282	26	308
	Expected count	125.8	108.0	74.1	308.0
	% within the kebele	.0%	91.6%	8.4%	100.0%
Total	Count	494	424	291	1209
	Expected count	494.0	424.0	291.0	1209.0
	% in all the kebele	40.9%	35.1%	24.1%	100.0%

genotypic rather than environmental effects (Charray *et al*., 1992). This crossbreeding activity will endanger the two breeds. It is well established that indigenous breeds are well adapted to the local environmental conditions. They are resistant to diseases, feed shortage, low level of management and harsh climatic conditions (EARO, 2001b). Hence, crossing the two breeds which have advantages of their own will endanger their survival and utilization by farmers currently and in the future.

There is a possibility of inbreeding danger in the area. Farmers mostly sell, slaughter or castrate males at young age. In addition, the number of males found in the system is small in number (30.5%). Most farmers use their neighbours breeding males for breeding. The breeding males' age is also low. This affects their sperm production (Charray *et al*., 1992). In some areas, there is individual herding of sheep flocks and small flock size during herding of animals. This reduces random mating and genetic diversity in animals. More productive animals are being sold, slaughtered or castrated, so, there is a chance to reduce the population of such animals in future generations. According to Sansthan and KÖhler-Rollefson (2005), animal genetic resources are very important for farmers and breeders. According to this source, agricultural biodiversity safeguards the natural potential of a farming system to adapt to changes in environment or changing patterns of demand for food. A great diversity of local breeds supports the livelihood of smallholder farmers. They give products to the producers under unfavourable environmental conditions. So, to the smallholder farmers those local breeds which are low productive are preferable to them than those breeds which give higher yields considering the uncertain climate and attack due to diseases. Using local breeds under such circumstances decreases risk. According to Gibson *et al*. (2006), the diversity of livestock species represents an irreplaceable source of traits for livestock development in response to changing environmental and human needs. But, these genetic resources are being eroded as a result of changing agricultural practices and economic, environmental and other factors. There is a high rate of loss of indigenous animals in developing countries. According to this same source, conservation of livestock genetic diversity is important to maintain genetic diversity to meet the needs of current and future utilization. In addition, it also provides genetic resources for cross-breeding and development of new genotypes and the demands of new markets for livestock products and services.

From the current study of the flock structure, about 69.5% are females and 30.5% are males in the flock (Table 5). Male animals are either sold or slaughtered at home and their number is less in the flock. Female animals are retained at home for breeding purposes. From the flock structure, it is evident that there are more young animals in the flock during the study (Figure 2). Flock structure is dynamic in nature. So, the period in which the data were collected may have contributed to this result. As farmers sell young male sheep

during festivals and as the date in which the data were collected is between New Year and Easter, this may have contributed for the presence of more young animals in the flock.

Table 5. Proportion of male and female sheep in the sheep flocks in the study kebeles of Burie Woreda

Name of kebele		Sex of the sheep		
		Male	Female	Total
Woheni	Number of animals	84	219	303
Durebetie	% within the kebele	27.7	72.3	100.0
Woyenema	Number of animals	81	219	300
Ambaye	% within the kebele	27.0	73.0	100.0
Denbun	Number of animals	105	195	300
	% within the kebele	35.0	65.0	100.0
Boko Tabo	Number of animals	99	209	308
	% within the kebele	32.1	67.9	100.0
Total	Number of animals	369	842	1211
	% of all the kebele	30.5	69.5	100.0

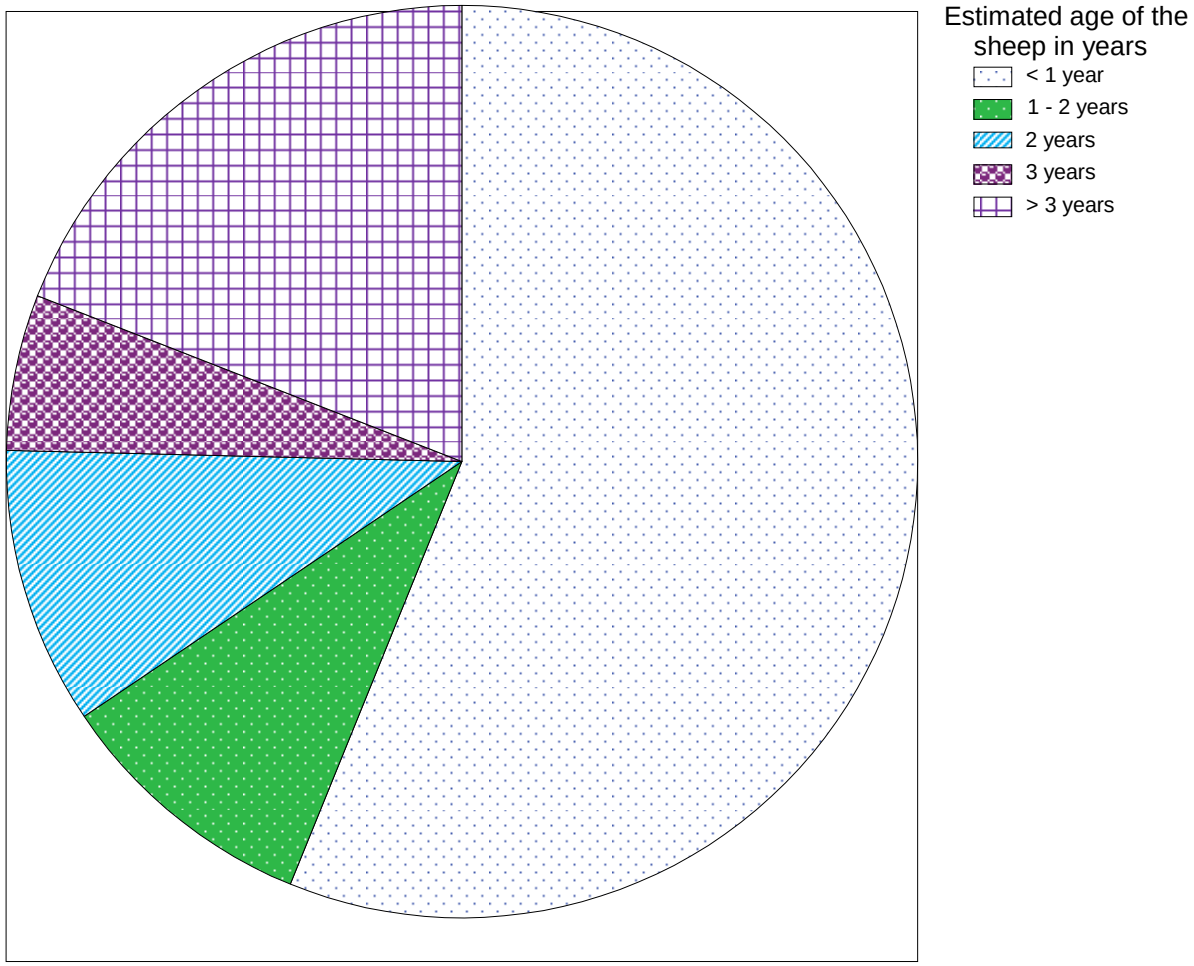


Figure 2. Proportion of different age groups of sheep in the sheep flocks in the study kebeles of Burie Woreda

There is BW difference between animals in each kebele and in each age group (Table 6 and 7). But there is no BW difference ($P>0.05$) between the sheep breeds (Table 8). The mean BW of sheep in each age group in different kebeles and breeds is given in Appendix Table 7and 8. The BW increased ($P<0.05$) with advance in age of the animals as expected. The mean body weight of sheep in Denbun and Boko Tabo kebeles was significantly

higher (P<0.05) than Woyenema Ambaye kebele which could be attributed to differences in breed composition of the sheep flock, inbreeding or feed availability in the area.

Table 6. Mean body weight of sheep in different age groups in the study kebeles of Burie Woreda

Estimated age of the animal (year)	BW (kg) Mean±SE	N
<1	15.3^{d}±0.23	680
1 – 2	26.6^{c}±0.53	114
2	28.6^{bc}±0.46	119
3	30.6^{ab}±0.65	67
>3	31.6^{a}±0.38	231

SE = Standard error; Means with different superscript letters within a column are significantly different (P<0.05)

Farmers castrate rams for fattening purposes. They employ either modern or traditional methods of castration. Lambs between the age of 5 to 12 months are mostly castrated. Farmers castrate lambs during September, October or November. During this time the ambient temperature is suitable and there is more quality feed available to the animals and the animals increase in BW and condition after castration. The farmers believe that if the animals are castrated in other months, they will be susceptible to diseases and do not increase in BW and body condition.

Table 7. Mean body weight of sheep in the study kebeles in Burie Woreda

Name of kebele	BW (kg) Mean±SE	N
Woheni Durebetie	21.2^{ab}±0.49	303
Woyenema Ambaye	20.0^{b}±0.48	300
Denbun	22.6^{a}±0.53	300
Boko Tabo	22.5^{a}±0.62	308

SE = Standard error; Means with different superscript letters within a column are significantly different (P<0.05)

Table 8. Mean body weight of sheep in different breeds in the study kebeles in Burie Woreda

Name of kebele	BW (kg) Mean±SE	N
Washera	21.5^{a}±0.37	494
Horro	21.5^{a}±0.51	424
Crossbreds	22.0^{a}±0.54	291

SE = Standard error; Means with the same superscript letter within a column are not significantly different (P>0.05)

Farmers cull both male and female animals. They have their own criteria for culling. For males, Horro rams are not preferred in the highland kebeles. Black coloured and poor conditioned and small sized males are not preferred in all places. These sheep types are

culled at an early age. They will be sold or slaughtered. For females, black coloured, old aged, poor conditioned and those females which do not produce adequate milk for their new born lambs and those ewes which have long lambing interval are culled. Those female animals which give birth to small or poor conditioned lambs are culled after lambing one or two times. Unlike the Horro rams, Horro ewes are preferred for rearing in the highland kebeles, especially for crossbreeding purposes.

Selection of animals for rearing is common in the area. Farmers have their own criteria for selection of animals. The selection criteria used for male and female animals is different. For males, colour, body size and tail type are given the most emphasis for selection. Hence, males with large body size, brown body colour and having white patches on their forehead, legs and tip of the tail are selected. Males of big body size, long body length and fat tailed types are the most preferred. Those males with white and off-white colour are also preferred. In all areas black coloured males are not preferred. In the highland kebeles, Horro males are not preferred. For females, there is a difference in the criteria for selection used in the study kebeles. In all areas, farmers select female sheep based on their colour, body size, breed, reproductive performance and milk yield for the new born lamb. Its pedigree is also considered when the female is a home grown one. Hence, females with large body, brown and white colours or a mix of them are preferred. In the Kolla kebele, farmers prefer Horro ewes and in the Woina Dega kebeles they prefer crossbred females. But in the Dega kebele farmers prefer Washera breed. Those ewes which give birth to twins and triplets are also preferred by farmers. But twins have a high rate of mortality and less growth rate than single born lambs (Gatenby, 1986). So, selection of females based on this criterion is not recommended. For female selection, colour of the sheep is not as strict a criterion as male selection.

4.2.2. Feed resources and feeding of sheep

The main feed resources for sheep production in the study area are natural pasture and crop stubble grazing (Table 9). This is also true in other parts of the country. According to Alemayehu (2005), livestock are fed entirely on natural pasture and crop residues at present in the country. According to the same source, studies estimated that natural pasture

provides from 80 – 90% of the feed intake of the animals and crop residues provide from 10 – 15% of the total feed intake. Farmers in the study area usually supplement local beer residue (*atella*), maize grain, food leftover and salt to their sheep (Table 10). Supplementation of agro-industrial by-products is rare and is commonly practiced only for fattening sheep. According to EARO (2001a), in the mixed crop livestock system, small ruminants depend on grazing on communal lands, fallow lands and stubble and occasionally supplemented with crop residues and household food leftover. The main feed resources in the dry and rainy season for sheep in the study area are different. Natural pasture is the main feed resource during the rainy season; natural pasture and stubble grazing, in the dry season (Table 9). In the lowland kebele, the grazing lands have more browse species and sheep utilize these feed resources. These feed resources are believed to be better in their nutritive value than natural pasture during the dry season. In the lowland kebele, there is more land that is available for grazing and hence feed shortage is not the main problem when it is compared with the highland kebeles (Appendix Table 4 and Appendix Figure 6).

Farmers mainly feed crop residues to cattle and they also feed crop residues to sheep. About 42.5% of the respondents feed crop residues to sheep in the study area. Finger millet straw, maize stover and *tef* straw feeding to sheep during feed scarcity periods is common (in April, May, June, July and August). Farmers say that finger millet straw is good in nutritive value. There is better animal performance when sheep are fed with this material. This may be due to its low lignin content (Table 12). Farmers sprinkle salt solution on *tef* straw before feeding it to the animals. It is believed that utilization of crop residues in mixed crop/ livestock systems is greatest (Alemayehu, 2005). The nutritive value of the main feed resources found in the study area is poor; they are low in CP and digestibility (Table 12). So, supplementation of animals with better quality feeds, especially during the dry season is essential.

Table 9. Major feed resources for sheep during different seasons in the study kebeles of Burie Woreda

Major feed resource	Sept. – Nov. N = 127		Dec. – Feb. N = 127		March – May N = 127		June – August N = 127	
	N	%	N	%	N	%	N	%
NPO	114	90	52	41	65	51	98	77
SO	6	5	46	36	50	39	4	3
NPAS	6	5	29	23	12	10	25	20
NR	1	1	0	0	0	0	0	0

N = Number of respondents; NPO = Natural pasture only; NPAS = Natural pasture and stubble; SO = Stubble only; NR = No response

Farmers give boiled salt water for newly lambing ewes to make them produce more milk for their newly born lambs. The nutritive value of salt is low except in providing minerals to the animals. Generally, there is no supplementation of better quality feeds to ewes before and after giving birth and lambs before and after weaning. They only depend on grazing and their dam's milk, respectively.

Table 10. Feed supplements for sheep during different seasons in the study kebeles of Burie Woreda

Feed supplement type	Sept. – Nov. N = 127		Dec. – Feb. N = 127		March – May N = 127		June – August N = 127	
	N	%	N	%	N	%	N	%
MGO	27	21	12	9	14	11	7	6
AO	51	40	65	51	59	47	55	43
FLO	8	6	5	4	9	7	19	15
MGA	14	11	15	12	12	9	5	4
MGAFL	2	2	11	9	8	6	5	4
AFL	6	5	3	2	4	3	1	1
other	16	13	15	12	18	14	14	11
NR	3	2	1	1	3	2	21	17

N = Number of respondents; AFL = Atella and food leftover; AO = Atella only; FO = Food leftover only; MGA = Maize grain and atella; MGAFL = Maize grain, atella and food leftover; MGO = Maize grain only; NR = No response

Table 11. Feed calendar for sheep in the study kebeles of Burie Woreda

Feed type	Months											
	S	O	N	D	J	F	M	A	M	J	J	A
Natural pasture	++	++	+	+	+	+	+	+	+	+	++	++
Stubble	-	+	++	++	++	++	++	+	+	+	-	-
Crop residues	-	-	-	-	-	-	-	+	+	+	+	+
Atella	-	+	+	+	+	+	+	+	+	+	-	-
Private grazing land	+	+	-	-	-	-	-	-	-	-	+	+
Weeds	+	+	-	-	-	-	-	-	-	-	+	+
Maize leaves and cobless maize plant	+	+	-	-	-	-	-	-	-	-	+	+
Feed shortage	++	++				+	+	++	++		++	++
Feed abundance			++	++	++							

++ = very important, + = important, - = negligible

Table 12. Estimated mean chemical composition of the major feed resources available in the study kebeles of Burie Woreda

Feed type	DM	OM	ADF	NDF	ADL	CP	Ca	P
Natural pasture (Dry season)*	-	-	-	-	-	3.2	-	-
Natural pasture (Rainy season)*	-	-	-	-	-	12.1	-	-
Atella	91.33	94.19	-	-	-	18.38	0.62	0.42
Wheat straw	91.38	90.34	51.89	81.08	6.52	6.10	-	0
Maize stover	91.15	92.52	47.35	70.69	5.63	4.59	0.13	0.12
Finger millet straw	89.73	89.89	40.93	69.54	3.99	4.12	0.60	0.32
Barley straw	91.12	92.44	48.28	73.89	6.16	2.35	0.44	0.13
Tef straw	91.72	92.23	44.65	76.44	5.44	4.18	0.36	0.15
Sesbania sp.	89.74	88.09	13.82	20.48	4.03	28.15	-	0.32
Noug seed cake	92.27	89.69	31.55	37.61	12.38	31.44	0.76	1.15
Maize grain	91.46	92.86	4.38	-	0.81	5.93	0.06	0.31

ADF = Acid detergent fiber; ADL = Acid detergent lignin; Ca = Calcium; CP = Crude protein; DM = Dry matter; NDF = Neutral detergent fiber; OM = Organic matter; P = Phosphorus

Source, ILRI (2008)

*Source, EARO (2001b)

The private grazing lands in the area are very small. Farmers on average have 0.04 ha private grazing land. This is also true in other places due to severe shortage of land in the highlands of Ethiopia (Abebe *et al*., 2000). The communal grazing lands are very overgrazed especially in the highland kebeles (Appendix Figures 12 and 13). There is feed shortage problem during the dry and the rainy season. Feed shortage is also the main problem in other parts of the country currently (Agajie *et al.*, 2002, Alganesh *et al.*, 2004). About 46% of the respondents encountered feed shortages in sheep production in the area. Feed shortage occurs in the dry season from February to May and in the rainy season, from July to end of October as most of the area will be covered by crops. As there is feed shortage problem during the rainy season in the highland kebeles, some farmers have allocated private grazing lands from their landholdings to their livestock and they supplement feed to their animals from these grazing lands (Table 11). Farmers either graze their animals on these grazing lands or mow the grass and supplement the animals at home. Feed supplementation from private grazing lands is usually practiced from July to end of October. Feed supplementation from private grazing lands is done for all livestock species especially to cattle. In addition, supplementing maize leaves, maize stalks having no cobs and weeds from maize fields is also practiced in the highland kebeles of the study area during this period (Table 12). From field observation in the study area, farmers' responses and their feed shortage coping mechanisms and estimation of the feed production from various sources per household less estimation of the feed requirement of the available livestock species per household in the highland kebeles, it is evident that there is feed shortage problem in the highland kebeles (Table 13, 14, 15 and 16). On average, there is a deficit of 0.7 ton DM per year per household. According to Lulseged and Hailu (1985), a study conducted on the carrying capacity of natural pasture, the authors recommended that if there is no concentrate feed readily available, the medium stocking rate (10 sheep/ ha = 1 TLU) is optimum for year round grazing. In the highland kebeles of the study area, one household on average has 0.2 ha natural pasture and 3.7 TLU. Hence, for optimum productivity of livestock in the area, one household should share about 3.7 ha of natural pasture for year round grazing. So, currently the livestock in the study area may certainly depend on stubble grazing and crop residues. Generally, the crop residues are poor in nutritive value. The quality of the available feeds in the study area is generally poor (Table 12).

Optimum livestock productivity depends on the quantity and quality of feeds fed to the animals. Milk production, meat production, draft power generation, reproduction and disease resistance largely depend on better nutrition of the animals. Hence, as there is feed scarcity both in quantity and quality in the highland kebeles of the study area farmers are mainly keeping livestock by feeding nearly at maintenance level and hence little or no productivity from the animals kept. The available communal grazing land in Woyenema Ambaye kebele is lower than Denbun kebele (Appendix Table 4) and the communal grazing lands in Woyenema Ambaye kebele are overgrazed (Appendix Figure 12). Sheep disease is the main problem in Woyenema Ambaye kebele. In addition, the number of sheep death per HH in Woyenema Ambaye kebele is greater than Denbun kebele (Table 20) and the mean body weight of the sheep in different age groups is also lower than other kebeles (Appendix Table 7). This may be due to serious feed shortage problem in this kebele or inbreeding. The net stocking rate in Woyenema Ambaye kebele is 59 TLU per ha while in Denbun Kebele it is 12 TLU per ha (Table 2 and; Appendix Tables 4 and 11). Net stocking rate is the actual number of TLU per ha of land that is specifically allocated to grazing (ILCA, 1990). According to Solomon and Gemeda (2002), a 1% increase in inbreeding coefficient has resulted in a decrease in body weight of lambs. In addition, dam inbreeding has a significant ($P<0.05$) effect on survival to yearling. Optimum performance from livestock can be achieved through feeding better quality and adequate quantity of feed which is beyond maintenance requirement of the animal. Hence, this condition must be stressed in the study area and farmers in the area should feed their sheep better quality and adequate quantity of feed for better productivity of their animals. According to Kebreab *et al*. (2005), lack of livestock products in developing countries is not due to lack of livestock number. But it is mainly due to feed shortage in both quantity and quality and its inefficient utilization. According to Zinash and Seyoum (1991), integration of forages with crop production can be an option to reduce the feed shortage problem. In addition, improvement of the quality of the cereal straws and strategies that aim at increasing feed availability will reduce the feed deficit in the area.

Table 13. Mean livestock and estimated TLU holding per household in the highland kebeles of Burie Woreda

Livestock species	No. per HH	TLU per HH
Cattle	4.3	3.0
Sheep	3.7	0.4
Goat	0.3	0.03
Mule	0	0
Donkey	0.4	0.2
Horse	0.1	0.04
Total TLU per HH		3.7
Total feed requirement per year (ton DM)		8.4

HH = Household; TLU = Tropical Livestock Unit

Table 14. Estimated total feed produced per household from natural pasture, stubble and private grazing land in the highland kebeles of Burie Woreda

Feed resource type	Area per HH	Conversion factor	Total feed produced (ton DM)
Natural pasture	0.2	2	0.3
Stubble	1.0	1	1.0
Private grazing land	0.03	2	0.1
Total (ton DM)			1.4

HH = Household; DM = Dry matter

Table 15. Estimated total crop residue produced per household in the highland kebeles of Burie Woreda

Type of crop residues	Area of crop land for that crop	Average grain Yield per ha	Total grain yield (quintal)	Conversion factor	Total feed produced (Quintal DM)
Maize stover	0.4	63	22.4	2.0	44.7
Finger millet straw	0.2	22	4.5	1.5	6.7
Barley straw	0.1	26	2.2	1.2	2.6
Wheat straw	0.1	38	4.1	0.8	3.3
Tef straw	0.1	20	2.6	1.5	3.9
Bean	0.1	16	1.3	1.0	1.3
Pea	0.01	12	0.1	1.0	0.1
Total feed produced (ton DM)					6.3

DM = Dry matter

Table 16. Estimated feed balance per year per household in the highland kebeles of Burie Woreda

Source of feed for livestock per HH	Total feed produced (Ton DM)
Feed produced from natural pasture, private grazing land and stubble	1.4
Feed produced from crop residues	6.3
Overall feed produced per HH	7.7
Total feed requirement per year per HH	8.4
Feed balance	- 0.7

HH = Household; DM = Dry matter

There are several communal grazing lands per kebele. The area of the communal grazing lands is different within as well as between the study kebeles in the woreda. In general, the area of the communal grazing lands has decreased as they are cultivated for crop production and used for other purposes. About 48% of the farmers responded that the communal grazing lands in their area have decreased. According to Alemayehu (2005), this case is also true in other parts of the country. As the human population is rapidly increasing, grazing lands are gradually decreasing and shrinking and are being used for crop production. The productivity of the communal grazing lands in the study area has also decreased. This is because the livestock population in the area has increased and on the other hand the area of the grazing lands has decreased. Shortage of rainfall duration in recent decades has also contributions of its own on feed shortage, especially at the end of the dry season.

Farmers say that there is a difference in botanical composition of the grazing lands now when they are compared with the previous ones. S*eredo* (*Cynodon spp.)* and other grass

species which are annuals are decreasing. There is also a report in botanical composition change in the grazing lands in other parts of the country (Alganesh *et al*., 2004). As annuals are grazed before they mature and produce seeds, they will not appear in the next generation. On the other hand, clover species (*Trifolium spp*.) are increasing in amount in the grazing lands. Improved forages are not common in the area. Sesbania, Napier grass, Rhodes grass and oats are planted and used. Among these forage crops especially sesbania is found in most places and is common in the area. Farmers give sesbania leaves to cattle mainly and to sheep occasionally. They plant sesbania around their homestead. But they do not use sesbania effectively for their livestock feeding during feed scarcity periods (during the dry season).

Farmers in the area practice sheep fattening. Their main purpose of fattening sheep is for sale or for home consumption. Farmers use different feed resources to fatten the animals. They fatten sheep mainly for three occasions, for Easter, New Year and Christmas. The starting date for Christmas and Easter sheep fattening is mainly September. For New Year, the starting month is mainly May or June. Farmers use different feed resources in sheep fattening. The animals to be fattened graze on the natural pasture and stubble during the day time and they are given supplement feeds at home. In some cases, fattening sheep are separated from the flock and graze in a different area which is better in feed quality. The supplements used and the amount used per day per animal differs from household to household. Maize, beans, different grain screenings, *atella*, salt, noug seed cake and food left over are mainly supplemented to the fattening sheep. From all the supplement feeds used for sheep fattening, maize grain is widely used for this purpose. Maize grain is mainly roasted or boiled and salt is added before feeding it to the animals. The amount of grain supplemented to the sheep depends on the socio-economic status of the farmer. Rich farmers give more grain to their fattening animals than the poor ones. The animals used for fattening are usually males. They are usually castrated (32%) and dewormed (36%) before starting the fattening. Additional anthelminitics is given throughout the fattening period. The starting age of the animals to be fattened is 5.7 months (n = 46, SD = 2.30). Some farmers give anthelminitics more frequently to their fattening sheep.

There are many constraints in sheep fattening in the study area. Diseases and feed shortage are the main constraints in sheep fattening. In addition, labour shortage, theft, water shortage, low market prices in some months of the year, knowledge shortage in fattening animals and financial shortage are common constraints in sheep fattening. Generally, sheep fattening in the study area is more practiced recently than when it is compared with a decade or so earlier.

Farmers traditionally practice some wrong practices in sheep fattening. They use different levels of one feed type and varying sources of feed supplements for sheep fattening. These have adverse effects on digestion and weight gain of the animals. The supplements are not given in a continuous manner, on daily basis. In addition, farmers give more emphasis to anthelminitics rather than better feeding. Some farmers in the highland kebeles believe that feeding food left over to fattening sheep for sale has adverse effects. They believe that if they sell food leftover fed sheep they will become poor.

Rivers, wells and springs are the main sources of water for sheep. There is a severe water shortage problem in the lowland kebele (Boko Tabo). Generally, farmers water their animals 2 times per day. Water shortage in the study area is exacerbated by irrigation of crops during the dry season in the highland kebeles. Some of the water sources in the area also dry up in the dry season. Farmers usually encounter water shortage problem in April and May. During this time to alleviate the water shortage problem they take different measures. They go to the next nearest water source to water their animals or they fetch water and give water to their animals at home. Watering of sheep is mainly the responsibility of children.

4.2.3. Housing of sheep

Farmers in the area use different types of sheep houses. Sheltering sheep in the main house is predominant in the area (58%) followed by sheep houses constructed attached to the main house (33%). In some cases a separately constructed sheep house (9%) is also found in the area. Sheep houses are made of locally available materials. It is advantageous to

build sheep houses from locally available materials as it lowers costs of production. The type of material used for wall construction of sheep houses is different in the highland and the lowland kebeles. The wall is usually made of eucalyptus tree wood in the highland kebeles and lowland tree wood in the lowland kebele. The wall is usually plastered with mud in the highland kebeles and plastering with mud in the lowland kebele is not usually common as the ambient temperature in the area is high. In all places, the roof is usually made of corrugated iron sheet (90%). In some cases, it is made of grass (9%). The floor in the dry season is usually earth (70%) but in some cases stone (23%) and wooden paved floors (7%) raised from the ground are available (Table 17). Wood and stone paving of floors is usually practiced during the rainy season when the floor gets moist and dirty. During this period, earth, stone and wooden paved floors have values of 52%, 36% and 12%, respectively, in the area (Table 17). In all places, sheep houses are well ventilated. This condition is important to remove heat, moisture and pollutants (ammonia) from the house.

Cleaning of sheep houses is common in the study area. Cleaning sheep houses is more frequent during the rainy season. About 46.5% of the households clean sheep houses daily in the dry season. But in the rainy season, about 78% of the households clean sheep houses daily (Table 18). Cleaning frequency also differs between the highland and the lowland kebeles. The highland kebeles clean sheep houses more frequently than the lowland kebele. Cleaning frequency also differs by the type of floor adopted. Wooden paved floors are less frequently cleaned. Cleaning of sheep houses is not common on observant days (Sundays, St Mary day, etc) especially in the highland kebeles as most of the population in these kebeles are Orthodox Christian followers. Cleaning is usually the responsibility of women and children. There is no adequate cleaning of sheep houses especially when they are separately constructed.

Table 17. Type of floor adopted by farmers during the dry and wet season in the study kebeles of Burie Woreda

Type of floor	Dry Season N = 127		Rainy season N = 127	
	N	%	N	%
Earth	89	70	66	52
Stone	29	23	46	36
Wood	9	7	15	12

N = Number of respondents

Table 18. Cleaning frequency of sheep houses by farmers during the dry and rainy season in the study kebeles of Burie Woreda

Frequency of cleaning	Dry Season N = 127		Rainy season N = 127	
	N	%	N	%
Daily	59	46.5	99	78
1 times per week	28	22	10	8
2 times per week	20	16	15	12
3 times per week	20	16	3	2

N = Number of respondents

The house type and its conditions affect animals' health and productivity. About 90% of the farmers have corrugated iron sheet roofed sheep houses and 9% of the farmers have grass roofed sheep houses. There is no adequate cleaning of sheep houses when they are separately constructed. From observations made during the informal survey, it was evident that most of the sheep houses are not cleaned daily. Hence, the floors are not clean and dry. This may be a better place for disease causing organisms to multiply and proliferate. In addition, in some cases the floor is not flat, smooth and sloping and has protruding stones and surfaces. Protruding stones may injure the animals and predispose them to diseases and infections. Corrugated iron sheet roofed houses may predispose the animals to cold stress and respiratory diseases especially during the rainy season. Farmers utilize the manure of sheep for crop production.

There is no separation of animals in the house at night. All age and sex groups dwell together. This has adverse effects on controlled mating and maintenance of improved genotypes on-farm (EARO, 2001b). But in most cases, newly born lambs (50%) and fattening sheep (22%) are separated from the adult animals. Some farmers tether adult sheep and others allow them to move freely in sheep houses at night. This depends on the type of house adopted by the farmer.

4.2.4. Diseases and disease control

Sheep diseases are the main constraints for sheep production in the area. Based on the informal survey result, foot rot, streptothricosis, pasteurellosis, orf and internal parasites are the main sheep diseases in the area. Especially pregnant and lactating ewes in the highland kebeles are affected by diseases. When animals get sick farmers get most of the animals treated at public vet clinics. About 80% of the farmers take their sick animals to vet clinics, 15% of the farmers treat the animals using modern drugs themselves and about 3% of them treat the animals' using traditional medicine (Table 19). Treating animals using modern drugs is common in the lowland kebele. The sources from which farmers buy drugs mainly are private vet clinics. Medication of sick sheep using modern drugs by famers is true especially in the lowland kebele as the public vet clinic is very remote to them (Table 19). Farmers treat their animals using modern drugs themselves to avoid

animal losses. They believe that trying to cure the animal using modern drugs is better than none trying and death of the animal. Farmers who practice medication using modern drugs have no training or education on the profession. This practice encourages the development of disease resistant microbes in animal health.

Table 19. Measures taken by farmers when animals get sick in the study kebeles of Burie Woreda

Measures taken	Woheni Durebetie N = 38		Woyenema Ambaye N = 39		Denbun N = 30		Boko Tabo N = 20	
	N	%	N	%	N	%	N	%
Taking the animal to public vet clinic	35	92	38	97	22	73	6	30
Farmers treatment using modern drugs	1	3	0	0	6	20	12	60
Traditional treatment	1	3	0	0	1	3	2	10
Sale	0	0	0	0	1	3	0	0
other	1	3	1	3	0	0	0	0

N = Number of respondents

Farmers use traditional medicine to treat sick animals. For orf, they spread locally made pepper (*Dekus*) on the area of infection. They also cover it with hot porridge made of *tef*. For pasteurellosis, they smoke the animals with cow dung, donkey dung, pea straw or cactus wood. For foot rot, they pierce the swelling area of infection with pointed materials and get the pus out and wash the area with salt water. They also cut the ears and noses of the sick sheep with razor blade for infectious diseases.

Farmers encounter animal deaths due to diseases every year. On average, one household lost 0.7 heads of sheep (n = 127, SD = 1.32) the previous year (Table 20). There is no difference (P>0.05) in the number of sheep deaths per HH per year. But the figure for Woyenema Ambaye is greater than the other kebeles (Tables 20, 49 and 50). This may be due to lack of feed and inbreeding in the sheep flock as the number of male sheep found in this kebele is lower than the others (Tables 5 and 7; and Appendix Table 4 and 7). In addition, the number of sheep loss per HH in Boko Tabo kebele is also higher. This may be due to the utilization of modern drugs by farmers (60% of the respondents), low dosage utilization or the development of drug resistant microbes in animal health (Tables 19 and 20). There is a difference between breeds in disease resistance. Horro sheep is believed to resist diseases better than Washera (59% of respondents). Due to this reason farmers in the highland kebeles are now rearing more Horro sheep and their crossbreds. Farmers deworm their animals frequently. About 95% of the farmers deworm their ewes every year. About 80% of the farmers deworm their ewes 2 to 4 times per year in the study area. They buy the drugs from public vet clinics (59%), private vet clinics (17%) or groceries (9%). Farmers believe that giving anthelminitics frequently improves the sheep condition and productivity. They also believe that giving anthelminitics prevents the animals from infectious diseases. Due to this reason giving anthelminitics to animals by some farmers is done beyond recommended rates.

Table 20. Mean number of sheep deaths per HH per year in the study kebeles of Burie Woreda

Name of kebele	Number of sheep	
	Mean±SE	N
Woheni Durebetie	0.5[a]±0.13	38
Woyenema Ambaye	1.1[a]±0.27	39
Denbun	0.5[a]±0.18	30
Boko Tabo	1.0[a]±0.35	20

SE = Standard error; N = Number of respondents; Means with the same superscript letter within a column are not significantly different (P>0.05)

There seems to be a relationship between disease occurrence and feed scarcity and nutrient deficiency period in the area. Feed and nutrient deficiency occurs from July to end of October and again from February to May. Sheep in the area get sick during these periods. This may be due to low feed intake and nutrient deficiency which predisposes the animals to low disease resistance. In addition, during feed scarcity period the sheep may consume the locally available poisonous plants and this may predispose them to diseases and death (Gatenby, 1986). In the lowland kebele, sheep are mainly sick from August to November and many sheep die during this period in the area. In the highland kebeles, sheep mainly get sick and die in September and October. Farmers can prevent animal death and morbidity through better nutrition of their animals to some extent.

Based on farmers' opinion veterinary services given in all kebeles are not adequate. Not only sheep but also other livestock species will be treated when they get sick. Taking sick animals to remote vet clinics will take time on-foot and expends farmers' time and labour in vain. In addition, during peak labour months farmers spend most of their time in crop production. So, when animals get sick during this time farmers retain the animals at home

to save labour and time. In addition to the above problems, farmers say that drugs are not usually available when they take sick animals to the rural vet clinics. Men are usually responsible to get sick animals treated in vet clinics.

4.2.5. Animal slaughter per household

The purpose of sheep rearing in the study area is for sale and home slaughter during festivals. Easter, New Year and Christmas are the main occasions on which farmers slaughter sheep in the study area. Most of the households in the study area slaughter sheep on Easter. In addition, farmers slaughter sheep at the beginning or end of fasting periods i.e. Lent and Christmas fasting. On average, one household slaughters about 1.6 heads of sheep (n = 127, SD = 0.74) per year. Male sheep at young age (from 3 to 12 months of age) are mostly slaughtered for home consumption.

Breed (51%), tail type (62%) and colour (87%) of the sheep are the main sheep selection criteria for home slaughter. Farmers in the highlands prefer Washera sheep for home slaughter on festivals. But in the lowland, farmers prefer Horro sheep. Preference ranking for home slaughter in the highland kebeles in descending order of importance is Washera, crossbreds and Horro sheep. Generally, black sheep are not preferred for home slaughter in all places. Colour of the sheep to be slaughtered on New Year is given much emphasis. On this festival, sheep having full white or brown body colour with white patches on forehead, lower parts of legs and tip of the tail are the most preferred. Those sheep having full brown colour, full white colour or brown body with white patches on their forehead, lower parts of legs and tip of the tail are the preferred sheep colour for home slaughter during festivals.

4.2.6. Herding of animals

About 71% of the farmers in the area herd their sheep year round. Farmers in the lowland kebele herd sheep only during the rainy season (from May to end of November). The main objective of herding sheep is to prevent sheep from damaging crops, theft, predator loss and straying loss of animals. Sheep herding is done in a group or in private. Generally, farmers herd their animals in a group during the rainy season to save labour as they spend most of their time and labour input in crop production. On the other hand, most farmers herd their sheep privately during the dry season (from December to end of April) as they are relatively free from crop production and labour is available during this time. Farmers encounter labour shortage (43% of the respondents) in sheep herding at the beginning of the dry season especially during crop harvest time. During this time, adults are usually involved in crop harvest and children spend their time in school. In sheep herding all age and sex groups are herded together. In some cases, fattening sheep are separately herded and separately fed. During the dry season sheep are herded in grazing fields from 7 – 11 AM and then from 3 – 6 PM. From 11 AM to 3 PM sheep are kept usually in their houses or under tree shade to avoid heat stress. In general, the grazing time duration per day during the dry season is less in 1 hour from the recommended minimum sheep grazing hour per day (8 hours per day) (Gatenby, 1991). In the rainy season the animals stay from 8 AM – 6 AM in grazing lands. Children especially males usually herd sheep in grazing fields. There are predators to sheep in the study area. In some places the number of predators has increased. This case is true in Boko Tabo and Woheni Durebetie kebeles. In Woheni Durebetie kebele the regeneration of forests in the area is blamed for the predators increase in number. Farmers want to hunt predators and prevent animal loses but they fear that legal measures will be taken against them.

4.2.7. Sheep marketing

Sheep rearing is one of the main cash income sources for the farmers in the study area. There are three sheep market places in the Woreda. These are Derequa, Burie and Kuche (Appendix Figure 19). These market places seem to fall in the category of intermediate and re-distributive markets (EARO, 2001a). Men are usually responsible for selling sheep

on markets. The sheep to be sold are usually transported on foot from home to the sheep market. Sheep from the woreda, neighboring woredas and even from neighboring region (Oromia) enter into the woreda for marketing. Sheep entering from neighboring areas into the woreda can be a potential source of diseases to the sheep found in the woreda. There are reports from farmers in the area from the current informal survey result that confirm this idea. Farmers in Boko Tabo and Woheni Durebetie kebeles reported the introduction of diseases from neighboring areas through purchased sheep into their kebeles. The number of sheep offered for sale per one market day in each market place is given in Table 21. The number of sheep offered for sale in Burie market is significantly higher ($P<0.001$) than that presented at Derequa and Kuche markets.

Generally, male sheep at young age are sold on market. One household in the study area sells on average 1.1 heads of sheep (n = 127, SD 1.40) per year. Based on the market prices of sheep during the study, one household gains on average 317.0 Birr per year (based on the market price of 283.1 Birr per head). From the total number of sheep sold on market, and within the kebele about 60% are males and 40% are females. Farmers usually sell sheep during Easter, New Year and Christmas. During this period there are more consumers on market and market prices for sheep are higher. There is demand and price increase during festivals in the country in general (EARO, 2001b). During this time the demand is very high and the animals sold fetch better prices. According to Deneberu (2003), there is a considerable week to week variation in sheep BW prices throughout the year in markets of North Shewa. According to this study, this variation is related to variations in overall supply and demand as well as in the characteristics of animals offered for sale. Factors affecting the number of animals offered for sale include demand during festivals, cash needs for crop inputs and food purchases. Animal characteristics that affect BW price are weight, sex, age, body condition and colour of the animal sold (Deneberu, 2003).

Table 21. Market places in Burie Woreda and estimated average number of sheep offered for sale per one market day in each market place

Name of the market place	Number of sheep Mean±SE	N
Derequa	236.0[b]±41.61	8
Burie	679.2[a]±78.12	6
Kuche	188.7[b]±55.65	7

SE = Standard error; N = Number of market days the data were collected; Means with different superscript letters within a column are significantly different (P<0.001)

Table 22. Mean price per head and per kg of sheep in the three sheep market places in Burie Woreda

Market place	Price per head (Birr) Mean±SE	Price per kg (Birr) Mean±SE
Derequa	265.0[a]±20.21	9.8[b]±0.44
Burie	289.8[a]±5.49	10.9[ab]±0.24
Kuche	279.0[a]±12.60	11.2[a]±0.23

SE = Standard error; Means with different superscript letters within a column are significantly different (P<0.05)

According to the results of this study, there is price variation per kg of sheep every two weeks. On average, there was a market price of 10.8 Birr per kg of BW during the study period (Table 22). There is variation in price per head between the two sexes. Females fetched better prices than males (296.6 vs. 271.6 Birr per head). In addition, there is variation in price per kg between the two breeds found in the woreda. But, this variation does not have the same pattern for the two breeds in all the three market places. So, it is not safe to say one breed fetches higher prices than the other breed. But, it is evident that due to the preference of Washera sheep by consumers on market, farmers in the lowland kebele are currently starting to rear Washera sheep.

There is a difference in market price of sheep per head in the three market places. But, this difference is not statistically significant ($P<0.05$) (Table 22). There is a difference ($P<0.05$) in price per kg of sheep sold among the three markets. In general, sheep marketed in Burie market have higher prices followed by Kuche market. This may be due to their location, found in a relatively urban area, road and transport access.

About 80% of the total sheep farmers sell per year are sold on market. Most of the animals sold on market are males at young age. From the informal survey result, the age of animals ranges from 6 to 12 months. These animals are preferable on market. According to Deneberu (2003), younger sheep fetch higher prices this case is not only for economic purpose but also the choice for their tenderness, softness and the like. According to EARO (2001b), about 62 – 86% of the sheep sold on markets have no permanent teeth (under 15 – 18 months old) with BW around 20 kg. According to Girma and Alemu (2008), the central pair of temporary incisor teeth in small ruminants is shed and replaced by permanent teeth at approximately 14 months of age. In addition, about 94% of the sheep sold that are less than 2 years are males. Farmers in the study area sell about 20% of the sheep they sell within their own kebeles. The animals sold in these places are mainly males for slaughter during festivals and females for breeding purposes and the buyers are always local farmers themselves. Farmers on average buy 0.8 heads of sheep ($n = 127$, SD 0.94) per year for breeding or home slaughter.

There is difference in the number of sheep brought per one seller in each market place in Burie Woreda. In addition, the sex and breed composition of the sheep brought for sale is also different. On average, for the three market places, one seller brings 2.6 heads of sheep ($n = 314$, $SD = 1.87$) at one time for sale on market (Table 23). The number of sheep brought for sale per person is higher ($P<0.001$) for Burie market compared to Derequa and Kuche markets. From this total number, 1.5 heads ($SD = 1.57$) are males and 1.1 heads ($SD = 1.25$) are females. In addition, from the 2.6 heads of sheep brought for sale on market 1.9 heads are Washera, 0.6 heads are Horro and 0.1 heads are crossbreds. There is difference in the breed composition of sheep brought for sale in the three market places by sellers. In Derequa market place, about 97% of the sheep brought for sale are Washera breed, whereas in Kuche market place, about 76% of the sheep brought for sale on the

market are Horro breed. This means there are more Washera breed for sale in Derequa market place and Horro breed on Kuche market place.

Table 23. Mean number of sheep brought for sale per sheep seller in the three market places in Burie Woreda

Market place	Number of sheep Mean±SE	N
Derequa	2.3^{b}±0.14	119
Burie	3.4^{a}±0.23	99
Kuche	2.1^{b}±0.15	96
Total	2.6±0.11	314

N = Number of respondents; SE = Standard error; Means with different superscript letters within a column are significantly different (P<0.001)

Sheep sellers (most of them are sheep producers) who sell sheep in Burie Woreda market places do not have adequate information on market prices of sheep (67%) when they take their animals to market. According to Muturi *et al.* (2001), farmers need periodical market information to enable them negotiate for better prices. In addition, availability of market information creates transparency among all players in the market. Lack of transparency in the market discourages production and perpetuates poverty. According to Muturi *et al.* (2001), a good flow of market information makes commodity prices competitive and results in fair distribution of benefits to producers, traders and consumers. Some of the sheep sellers in the study area get market price information mainly from traders or their neighbors. There is no public market information source in the area to the producers, traders or consumers in general. This case reduces the marketing system transparency and efficiency. This condition may increase the marketing cost and this in turn reduces the amount of money the producers get from the buyers.

The buyers on the market places are mainly farmers (56%), hotel and other food catering owners (21%), civil servants (13%), sheep traders (3%) and others (7%) (Appendix Figure 20). Purpose of sheep buying from the market places by sheep buyers is given in Table 24.

Table 24. Purpose of sheep buying by sheep buyers in the study markets in Burie Woreda

Purpose of sheep buying	N	%
For slaughter	90	60
For slaughter and rearing	1	1.0
For breeding	43	29
For resale (trading)	16	11
Total	150	100

N = Number of respondents

The sheep traders buy sheep from Burie Woreda market places and sell them on Burie market (Burie Woreda), Mankussa market (Jabi Tehinan Woreda) and Shendi Market (Womberma Woreda). Sellers usually transport the animals from the market of origin to the next selling market place on foot. So, there is no cost for transportation except the labour cost for driving the animals to these markets. From the survey result and the data available there is no clear pattern in the flow of animals from Burie Woreda markets to distant and large markets found in bigger towns. In Burie Woreda, sheep traders buy sheep from different places and sell almost all of them within the woreda market places. Hence, a market chain which links the smallholder producers to large urban consumers and processing plants is non-existent.

The market places where farmers buy and sell sheep are different. Farmers usually go to remote and rural market places for sheep buying that are found in other woredas where market prices for sheep are lower. Farmers buy sheep from these market places for trading or breeding purposes. On the other hand, farmers sell sheep in the nearby and urban market places where market prices are better. It seems that there is no woreda or regional boundary that limits sheep marketing in the study area. In most cases, sheep are going in from neighbouring areas into the woreda for marketing. In some cases, they also go out of the woreda to Shendi (Womberma woreda) and Mankussa (Jabi Tehinan Woreda) market places.

To the three market places found in Burie Woreda, farmers from the woreda and neighbouring woredas bring sheep on these market places for sale (Figure 3 and Appendix Figure 20). About 80% of the sheep sellers in Burie Woreda sheep market places come from within the woreda. On the other hand, farmers from Womberema Woreda (9%), Tilili Woreda (6%), Sekella Woreda (3%) and Jabi Tehinan Woreda (1%) bring sheep for sale to the three sheep market places found in the woreda (Figure 3 and Appendix Figure 20). The remaining 2% of the sheep sellers come from Banja Shekudad, Gemeja Bet, Guagussa Shekudad and Kosober woredas. Generally, in Derequa market place, farmers bring sheep for sale from Burie, Sekella, Jabie Tehinan, Guagussa Shekudad, and Dembecha Woredas. In Burie market place, farmers bring sheep for sale from Burie, Dangella, Guagussa Shekudad, Debub Achefer, Mecha, Tilili, Sekela and Kosober woredas. In Kuche market place, farmers bring sheep for sale from Burie and Womberma Woredas.

In addition to farmers, sheep traders bring sheep from different market places and sell them on the three sheep market places in the woreda. In Derequa market place, sheep traders bring sheep for sale from Ashefa (in Sekela woreda woreda), Agute (Sekela woreda), Tilili (Guagussa Shekudad woreda) and Dembecha (Dembecha woreda) market places. In Burie market place, sheep traders bring sheep for sale from Burie, Dangella (Dangella woreda), Tilili (Guagussa Shekudad woreda), Durebetie (Debub Achefer woreda), Merawi (Mecha woreda), Derequa (Burie Woreda), Robit (Banja Shekudada woreda), Ashefa (Tilili woreda) and Gushe (Kosober woreda) market places. In Kuche market place, sheep traders bring sheep for sale from Ashefa, Agute, Harro (Gida Kiram woreda), Amuro (Gida Kiram woreda), Agamessa (Gida Kiram woreda), Kiram (Gida Kiram woreda), Dangella, Derequa (Burie Woreda) and Shendi (Womberma Woreda) market places (Figure 4 and Appendix Figure 20).

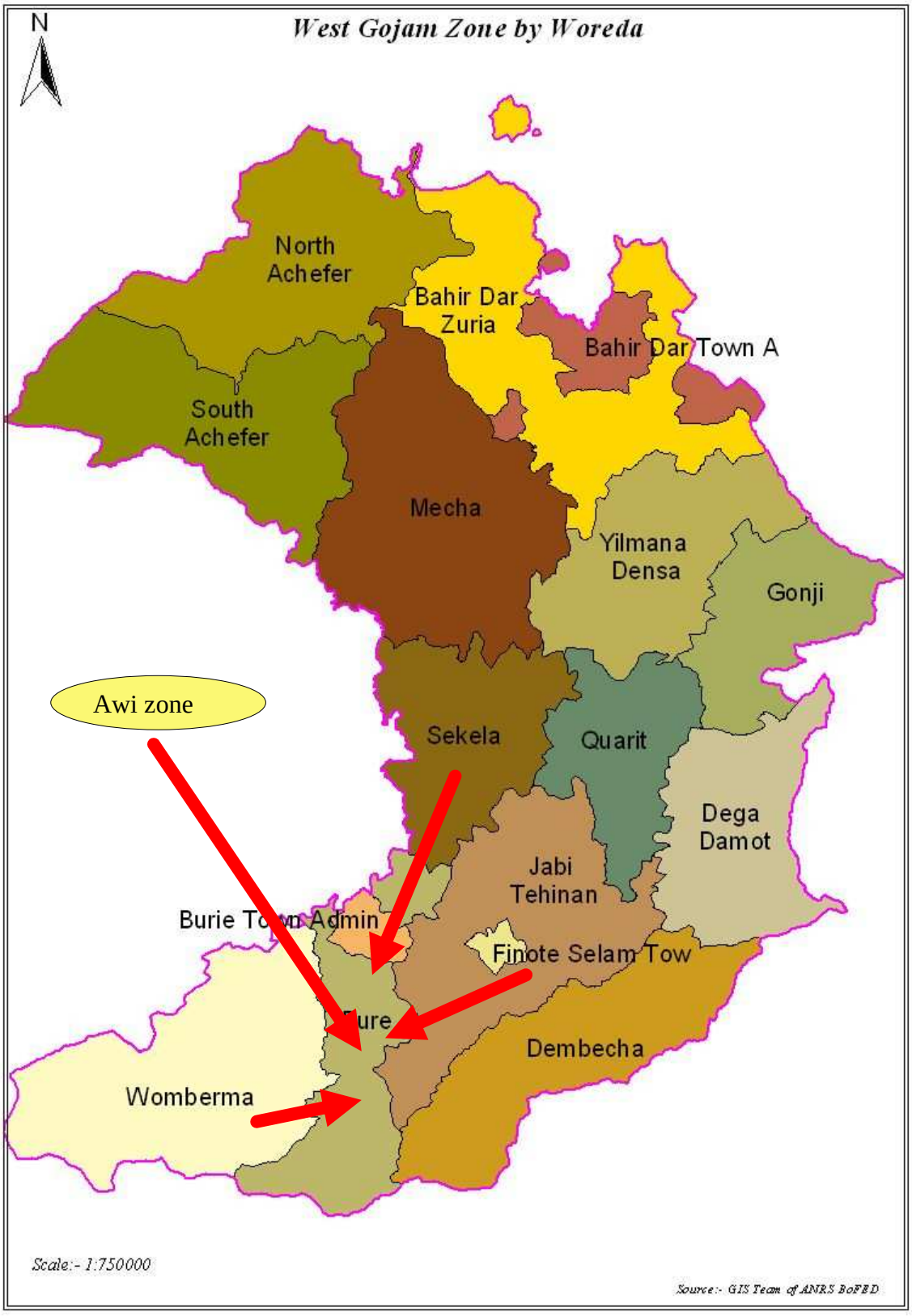


Figure 3. Main source areas of sheep for sale in sheep market places of Burie Woreda (Farmers)

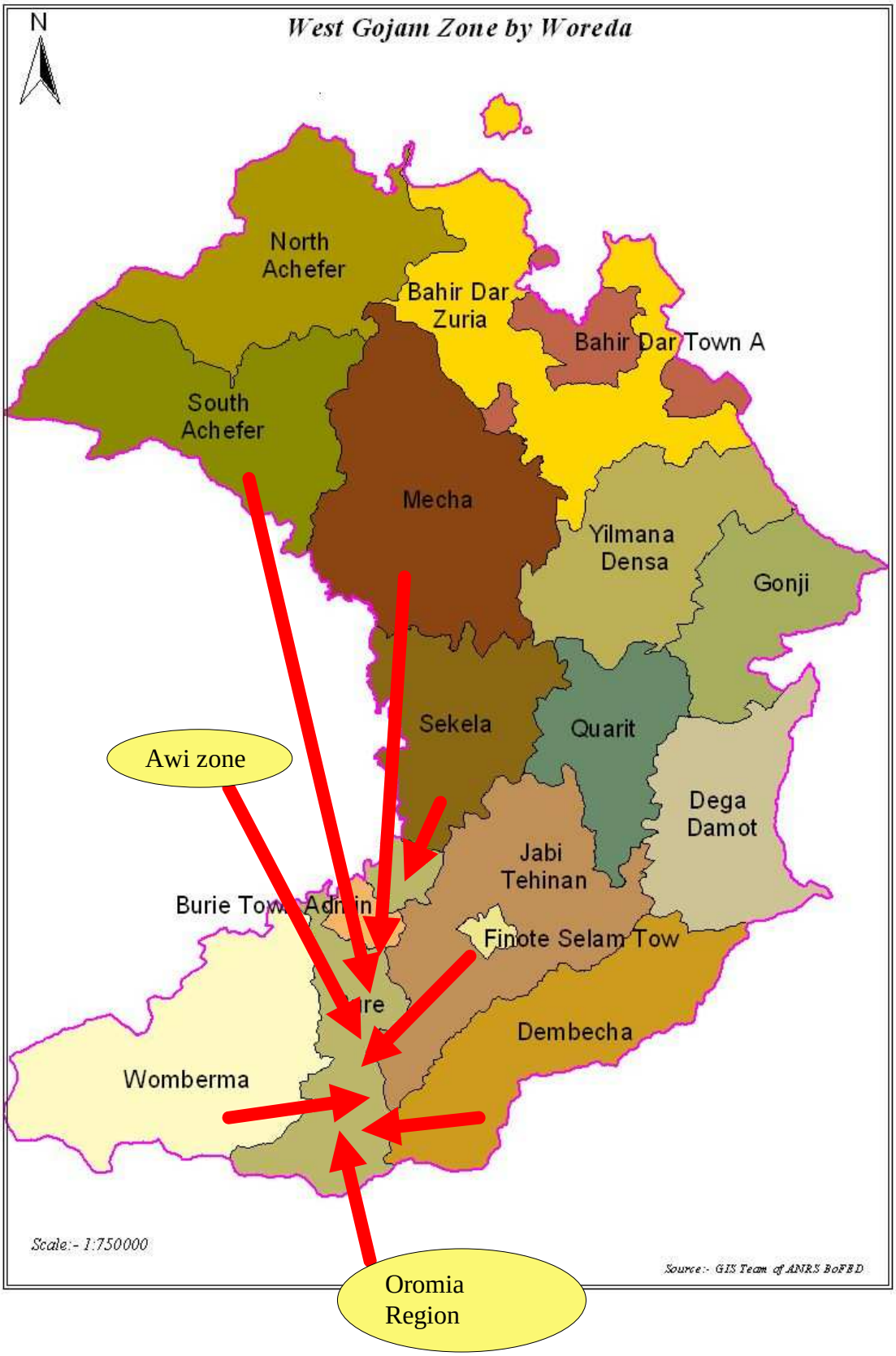


Figure 4. Main source areas of sheep for sale in sheep market places of Burie Woreda (Traders)

From the market study result, sheep traders get on average 31.4 Birr per head of sheep sold. This is very low considering the marketing costs incurred during the process of marketing the animals. This value is almost equal to two days of wage for a daily laborer in the area. But as traders buy and sell several animals at one time, the profit they obtain depends on the number of animals they buy and sell on markets. On average, one trader brings to the market for sell 4.5 heads of sheep (n = 31, SD = 1.88) on market at one time. Assuming all the animals brought for sell to the market to be sold and the estimated profit per head (31.4 Birr), one trader may get 139.6 Birr per one market day.

There are several sheep marketing constraints in the woreda. There is no market information service (current prices, long-term prices, characteristics of buyers and their preferences) for the producers, traders and consumers. There is also lack of market infrastructure. The market places are not fenced and they do not have facilities. Farmers encounter several problems during sheep selling on markets. Low market prices in some months of the year, forged Birr and remote market places especially to the lowland people are the main ones. Farmers say that the current sheep market prices are generally good and encouraging when the prices are compared with several years before. Good market price is an opportunity for the sheep producers in the area. In the sheep markets there is no weighing or grading of animals to be sold. Buyers and sellers judge the sheep they buy/ sell through physical observation only. This is a disadvantage especially for sellers. There is no precise method to know the quantity (in kg) as well as the quality (fat or lean meat) of produce sold or bought. As there is no grading system on the market places of sheep in the area, this will affect the production of quality sheep and sheep productivity in the smallholder system. For the sheep buyers, higher market prices and buying sick sheep are the main problems. Generally, sheep buyers complain that quality sheep on market is not available for slaughter as well as for breeding purposes.

Farmers buy few materials for sheep production from the market. They mainly buy salt (73% of respondents) and anthelminitics (80% of respondents) for their sheep. In addition, some farmers buy noug seed cake (7%) and drugs for medication of their sheep when the animals get sick. In general, buying agro-industrial by-products for sheep production is not

common. Farmers generally depend on the naturally available feed resources for sheep production in the study area.

4.2.8. Sheep production constraints in the study area

There are several sheep production constraints in the study area (Table 25 and 26). These include sheep diseases, lack of adequate veterinary service, feed shortage and nutrient deficiency, low market prices and remote market places (marketing), theft of animals, labour shortage to tend the animals, predator loss of animals, money shortage to purchase and rear or fatten animals, water shortage and lack of modern knowledge of owners in sheep production. According to EARO (2001b), feed shortage, diseases and parasites, animal management, genotype and genetics and socio-economic and institutional constraints are the main problems in sheep and goat production in the country. According to Abebe *et al.* (2000), feed shortage in the dry and rainy season, diseases, inadequate veterinary service and lack of capital are the main sheep production constraints in Lallomamma Mider Woreda, North Shoa. From the current study it was observed that the severity and scope of the sheep production constraints differs from kebele to kebele, even within the same kebele. For instance, water shortage is the main problem in Boko Tabo kebele, but it is not the main problem in the highland kebeles.

The sheep production constraints have been prioritized in the woreda based on their severity in the area (Table 25). Hence, sheep diseases, lack of adequate veterinary service and feed and nutrient shortage are the main sheep production constraints in the study area in descending order of importance. There is a difference in the priority of constraints in the formal and informal surveys (Tables 25 and 26). This may be due to farmers' poor understanding of the main constraints and their relationships with productivity of the animals. From the informal survey result, it was evident that there is feed shortage problem in the highland study area. Farmers selected sheep diseases as the first priority problem in the formal and informal survey results. But for the feed shortage, it is 3rd in priority in the informal survey and 8th in the formal survey result. This may have resulted from poor understanding of the importance of the constraint and its relationship with

productivity and health of animals, a result of poor analysis during their response in the formal survey by sheep rearing farmers.

Table 25. Rank of sheep production constraints in the study kebeles of Burie Woreda (Informal survey result)

Constraint identified	Woheni Durebetie	Woyenema Ambaye	Denbun	Boko Tabo	Total score	Priority in the Woreda
Sheep diseases	1	1	1	2	5	1
Lack of adequate vet service	2	8	2	3	15	2
Feed shortage	3	4	5	8	20	3
Theft	5	5	6	7	23	8
Labour shortage	5	6	4	8	23	6
Money shortage	4	8	3	8	23	7
Water shortage	5	8	8	1	22	5
Marketing problem	5	2	8	5	20	4

Table 26. Rank of sheep production constraints in the study kebeles in Burie Woreda (Formal survey result)

Constraint identified	1st Priority (5)	2nd Priority (4)	3rd Priority (3)	4th Priority (2)	5th priority (1)	Total weighted score	Priority in the Woreda
Sheep diseases	84	14	11	1	1	512	1
Lack of adequate vet service	1	13	22	23	5	174	5
Feed shortage	4	8	7	4	0	81	8
Labour shortage	1	5	12	10	10	91	6
Money shortage	17	14	9	8	8	192	3
Knowledge shortage	0	6	14	8	7	89	7
Marketing problem (remote market places)	6	16	16	13	9	177	4
Predators	7	24	13	7	10	194	2

4.2.9. Solutions suggested by farmers to alleviate the constraints identified

4.2.9.1. Sheep diseases and lack of adequate veterinary service

Farmers say that the sheep diseases in the area should be studied in detail and adequate control measures planned and implemented. They say there should be vet service nearby if possible within their residence kebeles. The drugs and personnel needed for the veterinary service should be provided adequately. If the disease problem is alleviated they want to rear more animals per household. Disease control measures should be accompanied by other development packages so as to bring optimum level of productivity from the animals in the area. To alleviate the disease problem in the woreda, better management practices should be adopted. Some of the diseases can be prevented by improved feeding of animals. In addition, better house construction (insulation of roofs) and cleaning of sheep houses should also be improved. Training on disease control and better sheep management practices to the farmers should be given. Those farmers who treat their animals themselves using modern drugs should be prohibited. Vaccination of animals should also be encouraged. Awareness creation in this area should be done through training as most of the farmers in the area are not aware of the importance of vaccination of animals. Better breeding practices in the area should be practised.

4.2.9.2. Feed shortage problem

Burie Woreda is one of the main maize and wheat producing woredas in the region. Integration of forage legumes with these crops in the area is feasible. Hence, undersowing forage legumes together with these crops is possible. This practice increases both forage production and soil fertility in the area. As soil fertility is declining, maintaining soil fertility is important for crop production. The socio-economic feasibility of integrating forage crops with cereals should be studied further. According to Gemechu *et al.* (1991), intercropping Rhodes grass or desmodium in maize has no effect on maize grain yield. In addition, by intercropping Rhodes grass and desmodium a mean dry matter herbage yield of 14 t/ ha and 9.33 t/ ha was obtained, respectively. This practice saves labour when compared with sole forage planting in addition to increasing forage yield. Assuming the

same forage crops, practices and environmental conditions in the study area, if farmers practice growing Rhodes grass or desmodium they can obtain 6.2 ton or 4.1 ton DM forage per year per HH, respectively, from their maize field (0.4 ha per HH) only. This practice alleviates the feed shortage problem in the highland study area. In addition, if farmers grow forage legumes they not only increase feed production but also the soil fertility of their crop land. According to Daniel (1996), intercropping/ undersowing forage legumes of the genera Trifolium and Vicia and multipurpose tree legumes such as sesbania and Chamaecytisus species can be incorporated into wheat based farming systems to maintain wheat yields and to improve the quality of crop residues as livestock feed. According to this source, introduction of leguminous fodders into mixed farming sytems will increase soil fertility, crop yield, roughage quality and make the system more sustainable. According to Tekleyohannes and Worku (2000), clover and alfalfa can be undersown simultaneously with barley for better forage yield without significantly reducing barley grain yield. In addition, vetches can be undersown with barley after 30 days of barley planting for better barley grain and forage yield.

Growing improved forage crops on private grazing lands is another option. This can be practiced in the highland kebeles of the woreda. If forage seeds are available farmers are willing to allocate land for forage production. This condition increases forage production as improved forage crops are better in dry matter production than indigenous ones. According to Alemayehu (2002), many indigenous forage species have low productivity or digestibility. According to this source, local grasses have low palatability, poor productivity and inadequate nutrient to maintain the animals. On the other hand, improved grasses have better productivity, palatability and nutrient composition. There are several improved forage grasses and legumes with proven characteristics that can be used for forage production program in Ethiopia (Alemayehu, 2002). Utilization of improved forage species available in the area (sesbania) and other indigenous fodder trees is essential. Supplementation of improved forage crops should be strategically done during feed and nutrient scarcity periods. To implement such practices, the socio-economic feasibility of these practices should be studied further in the study area. In addition to improved forage crops, utilization of the locally available agro-industrial by-products is another alternative.

4.3. Goat Production System

4.3.1. Breeds and breeding of goats

Farmers rear goats in the study area for the purpose of home consumption and for sell and cash income. Milking of goats in the study area is not common. Farmers who rear goats are not widely distributed as the sheep rearing farmers in the highland study kebeles. Goat producing farmers in these kebeles are concentrated in areas where there is more natural browse in the vicinity of their home. According to FARM-Africa (1996), the goat types found in the study area are Western Highland goat types. These goat types are one of the 14 goat types found in Ethiopia and Eritrea. According to the same source, the mean flock size owned is 8 (SD = 6). In the current study, one household owns on average 4.8 heads of goats (n = 75, SD = 3.33). It has 1.4 male (SD = 1.43) and 3.5 female (SD = 2.58) goats. From the data available, on average one animal in the flock weighs 21.6 kg (n = 248, SD = 10.20). Based on mean BW of an animal in the flock, the *Kolla* kebele goats are less ($P<0.05$) in BW (18.7 kg) than the *Dega* kebele goats (Table 27). This may be due to the difference in age composition of the flocks, environmental effect or differences in genotype (Appendix Table 10). The BW of animals in different age and sex groups is given in Appendix Table 9. The mean body weight of the goats in the current study is lower than that reported in FARM-Africa (1996) (48.4±9.9 kg for males and 33.0±6.0 kg for females).The goat types found in the study area are classified within the same group, the Western Highland goat type is found in the area. There may be a difference between the highland and lowland goat types. This is evident from their BW differences and phenotypic characteristics (Table 27; Appendix Figures 14, 15, 16 and 17).

Farmers usually get their first breeding goats buying from the market (77%), gift from parents/ relatives (8%) or buying from their residence kebeles. Most farmers now rear their own goats and some of the farmers rear other farmers' goats for benefits to be gained through rearing and tending the animals. From the current study result, females (75%) are more in number in the flock (Table 28). This is comparable with the result of FARM-Africa (1996). It is reported in this source that about 27% of the animals in the flock are males and 73% are females in the flock of Western highland goats. From the females, those females which are mature predominate in the flock (Table 28). For males, young

males predominate in the flock. This may be due to the purpose of goat production in the area. As the main objective of goat production in the area is for sale and home slaughter, most of the males are slaughtered or sold at young age. Females predominate in the production system as they are retained for breeding.

Table 27. Mean body weight measure of goats in the flock in the study kebeles in Burie Woreda

Name of kebele	BW (kg) Mean±SE	N
Woheni Durebetie	25.0^{a}±1.21	61
Woyenema Ambaye	21.4^{ab}±1.32	62
Denbun	21.2^{ab}±1.29	63
Boko Tabo	18.7^{b}±1.24	62

SE = Standard error; kg = kilogram; Means with different superscript letters within a column are significantly different ($P<0.05$)

Farmers castrate goats for fattening purposes. About 36% of the farmers practice male goat castration. They use either traditional or modern way of castration of animals. The age of the animals to be castrated is 17.8 months (n =27, SD = 8.00). Farmers cull breeding animals that are not suitable for production. They cull both male and female animals. Farmers have different criteria for culling male and female goats. Goat owners usually cull males which are short, black coloured, poor conditioned and old aged ones. For females, if the goat has no milk for the new born, short, poor conditioned, and old aged the animals are usually culled. If the goat gives birth to poor conditioned kids it will be culled after giving birth 2 or 3 times. Those females which abort or are sick are also culled. Black coloured females are also culled. Both male and female animals that are culled are sold on market or home slaughtered.

Table 28. Sex and age composition of the goat flocks in the study kebeles of Burie Woreda

Estimated age (year)	Sex of the goat					
	Male		Female		Total	
	N	%	N	%	N	%
< 1	44	71	65	35	109	44
1	1	2	0	0	1	0.4
1 to 2	7	11	21	11	28	11
2	2	3	27	15	29	12
3	4	7	19	10	23	9
> 3	4	7	54	29	58	23
Total	62	25	186	75	248	100

N = Number of animals

Farmers practice selection of animals for rearing in the area. They select both male and female animals. For male selection, body size and colour and for female selection, reproductive performance is given the most priority. For male selection, traits such as polledness, body length and body size are used. In addition, colour is an important criterion for selection of males. Hence, farmers select males that are white; brown; white and black mix; brown and white mix. Black colour males are not selected. In addition, poor conditioned males are not selected also. In some places, colour is not given much emphasis as a criterion for selection of male goats.

For female goats, those which are good conditioned, reproduce more frequently, big sized, large bellied, long bodied, pedigree is seen if the female is home produced. In addition, those female goats which give birth to 2 or 3 kids at a time are selected. Those female animals which give birth to big kids and the kids that grow fast are selected. For females' selection, colour is not a strict criterion as male selection. In addition, farmers say that females having long ears are good for rearing, because they give birth to big kids and they give more milk to their kids. In addition, females with large and wider ears are considered

to be good because they give birth to big kids and the kids will survive. Farmers use big and wide ear and long teats as criteria for selection of female goats.

4.3.2. Feed resources and feeding of goats

The main feed resources for goats are browse species found in natural pasture and crop land (Table 29). In addition, most farmers supplement salt, food leftover, maize grain and *atella* to their animals (Table 30). Supplementation to growing kid is rare in the area. Farmers supplement salt or boiled salt solution to the dam to make the animals produce more milk to the new born. Feeding crop residues to goats is rare in the study area.

Table 29. Major feed resources for goats during different seasons in the study kebeles of Burie Woreda

Major feed resource	Sept. – Nov. N = 75		Dec. – Feb. N = 75		March – May N = 75		June – August N = 75	
	N	%	N	%	N	%	N	%
BNPO	57	76	48	64	55	73	56	75
BSO	7	9	13	17	12	16	10	13
BNPS	11	15	13	17	7	9	8	11
Other	0	0	1	1	1	1	0	0
NR	0	0	0	0	0	0	1	1

N = Number of respondents; BNPO = Browse in natural pasture only; BNPS = Browse in natural pasture and stubble; BSO = Browse in stubble only; NR = No response

There is feed shortage (browse) problem for goats in the area especially in the highland kebeles. About 29% of the respondents encountered feed shortage in the study area. In general, there is feed shortage problem in the dry season from March to May. During this time the leaves of browse species will shed and there will be less leaves to be consumed by the animals. In addition, in the rainy season, as the crop land will be covered with crops, goats will be confined to browse species found in grazing lands. The browse species found in the grazing lands are limited in amount and do not supply the required amount of feed to the animals. Feed is abundant for goats in the area from November to January.

About 25% of the farmers in the study area fatten goats. Fattening goats takes several months. It takes on average 12.2 months (n = 20, SD = 10.22). The goat being fattened grazes with the flock in the day time and it will be supplemented feeds at home in the evenings or in the mornings. The amount and frequency of supplementation differs from household to household. It depends on the socio-economic status of the farmers. Most of the farmers supplement maize grain, beans and *atella* to fattening goats. Salt is usually supplemented. In addition, food leftover and noug seed cake are also supplemented to the fattening animals by some farmers. The grains to be supplemented will be boiled or roasted and salt added before feeding it to the fattening animals. According to FARM-Africa (1996), supplementation of castrates with roasted beans is common in the study area. Supplements are more often given to fattening animals.

The starting age for the male animals to be fattened is 19.2 months (n = 19, SD = 10.57). Farmers usually deworm the animals to be fattened before or during fattening. About 27% of the respondents deworm the goats they fatten. The animals to be fattened are usually selected (27%) and castrated (27%). The goats are usually castrated at 17.8 months (n = 27, SD = 8.00). Farmers most usually select animals for fattening if they buy the animals from the market. Home grown animals are not usually selected.

Table 30. Feed supplements for goats during different seasons in the study kebeles of Burie Woreda

Feed supplement type	Sept. – Nov. N = 75		Dec. – Feb. N = 75		March – May N = 75		June – August N = 75	
	N	%	N	%	N	%	N	%
MGO	3	4	4	5	3	4	4	5
AO	6	8	16	21	13	17	13	17
FLO	9	12	4	5	8	11	5	7
MGA	7	9	9	12	3	4	1	1
MGAFL	10	13	7	9	6	8	4	5
AFL	4	5	9	12	6	8	7	9
Other	7	9	6	8	14	19	14	19
NR	29	39	20	27	22	29	27	36

N = Number of respondents; ALF = Atella and food leftover; AO = Atella only; FLO = Food leftover only; MGA = Maize grain and atella; MGAFL = Maize grain, atella and food leftover; MGO = Maize grain only; NR = No response

Farmers fatten goats either for home consumption or sale on market. There are many constraints in goat fattening. These include diseases, low market prices during off-festival periods, feed shortage, theft, predators, money shortage to purchase and fatten goats and modern knowledge shortage on goat fattening. In general, goat fattening takes a long time and hence instead of fattening goats farmers want to endeavour in other activities that are more profitable within a very short period of time, rearing of breeding animals. Farmers usually water their goats 1 or 2 times per day during the dry season. Watering goats is usually the responsibility of children.

4.3.3. Housing of goats

Farmers use different house types. These are housing in the main house, house attached to the main house and a separately constructed goat house. Many people use the separately constructed goat house to keep their goats at night in the study area (Table 31). If the animals are housed in the main house, the room will be separated and partitioned by walls made of locally available materials. Farmers house all sex and age groups together. But bucks (5% of respondents), fattening goats (16% of respondents) and kids (64% of respondents) are usually separated. Some farmers tether goats at night and others do not. Generally, if the animals are housed in the main house they are usually tethered. Farmers use locally available materials to build goat houses. The roof is usually made of corrugated iron sheet (72%), and the wall in the highlands is made of eucalyptus tree and it is usually plastered with mud. Some farmers have a goat house with a roof made of grass (25%). The wall of the lowland goat houses is made of lowland woods similar to sheep houses and it is not usually plastered with mud as the ambient temperature in the area is very high. The floor is usually made of earth and some times it is made of wood or stone. The floor in the dry and rainy season is usually different. In the dry season, there is more earth floor (43%) and in the rainy season, stone (17%) and wood floor (59%) types increase in number. During the rainy season about 21% of the farmers adopt earth floor.

Farmers clean goat houses regularly. They clean goat houses more frequently during the rainy season than the dry season (Table 32). In addition, the highland HHs clean goat houses more frequently than the lowland HHs. In the lowland kebele, some farmers do not clean goat houses during the dry season. Farmers in the highland kebeles do not clean goat houses on Sundays and other observant days. If goats are housed in the main house the house is usually cleaned daily. Women and children are usually responsible to clean goat houses. Farmers utilize the goat manure for crop production. Adding goat manure on crop land is practiced in all the study kebeles.

Table 31. Type of goat houses used by farmers in the study kebeles of Burie Woreda

Type of goat house	N	%
Main house	21	28
House attached to the main house	26	35
Separately constructed goat house	27	36

N = Number of respondents

Table 32. Goat house cleaning frequency per week per household during the dry and rainy seasons in the study kebeles of Burie Woreda

Cleaning frequency	Dry season N = 73		Rainy season N = 72	
	N	%	N	%
Daily	20	27	51	68
1 times per week	31	41	1	1
2 times per week	16	21	14	19
3 times per week	6	8	6	8

N= Number of respondents

4.3.4. Diseases and disease control

Foot rot, skin disease, internal parasites, pasteurellosis and diarrhea (with blood stained) are some of the main goat diseases in the area. There is also abortion problem. When goats get sick farmers in the highland kebeles take their animals to the veterinary clinics. But in the lowland kebele, farmers medicate the goats using modern drugs themselves (75%). Farmers usually do not get their animals vaccinated. Traditionally used medicine for goat treatment is the same as sheep. Most of the kids born in the dry season survive in the study area. Kids born in the rainy season do not usually survive. This is due to diseases and predator loss.

4.3.5. Animal slaughter per household

Farmers slaughter goats in different occasions. About 57% of the respondents slaughtered goats at home the previous year. On average, one household slaughters 0.9 heads of goats (n = 75, SD = 0.98) per year. Farmers usually slaughter goats on Easter, Christmas and before the fasting period of Easter (Lent). Goats are slaughtered occasionally before and after fasting periods (Easter, August), on weddings and when the household feels to slaughter animals for home consumption and in some occasions on *Hidar Mikayiel* and *Hamelie Abo*. They slaughter males mostly at young age. Females at young age, sterile females or old females are also slaughtered occasionally. Sometimes fattened goats are also slaughtered. Rarely, there is no colour preference for the goats that are going to be slaughtered at home. In some cases, farmers rear goats but they do not slaughter and consume goat meat. According to FARM-Africa (1996), there is a cultural taboo in goat meat and milk consumption in Gojjam.

4.3.6. Herding of goats

Herding of goats is common in the study area (69% of the respondents). In the highland kebeles, the farmers herd their goats year round. But herding in the dry season is not as intensive as the rainy season. In the lowland kebele, farmers only herd goats during the rainy season from May to end of November. The main purpose of herding of goats is to avoid crop damage by animals and to avoid animal losses through theft, predator and straying. All age and sex groups of goats are herded together. There is group and private herding of animals in the area. Farmers usually herd in a group in the rainy season from May to end of October (27%). In group herding, households ranging from 5 to 13 will participate in one group herding. In one group herding, the number of animals tended together in one group ranges from 20 to 120 animals. Farmers usually herd privately (43%) in the dry season from November to end of April. During the dry season herding of goats in the lowland kebele is not common. Tending and watering of goats is the responsibility of children. Peak labour period in the study area is usually from May to end of December. During this time planting crops, weeding and harvesting of crops is done and hence, there is serious labour shortage problem to tend the animals (51% of respondents). The slack period is from February to end of April.

4.3.7. Goat marketing

From the livestock species reared by famers, goat sell is one of the cash income sources in the study area. Generally, farmers employ different market places for buying and selling goats. They buy goats from remote rural and cheap market places. But they sell goats on nearby and expensive market places which are found in towns. In most cases, goats that are going to be sold on market are trekked from the farmers' residence to the market places on foot. Men are usually responsible for goat selling on markets. The goat market places in the woreda are the same as sheep market places. These market places are Derequa, Burie and Kuche (Appendix Figure 19). The average number of goats offered per one market day per each market place is given in Table 33.

Table 33. Estimated average number of goats offered for sale per one market day in the three market places in Burie Woreda

Name of the market place	Number of goats Mean±SE	N
Derequa	58.5[a]±12.30	8
Burie	27.2[a]±8.74	6
Kuche	57.0[a]±20.96	7

N = number of market days the data were collected
Means with the same superscript letter within a column are not significantly different (P>0.05)

On average, one household sells 1.7 heads of goats (n = 75, SD = 1.72) per year. From the total number of goats sold per household per year about 81% of the goats are sold on market and the rest are sold within the residence kebeles of the farmers. Based on the average market goat price per head from the three market places (240.7 Birr per head), one household on average gets 409.2 Birr per year from goat sell. The mean price of goats per head and per kg is given in Table 35. Generally, farmers usually sell male goats at young age. This age group is demanded on market and fetches better prices for the owners. This may be due to the meat quality of the young goats which are very demanded by consumers on market. The number of female goats sold per household is greater than the number of male goats sold. This may be due to culling and selling of old female goats on market. On

the other hand, farmers buy goats for breeding or slaughter purposes. On average, one household buys 0.2 heads of goats (n = 75, SD = 0.61) per year.

Goat sellers sell goats on market for various reasons. On average, one goat seller brings 2.3 heads of goats (n = 69, SD = 1.36) to the market for sale at one time. From this total number 0.8 heads are males and 1.4 heads are females. Most of the sellers on market are farmers. Hence, most of the sellers sell goats on market to get cash income for home expenditure (46% of respondents). This number is followed by goat traders who sell for profit (39% of the respondents). About 10% of the goat sellers sell goat to buy other goats for rearing or slaughter purposes (Table 34).

Table 34. Purpose of goat selling on market places by goat sellers in the three market places in Burie Woreda

Purpose of selling the animals	N	%
For exchange	7	10
For home expense	32	46
For profit	27	39
Others	3	4

N= Number of respondents

The cash income per head a household obtains from goat sell is less than that of sheep sell in the area. In addition, there is deforestation and depletion of vegetation cover in the area which depletes the browse available for goats. Hence, these two conditions seem to reduce the number of goats and goat producers in the highland kebeles of the study area. Due to this reason, there is a shift from goat production to sheep production in the study area. In some cases, farmers completely sell the available goats due to labour shortage or predator problems. In areas where browse is available, the goat production in the area should be assisted with better marketing system so as to make the goat production in the area sustainable.

The market price for goats fluctuates during the year. Market prices for goats is low in February, March, June, July, August, September, October, November and December. It is high during Easter, Christmas and at the start of Lent. The market price per head and per kg of goat sold during the study period on the three market places is given in Table 35. The current goat market price is high when it is compared with the price 5 or 10 years ago and better price ($P<0.05$) per kg is obtained at Kuche than at Derequa and Burie markets.

There are different buyers of goats on market. The main buyers on markets are farmers (85%), hotel and other food catering service owners (11%) and civil servants (4%). It is evident that goat traders are mostly farmers themselves. The main sellers on goat market places are farmers (83%) and goat traders (16%). From the total number of goats traded on market about 48% are home reared and 52% are brought from other market places by traders and are sold for profit.

Table 35. Mean price per head and per kg of goats in the three goat market places in Burie Woreda

Market place	Price per head (Birr) Mean±SE	Price per kg (Birr) Mean±SE
Derequa	221.2^{a}±16.90	8.9^{b}±0.35
Burie	248.1^{a}±7.82	9.6^{b}±0.19
Kuche	238.4^{a}±11.18	11.9^{a}±0.33

SE = Standard error; Means with different superscript letters within a column are significantly different ($P<0.05$)

Goat sellers bring goats for sale from different woredas into Burie Woreda market places. Most of the goat sellers come from Burie Woreda (78%). Goat sellers from Tillili Woreda (9%), Sekela Woreda (7%), Womberma Woreda (4%), and other places (1%) come to the three market places found in Burie Woreda for goat selling. In addition to the goat producers in Burie Woreda, traders bring goats from different market places to sell goats in Burie Woreda market places. In Derequa market place traders bring goats from Ashefa, Dembecha, Jiga (Jiga woreda), Fenote Selam (Jabi Tehinan woreda) and Sekela market places. In Burie market place, traders bring goats from Tilili, Merawi, Durebetie, Dangella, Burie, Robit (Tilili woreda) and Ashefa market places. In Kuche market place,

traders bring goats from Harro, Amuro, Agamessa, Kiram, Ashefa and Agute market places.

There are different constraints in goat marketing in the area for the goat seller farmers. There is low market price for goats during certain months of the year. This problem is mentioned by most of the goat sellers on market as a constraint (49% of respondents). On the other hand, goat market places are remote for goat producers (35% of the respondents) to sell goats on these market places. In addition to these problems, farmers have also encountered forged Birr during selling of their animals (Table 36).

Table 36. Type of problem encountered in the market places by goat sellers in the three market places in Burie Woreda

Type of problem	N	%
Low market prices	34	49
Forged Birr	1	1
Others	3	4
No problem	28	41

N = Number of respondents

Goat traders in Burie Woreda buy goats from the three market places found in the woreda: Derequa, Burie and Kuche. The traders sell goats in Burie, Mankussa and Derequa market places. In general, the amount of profit that traders get from goat trading seems to be low. From the market data collected, it was observed that goat traders got on average 19.8 Birr per head of goat traded. This amount is very low. It is below the daily wage of labourers in the area for two days, for buying and selling of the goats on market. But as traders buy and sell a number of goats at one time, the amount of profit they get per one market day will be higher.

Generally, the goat marketing system and its constraints are similar to the sheep marketing system and its constraints. But there are some differences. The market prices for goats are lower than that of sheep. The market linkage in the area is less pronounced than sheep

marketing. There are also few traders of goats compared with that of sheep. This may be due to the low number of goats traded on market and the low demand for goats in the area. The goat marketing system needs improvements to make the producers more beneficial. Hence, improvements in market information system, grading system for animals on sale, market infrastructure development and creation of a new market chain to potential market places by potential traders is necessary. This improvement conditions should be studied further and their feasibility precisely known. Better marketing system in the woreda will make the goat producers more beneficial and the goat production in the area more sustainable.

Goat producer farmers buy different materials from the market for their goats. Most of the farmers in the area buy salt (69% of the respondents) and anthelminitics (92% of the respondents) for their goats. Occasionally, some farmers buy drugs (Ampicillin, Penicillin and Oxytetracycline) for the treatment of sick goats. Buying drugs for sick goats' treatment is especially practised in the lowland kebele. Some farmers (9% of the respondents) buy noug seed cake for their goats.

4.3.8. Goat production constraints in the study area

There are several constraints in goat production in the study kebeles of the woreda. These are goat diseases, feed shortage (browse), predators, lack of adequate veterinary service, theft, marketing, money shortage, abortion, water shortage, external parasites and lack of modern knowledge in goat production. From all the goat production constraints identified, goat diseases, lack of adequate veterinary service, feed (browse) shortage, predators and marketing problem are the main goat production constraints in the study area (Tables 37 and 38).

Table 37. Rank of goat production constraints in the study kebeles in Burie Woreda (Informal survey result)

Constraint identified	Woheni Durebetie	Woyenema Ambaye	Denbun	Boko Tabo	Total score	Priority in the Woreda
Goat diseases	2	1	1	1	5	1
Lack of adequate vet service	1	5	4	6	16	3
Feed shortage (browse shortage)	3	3	2	6	14	2
Leech	6	2	4	6	18	6
Water shortage	6	5	4	4	19	8
Knowledge shortage	6	5	4	2	17	5
Marketing problem	6	4	4	5	19	7
predators	4	5	4	3	16	4

Table 38. Rank of goat production constraints in the study kebeles of Burie Woreda (Formal survey result)

Constraint identified	1st Priority (5)	2nd Priority (4)	3rd Priority (3)	4th priority (2)	5th priority (1)	Total weighted score	Priority in the Woreda
Goat diseases	37	18	5	3	0	278	1
Lack of adequate vet service	2	5	11	4	2	73	4
Feed shortage	0	6	1	1	0	29	7
Labour shortage	3	5	6	4	0	61	5
Money shortage	6	3	4	1	2	58	6
Knowledge shortage	0	2	3	4	4	29	8
Marketing problem (remote market places)	1	4	13	10	1	81	3
Predators	23	20	4	2	1	212	2

There is a difference in the priority of constraints in the formal and informal surveys (Tables 37 and 38). This may be due to farmers' poor understanding of the main constraints and their relationships with productivity of the animals. The severity of the constraints differs from kebele to kebele. The constraints have their own causes and

consequences in the area. The predators in some kebeles (Woheni Durebetie and Boko Tabo) have increased in number. This is due to the regeneration of forests in some areas. Goat owners do not take their goats to these areas and browse their animals fearing loss of animals by predators. Feed shortage occurred due to the cultivation of grazing lands and the deforestation of most of the forest areas. Feed shortage occurs especially during the rainy season as the crop land will be covered by crops and the available browse for goats from the grazing lands will be limited.

4.3.9. Solutions suggested by farmers to alleviate the constraints encountered

For the disease problem, farmers need veterinary service to be given in their residence kebeles. For the feed shortage problem, farmers are willing to allocate land for growing improved forage crops. For this purpose, farmers need the supply of forage seeds. The cultivation of the grazing land should be banned. Forest areas should be conserved. In addition, awareness creation on forage production should be done. For the predator problem, farmers want the government to allow them to reduce the number of predators by hunting in some places. For the financial shortage problem, farmers need credit to be given to them. Especially the poor need credit to purchase and rear goats.

4.4. On-farm Feeding Trial on Sheep

4.4.1. Wheat straw varieties used in the trial

The wheat varieties from which the straw was obtained for the on-farm feeding trial were different. The wheat variety from which the straw was obtained in Arebesi kebele is local variety. The wheat variety from which the straw was obtained in Tiya Tiya and Sertekez kebeles is HAR 1685. As the straw used for the on-farm feeding trial was derived from different wheat varieties in the study area, there will be a difference in their nutritive value. This is evident in their different chemical composition and *in vitro* digestibility values (Table 39). This difference is not assumed to be from variety difference alone and hence environmental factors may also have contributions on these values (i.e. soil fertility, etc).

4.4.2. Chemical composition of the experimental feeds

The CP content of the untreated wheat straw ranged from 2.3 to 2.9% (Table 39). This figure is lower than that reported by Getahun (2006) (3.2%). The CP content of the urea treated straw ranges from 5.1 to 5.6%. This is also lower than the figure reported by the same author (6.0%). The NDF content of both the urea treated and untreated wheat straw is greater than or equal to 68.9%. According to Getu (2006), citing Singh and Oosting (1992) on the classification of roughages, these feeds can be classified into low quality feeds (> 65% NDF). The low CP content of the straw may have contributed for the low wheat straw intake by the animals during the trial as CP content affects both digestibility and intake of feed (Ranjhan, 1997).

The CP content of wheat bran, groundnut cake, wheat bran and groundnut cake mix is, 16.9, 42.7 and 22.3%, respectively. According to Tesfaye (2007), citing Lonsdale (1989) on the classification of protein source feeds, the concentrate feeds and their mix can be classified into medium (120 – 200 g CP/ kg DM), high (> 200 g CP/ kg DM) and high protein sources, respectively. The CP content of the wheat bran that is used in this trial is lower than that reported by Asnakew (2005) (19.6%) and Simret (2005) (20.1%). It is also lower than that is reported by Getnet *et al.* (2000) (17.2%). This may be due to various factors which affect the chemical composition of feeds. Soil type, variety and other environmental factors affect the chemical composition of feeds. The CP content of groundnut cake is also lower than 50.6% reported by Asnakew (2005), 51% reported by Simret (2005) and 54.4% reported by Getnet *et al*. (2000). From the chemical analysis results of the feeds used for the trial, it is evident that the feeds used in the trial were of lower quality when they are compared with other trial results. The chemical composition of the experimental feeds is given in Table 39.

Table 39. Chemical composition and *in vitro* digestibility values of the feeds used in the on-farm feeding trial

Source of feed sample	Feed sample type	Analysis result						
		DM (%)	Ash (%DM)	CP (%DM)	NDF (%DM)	ADF (%DM)	Lignin (%DM)	DOMD (*In vitro*) (%OM)
Arebesi	UNTWS	92.6	9.4	2.9	76.3	52.2	6.8	50.4
Arebesi	UTWS	93.5	12.1	5.6	69.4	59.6	9.0	53.1
Tiya Tiya	UNTWS	92.5	8.4	2.6	76.1	51.6	6.7	50.3
Tiya Tiya	UTWS	93.5	12.2	5.3	68.9	59.6	8.8	53.5
Sertekez	UNTWS	92.6	7.8	2.3	75.2	50.4	6.6	50.5
Sertekez	UTWS	93.6	12.7	5.1	72.1	59.2	9.1	47.9
-	WB	90.5	5.4	16.9	42.4	13.7	3.3	84.8
-	GNC	96.5	9.0	42.7	25.4	20.9	5.4	74.0
-	WB + GNC	92.9	7.0	22.3	33.7	17.8	5.3	82.0

ADF = Acid detergent fiber, CP = Crude protein, DM = Dry matter, NDF = Neutral detergent fiber. GNC = Groundnut cake; UNTWS = Untreated wheat straw; UTWS = Urea treated wheat straw; WB = Wheat bran

4.4.3. Digestibility of the feeds used in the on-farm feeding trial

The *in vitro* digestibility of organic matter of the untreated wheat straw ranged from 50.3 to 50.5% and that of the urea treated wheat straw ranged from 47.9 to 53.5% (Table 39). These figures are higher for the untreated wheat straw when compared with Getahun's (2006) report (48.4%). The digestibility of the urea treated wheat straw is lower than that reported by the same author (63.2%). This may be due to differences in variety, lignin content and other environmental factors which affect digestibility.

4.4.4. Feeds and nutrient intake

The animals in all the treatment groups (grazing and wheat straw experimental groups) consumed almost all the concentrate feed supplement (wheat bran and groundnut cake

mix) that was offered to them. Consumption of the urea treated and untreated wheat straw was very low (Table 40). This may be due to the quality of the wheat straw offered to the animals. Urea treatment was not that much effective in increasing straw intake. In some cases consumption of urea treated wheat straw also declined. On the other hand, there was little or no consumption of untreated wheat straw in most cases. The nutrient intake of animals in the trial is given in Table 41.

Table 40. Mean wheat straw intake of the animals in the two treatment groups in Arebesi kebele

Treatment	Intake (g/ day) Mean±SE	N
Untreated wheat straw	7.4^{a}±2.13	7
Urea treated wheat straw	52.8^{b}±14.99	7
Mean	30.1±9.62	14

g = Gram, N= Number of observations; SE = Standard error; Means with different superscript letters within a column are significantly different (P<0.05)

Table 41. Mean dry matter, organic matter, ash, crude protein, neutral detergent fiber and acid detergent fiber intake of animals in the on-farm feeding trial in Burie Woreda

Feed intake	Grazing experiment	Wheat straw experiment	
	Treatment	Treatment	
	2	1	2
GNC + WB intake (g/ d)	200.0	200.0	200.0
Straw intake (g/ d)	-	7.4	52.8
Total dry matter intake (g/ d)	200.0	207.4	252.8
OM intake in GNC + WB (g/d)	186	186	186
Ash intake in GNC + WB (g/ d)	14	14	14
CP intake in GNC + WB (g/ d)	44.6	44.6	44.6
NDF intake in GNC + WB (g/ d)	67.4	67.4	67.4
ADF intake in GNC + WB (g/ d)	35.6	35.6	35.6
OM intake in wheat straw (g/d)	-	6.8	46.3
Ash intake in wheat straw (g/ d)	-	0.6	6.5
CP intake in wheat straw (g/ d)	-	0.2	2.8
NDF intake in wheat straw (g/ d)	-	5.6	37.0
ADF intake in wheat straw (g/ d)	-	3.8	31.4

4.4.5. Body weight change of the animals

The animals gained BW during and at the end of the trial period. There was a significant final BW difference between the two groups (the concentrate supplemented and the farmers' traditional practices (supplementation of food leftover, *atella* and maize grain every three/ four days interval) at the end of the trial period (Table 42). The concentrate supplemented ones performed better ($P<0.05$) than farmers' traditional practices. This may be due to the frequency of supplementation and the high nutritive value of the concentrate feed supplement (WB + GNC) offered to the experimental animals compared with the feed farmers traditionally supplement to their fattening sheep. Hence, concentrate supplementation is effective in inducing more BW gain in the treatment group of sheep

than the farmers' traditional practices (control). In this study the concentrate supplemented animals gained on average 43.6 g per day which is higher ($P<0.05$) from the control group (12.9 g per day) (Table 42). In another study, there was also a significant average daily BW gain ($P<0.05$) in goats that were supplemented with wheat bran and groundnut cake when compared with the unsupplemented ones (Simret, 2005). The author reported that the animals that were supplemented 200 g concentrate feed per day gained on average 39.9 g/ day. In the current study, the animals gained on average 43.6 g per day. This value is greater than the value reported by Simret (2005). This may be due to the difference in the animal species and nutritive value of the feeds used in the trial. In addition, the nutritive value of the feed available on the grazing lands was better during the trial, rainy season.

It is observed that supplementation of goats on the lower (200 g) and the highest level (400 g) is not statistically significant ($P>0.05$) in BW gain and carcass parameters (Simret, 2005). The author recommended that supplementation of 75% groundnut cake and 25% wheat bran at the lowest level (200 g) as economical.

In the wheat straw feeding trial, the animals gained BW during and at the end of the trial. There was no significant difference ($P>0.05$) in final BW between the two groups (Table 43). There was also no significant difference ($P>0.05$) between the two groups in ADG and total BW gain at the end of the trial. There was no effect due to variety of wheat ($P>0.05$). There was no interaction effect ($P>0.05$) between urea treatment and wheat variety. The mean body weight change of the animals every week in the wheat straw feeding experiment is given in Figure 5.

Table 42. Mean initial body weight, final body weight, body weight change and average daily gain performance of the sheep in the grazing trial (Adjusted means)

Treatment N = 9	Initial BW (kg) Mean±SE	Final BW (kg) Mean±SE	BW change (kg) Mean±SE	ADG (g/ day) Mean±SE	Concentrate intake (g/ day)
Farmers' practice	21.6^{a}±1.22	21.9^{b}±0.79	1.1^{b}±0.79	12.9^{b}±9.14	0
Grazing +GNC + WB	20.1^{b}±1.39	24.6^{a}±0.79	3.7^{a}±0.79	43.6^{a}±9.14	200

BW = Body weight; g = Gram; GNC = Groundnut cake; N= Number of observations; SE = Standard error; WB = Wheat bran; Means within a column with different superscript letters are significantly different (P<0.05)

Table 43. Mean initial body weight, final body weight, body weight change and average daily gain performance of sheep in the wheat straw feeding trial (Adjusted means)

Treatment	N	Initial BW (kg) Mean±SE	Final BW (kg) Mean±SE	BW change (kg) Mean±SE	ADG (g/ day) Mean±SE	Concentrate intake (g/ day)
UNTWS	13	21.6^{b}±1.01	25.4^{a}±0.87	2.1^{a}±0.87	24.3^{a}±10.09	200
UTWS	19	24.5^{a}±1.04	25.9^{a}±0.69	2.6^{a}±0.69	30.6^{a}±7.97	200

BW = Body weight, g = Gram, N= Number of observations; UNTWS = Untreated wheat straw, UTWS = Urea treated wheat straw, SE = Standard error, Means within a column with different superscript letters are significantly different (P<0.05)

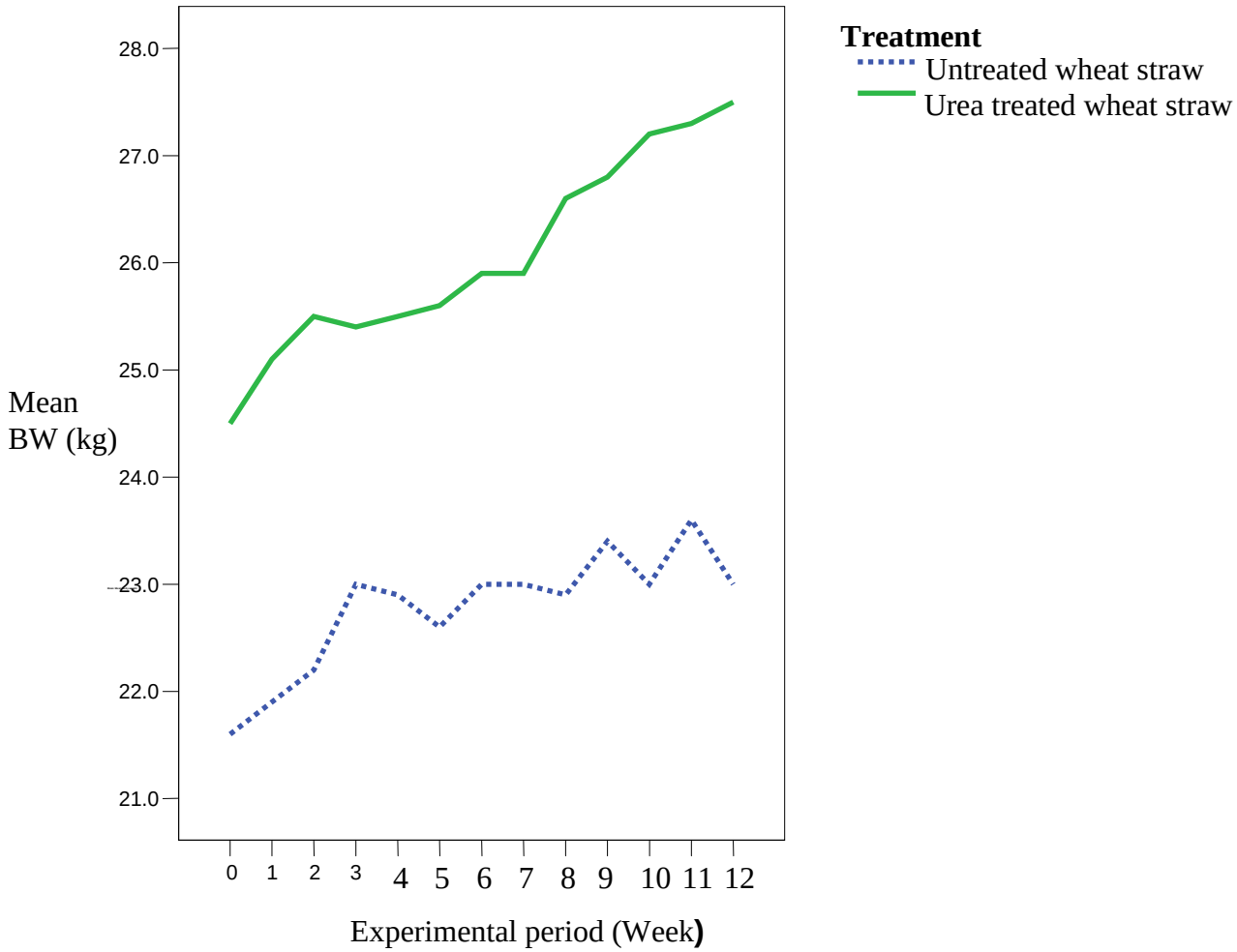


Figure 5. Mean body weight change of animals every week in the wheat straw feeding experiment in Burie woreda

4.4.6. Farmers assessment of the feeding trials

4.4.6.1. Grazing experiment

Farmers generally evaluated this feeding trial as good. They have observed BW gain and body condition change in the animals which were supplemented with wheat bran and groundnut cake mix. From farmers' evaluation, the wheat bran in the concentrate feed mix is blown away by the animals' breathing when animals start to feed on the concentrate feed mix and enters into the animals' nostrils. This made the animals to cough and sneeze while eating the concentrate feed. This condition was mentioned as a drawback for the concentrate feed mix by farmers. Farmers believed that the amount of feed given to the animal per day is too much so it should be reduced. If it is too much they say it will not be suitable for the animals' health. The fear may stem from the traditional fattening practices. In the traditional fattening practice farmers feed concentrates to the animals in small amounts with some days interval. The farmers believed that the cause of disease (pasteurellosis) is too much concentrate feed supplement to the animals. They also believe that concentrate feed supplementation should not be given daily. It should be at every third or fourth day interval. They believe that supplementing animals with concentrate feed more frequently is not good for the animals' health. Daily feeding of concentrate supplements is not practiced in the farmers' traditional fattening practices.

Disease was the main problem during the trial. Some of the experimental animals were sick of disease (pasteurellosis). Sick animals were treated for the disease in the nearest veterinary clinics. Farmers say that additional anthelminitics was necessary during the trial. This is because they deworm the fattening animals several times when they fatten animals traditionally. They believe that giving anthementics several times during fattening improves the animals' condition. In addition, they believe that the animals used in the trial should have been castrated. They also believe that castration of animals will have increased their BW gain. The uncastrated animals used in the trial were observed in mating female animals during the trial so that this would have adversely affected their BW gain. According to Demissie *et al*. (1989), a study conducted using Horro sheep to assess the effect of castration on their growth and development at different levels of concentrate supplementation (330 and 250 g per head per day), there was no significant effect of

castration on final BW and average daily gain at the lower level of supplementary concentrate feeding (250 g). But, the results also showed that intact sheep gained more (144 g vs 75 g) per day than castrated ones at the higher level of concentrate feeding (330 g). Generally, the authors concluded that sheep that are going to be fattened for slaughter should remain intact unless there are special reasons for castration. According to McDonald (2002), the quantities of nutrients to produce ova and spermatozoa by mammals are very small and of little significance. Hence, it is concluded by the authors that nutrient requirement for spermatozoa and ova production are inappreciable compared with the requirements for maintenance and for processes such as growth and lactation. But the energy expenditure for mating, running with the mate and the time spent during this process without consuming feed is not considered in these studies.

To make the farmers adopt the feeding practice, the concentrate feeds used for the trial should be available in the area. It is difficult to the farmers to bring the concentrate feeds individually from remote areas and feed their animals. For the concentrate feeds, a marketing system should be established in the study area. Some farmers also said that they have problems to adopt the feeding practice due to financial shortage. They are unable to buy sheep and concentrate feeds for sheep fattening. So, credit should be available to the farmers to alleviate the financial problem of the poor to buy sheep and the necessary inputs for sheep fattening. In addition to these factors, to make the farmers adopt this feeding practice, awareness creation through training is essential that concentrate feeding on daily basis at the recommended rate is not harmful. Generally, inadequate veterinary service in the study area and the concentrate feeds unavailability are the two main factors which determine the adoption of the feeding practice. Hence, not only for the adoption of new feeding practices but also for all the livestock species farmers' rear, adequate veterinary service provision is necessary to the farmers in the study area.

The grazing plus wheat bran and groundnut cake concentrate mix feeding practice is socially acceptable. Many farmers wanted to participate in the feeding practice. They were also eager to participate if there was a second term feeding trial. In addition, farmers took the remaining concentrate feed from the trial very interested and in competition. On the contrary, farmers do not socially accept feeding indoors in the case of urea treated wheat straw and concentrate feeding. Some believe that it is immoral and irreligious to keep animals restricted at home from movement when feeds are available outside.

Farmers were feeding their animals according to the recommendations in the grazing trial. They gave the concentrate feed supplement, water and common salt to the animals as recommended. For the control group (grazing), they fed food leftover, *atella*, maize grain and other household feed materials that are traditionally used for fattening. Supplementation to the control group was different depending on the households. Some farmers did not feed any supplement to the control animals to see the effect of the new treatment (wheat bran and groundnut cake concentrate mix) on the experimental animals. Generally, the farmers will certainly adopt this feeding practice in the future, grazing plus concentrate feed (GNC + WB) supplementation. Concentrate supplementation of animals is very easy and it does not require additional labour input to feed the concentrate supplement feeds when it is compared with the farmers' traditional fattening practices. The current practice of feeding animals also reduced the duration of the fattening period when it is compared with the traditional fattening practices. Farmers interviewed believe that most of the farmers in the area will adopt this feeding practice in the future.

It was observed that the effect of wheat bran and groundnut cake mix supplementation on BW gain of sheep is effective. The supplemented groups performed better than the farmers' traditional practices. This means that supplementing animals with wheat bran and groundnut cake mix is better than farmers' traditional practices. In addition, the on-farm feeding trial participating farmers select this treatment as better from all the treatment groups considering animal performance, cost, labour input and feasibility of adoption by the farmers found in the study area. As farmers use maize grain in their traditional sheep fattening practices, it is better to avoid it and use the agro-industrial by-products for sheep fattening as maize grain is used for human consumption and it is very expensive than groundnut cake and wheat bran mix. Especially, the poor farmers in the study area do not have maize grain to feed their animals. In addition, due to soil fertility decline and expected human population increase in the future, feeding maize grain to animals will be unlikely. This condition creates competition for food with humans. Fattening using the agro-industrial by-products is feasible biologically, economically and socially.

4.4.6.2. Wheat straw feeding experiment

Farmers generally evaluated this feeding trial as less effective. The animals consumed almost all the concentrate feed mix offered to them. Farmers have observed BW change and body condition change on the animals at the beginning of the feeding trial. From the current study, intake of both the untreated and urea treated wheat straw was very low (Table 40). Some farmers considered the urea treated wheat straw as poisonous. During the trial some of the trial animals were sick of pasteurellosis. They were treated for the disease. Disease was the main problem during the trial.

Farmers in this group were not feeding their animals according to the recommendations made at the beginning of the trial. Farmers fed the concentrate feed supplement, treated/ untreated wheat straw, water and common salt to the animals. They fed wheat straw (urea treated and untreated) and also grazed the animals on grazing fields, whenever they were not supervised. So, feeding urea treated wheat straw alone with concentrate supplements indoors is not feasible in the area considering farmers' beliefs and social feasibility. Rather feeding animals urea treated wheat straw together with grazing and concentrate feed supplements seems to be feasible considering farmers' traditional fattening practices and social feasibility. In the one hand, feeding animals indoors entails labour input. On the other hand, feeding and fattening animals indoors is not traditionally common in the study area. This trial is not similar to the farmers' traditional fattening practices. So, to bring indoor feeding practice using urea treated wheat straw alone with concentrate feed supplements will take time to make it really feasible in the system. Generally, the labour input that is used to treat the wheat straw with urea, the labour input in indoor feeding and animal management and the amount of extra BW gain that will be achieved by urea treatment compared with the control group (untreated wheat straw) will determine the adoption of this practice.

Generally, the probability of adoption of concentrate feed (GNC + WB) supplementation to grazing animals is more probable compared to the urea treated wheat straw and concentrate feed supplementation. Farmers have observed better body condition in the animals that were in the grazing plus concentrate feed supplementation group. Hence, those farmers who participated in the urea treated wheat straw feeding trial evaluated the wheat straw feeding trial as less effective based on their animals performance.

4.4.7. Economic analysis of the on-farm feeding trials

Concentrate supplementation (GNC + WB) to grazing sheep is feasible economically based on partial budget analysis (Table 44). For a technology to be adopted by the farmers, it should not only be technically feasible but also profitable. Since net income and variable costs has increased and marginal rate of return is high in the grazing and groundnut cake and wheat bran supplemented group, this feeding practice can be recommended to farmers to be widely used in the area. In the current study, the costs for the feeds used by the farmers' traditional sheep fattening practices were not included. If they were included the total variable costs for the control group (Farmers practice) will increase and the concentrate supplementation (GNC + WB) would have more net income and marginal rate of return values than the control group. In the current study, there is an increase in net income and for each 1 Birr per head of sheep invested by farmers for the purchase of concentrate feed mix (GNC + WB), the famers will regain their 1 Birr and get an additional 0.8 Birr per head of sheep net income (MRR = 79.35%).

Table 44. Partial budget analysis of the on-farm feeding trials

Particulars	Treatments			
	Farmers' practice	Grazing + GNC + WB	Untreated wheat straw + GNC + WB	Urea treated wheat straw + GNC + WB
Initial price of sheep (ETB)	244.81	238.48	265.13	280.79
Total concentrate consumed (kg)	-	17.2	17.2	17.2
Total straw consumed (kg)	-	-	0.64	4.54
Cost for concentrates (ETB)	-	32.25	32.25	32.25
Cost for urea (ETB)	-	-	-	1.67
Cost for labour, digging pit (ETB)	-	-	-	17.47
Cost for labour, urea treatment of the straw (ETB)	-	-	-	27.90
Total variable costs (ETB)	0	32.25	32.25	79.29
Gross income (ETB/head)	395.55	447.06	332.31	504.04
Total return (ETB/ head)	150.74	208.58	67.18	223.25
Net return (ETB/ head)	150.74	176.33	34.93	143.96
ΔNI	-	25.59	-	109.03
ΔTVC	-	32.25	-	47.04
MRR (%)	-	79.35	-	231.78

4.5. Monitoring Sheep Reproduction, Lamb Growth and Mortality

4.5.1. Sheep management during the study period

Farmers' traditional practices of sheep management were adopted during the study. The sheep grazed during the day time and local feed supplements were fed during the evenings based on each individual farmer's practice. The supplements given differ from household to household. Generally, most households supplemented their sheep with *atella* and food leftover. In addition, farmers treated their animals with anthelminitics during the study. Sick animals got treated in their respective veterinary service areas. There was almost no supplement offered to the growing lambs during the study. They depended on their dam's milk only.

There were 458 sheep at the beginning of the study (Table 45). Among these, 366 were females and 92 were males. One household on average had 7.63 heads of sheep (n = 60, SD = 2.58) at the beginning of the study (Table 46). At the end of the study, it had on average 8.0 heads of sheep (n = 60, SD = 3.50) per household. There was an increase in sheep number per household at the end of the study period. Sheep number per household increased in Woheni Durebetie and Woyenema Ambaye kebeles, while in Boko Tabo kebele it decreased (Table 46). From the total number of sheep (458) at the start of the study, only 362 (79%) of the original sheep were present at the end of the study. About 63% of the males and about 83% of the females were present at the end of the study. From the 458 sheep present at the beginning of the study 71 (15.5%) were sold within the 6 months, 22 (5%) died due to diseases and 3 (0.7%) were slaughtered. During the study, there was no loss of animals due to predators.

Within the 6 months, 2 sheep were bought and added as breeding females and 118 lambs were born. At the end of the study there were 481 sheep present in the 3 kebeles in the selected households including the number of lambs born within the 6 months. From this total number of sheep, 104 heads (22%) were males and 372 (77%) were females. From the total 118 lambs born within the 6 months, 117 lambs have been measured and records taken. Record for one lamb was not taken. Among the 117 lambs 46 were males and 66 were females. From the total lambs born (117), the sex of the 5 lambs was not recorded.

Table 45. Total sheep number per kebele at the beginning and end of the study in the study kebeles of Burie Woreda

Total sheep number	Woheni Durebetie N = 20	Woyenema Ambaye N = 20	Boko Tabo N = 20	Total N = 60
Beginning of study	177	139	142	458
Male	33	26	33	92
Female	144	113	109	366
End of study	200	141	140	481
Male	46	37	21	104
Female	152	102	118	372

N = Number of households

Table 46. Mean sheep number per household at the beginning and end of the study in the study kebeles of Burie Woreda

Sheep number per HH	Woheni Durebetie N = 20 Mean±SD	Woyenema Ambaye N = 20 Mean±SD	Boko Tabo N = 20 Mean±SD	Total N = 60 Mean±SD
Beginning of study	8.9±3.94	7.0±1.28	7.1±1.07	7.6±2.58
Male	1.7±1.18	1.3±0.92	1.7±0.67	1.5±0.95
Female	7.2±3.47	5.7±1.31	5.5±1.10	6.1±2.33
End of study	10.0±3.89	7.1±3.10	7.0±2.66	8.0±3.50
Male	2.3±1.46	1.9±1.57	1.1±1.1	1.7±1.45
Female	7.6±3.66	5.1±2.55	5.9±2.38	6.2±3.06

N = Number of households; SD = Standard deviation

4.5.2. Birth weight and sex of lambs

The birth weight of males (2.6 kg) was greater (P<0.001) than the birth weight of females (2.1 kg). The mean BW of the two groups is given in Table 47. According to Kassahun (2000), a study on Horro and Menz lambs, males were heavier at birth than females. Male and female lambs had a birth weight of 2.4 ± 0.03 and 2.2 ± 0.02 kg, respectively. The difference between this result and the current study may be due to environmental and genetic differences. According to Markos (2006), birth weight for male lambs is higher than birth weight for female lambs based on a study on Menz and Horro sheep.

Table 47. Mean birth weight and growth rate of male and female lambs in the study kebeles of Burie Woreda

Sex of lamb	N	BW (kg) Mean±SE	N	Growth rate (g/ day)
Male	46	2.6^{a}±0.10	12	109.3^{a}±4.33
Female	66	2.1^{b}±0.09	16	114.8^{a}±2.95
Total	112	2.3±0.07	28	112.4±2.51

N = Number of lambs; BW = Body weight; g = Gram; SE = Standard error; Means with different superscript letters within a column are significantly different (P<0.001)

4.5.3. Birth weight and ago-climatic zones

There is birth weight difference among the agro-climatic zones. Lambs born in the Dega kebele have higher birth weight (2.9 kg) followed by the Woina Dega kebele (2.4 kg) (Table 48). There is a difference (P<0.001) in birth weight of lambs among the three agro-climatic zones. This may be due to breed and environmental factors (nutrition of dams, etc). In addition, the Horro breed which is found in the kolla kebele usually gives birth to twins (48% of the lambs born), but the Washera breed which is found in the Dega kebele usually gives birth to single lambs (87% of the lambs born). According to Markos (2006), single lambs have higher birth weight than multiples. In another study (Kassahun, 2000), single born lambs were heavier than twin born lambs.

Table 48. Mean birth weight of lambs in different agro-climatic zones in the study kebeles of Burie Woreda

Agro-climatic zone	Birth weight (kg) Mean±SE	N
Dega	2.9^{a}±0.07	47
Woina Dega	2.4^{b}±0.03	41
Kolla	1.2^{c}±0.05	29

N = Number of lambs; kg = kilogram; SE = Standard error; Means with different superscript letters within a column are significantly different (P<0.001)

4.5.4. Birth weight and breed of lambs

There is a difference in birth weight between the two breeds, Horro and Washera. Birth weight of Washera lambs (2.8 kg) is greater (P<0.001) than birth weight of Horro lambs (1.8 kg) (Table 49). This may be due to breed, environmental factors and/ or type of birth effects. This difference may be due to the effect of genotype and nutrition of the dams during the study as the two breeds are found in different agro-climatic zones. In addition, Horro ewes give birth usually to twins but Washera ewes usually give birth to only one lamb at a time. So, type of birth may have also contributed to this result. According to Markos (2006), there was a difference in birth weight between breeds. According to this author's result, Horro lambs had higher birth weight than Menz lambs. In another study, Horro lambs had higher (P<0.001) (2.4 ± 0.03 kg) birth weight than Menz lambs (2.2 ± 0.03 kg) (Kassahun, 2000). According to Kassahun and Solomon (2008), Horro sheep weighs from 2.8 – 2.9 kg at birth and from 13 – 15 kg at weaning (90 days). According to the same source, Washera sheep weighs 2.8 kg and 13.8 kg at birth and at weaning, respectively. According to Kassahun *et al.* (1991), Horro lambs have an estimated birth weight of 2.9 kg. In addition, Horro lambs seem to be heavier at birth and keep their superiority over the Adal and Black Head Somali up to yearling age (Kassahun *et al*., 1991).

Table 49. Mean birth weight and growth rate of lambs by breed in the study kebeles of Burie Woreda

Breed of lamb born	N	Birth Weight (kg) Mean±SE	N	Growth rate (g/ day) Mean±SE
Washera	56	2.8^{a}±0.07	17	108.9^{a}±3.66
Horro	56	1.8^{b}±0.09	11	117.9^{a}±2.29
Total	112	2.3±0.07	28	112.4±2.51

N = Number of lambs; kg = kilogram; g = Gram; SE = Standard error; Means with different superscript letters within a column are significantly different (P<0.05)

4.5.5. Growth rate between male and female lambs

Many factors affect growth rate. The most important are feeding level, genotype, sex, health and management (Gatenby, 1991). According to Gatenby (1991), ram lambs grow faster than ewe lambs whether or not the diet is restricted. On a given diet, ewe lambs get fatter than ram lambs. Mean growth rate per day of male and female lambs up to 112 days of age is given in Table 47. There is no significant difference (P>0.05) in growth rate between the two groups. According to Gatenby (1991), males grow faster than females.

4.5.6. Growth rate and breed of lambs

There is no difference (P>0.05) in growth rate of lambs between the two breeds (Table 49). Washera and Horro lambs grew 108.9 g and 117.9 g per day during 112 days of age, respectively. But this difference is not significant (P>0.05). This result indicates that Horro lambs have low birth weight when compared with Washera lambs, but Horro lambs have similar growth rate with Washera lambs during the first 112 days of age (Table 49). According to Markos (2006), Horro lambs grow faster than Menz lambs during the pre-weaning and post-weaning periods. During the pre-weaning period Horro and Menz lambs had a growth rate of 78.0 g and 72.6 g per day, respectively. According to Kassahun (2000), there was no significant difference between Horro and Menz lambs from birth up to weaning (90 days). But birth type, dam parity and season of birth had significantly affected (P<0.001) on pre-weaning BW gain. According to Kassahun *et al.* (1991), Horro

lambs have a BW of 2.9 kg and 15.0 kg at birth and at weaning, respectively. In addition, the breed on average has a weight gain of 134 g per day from birth up to weaning. This difference from the current result may be due to nutrition of the dam or other environmental factors during the study.

4.5.7. Sheep mortality and agro-climatic zones

There was no mortality of lambs during the study. But there was mortality of adults. There is no adult sheep mortality difference (P>0.05) due to diseases among the agro-climatic zones within the six months. There is more sheep mortality in the Dega and Woina Dega kebeles than the Kolla kebele (Tables 50 and 51). There is high sheep mortality per household (0.5 heads) in the Woina Dega kebele followed by the Dega kebele (0.4 heads). Sheep mortality per household in the Kolla kebele is lower (0.3 heads of sheep) than other agro-climatic zone kebeles. This may be due to breed and environmental factors (differences in feed availability, housing and ambient temperature, etc) that affect the animals' health. From the informal survey result, it was observed that as the sheep breed in the highland kebeles (Washera) is currently susceptible to diseases and dies more frequently, farmers in these kebeles are crossbreeding Washera breed with Horro breed.

Table 50. Mean number of sheep death per household in the different agro-climatic zones of Burie Woreda within the six months

Agro-climatic zone	Number of sheep Mean±SE	N
Dega	0.4^{a}±0.18	20
Woina Dega	0.5^{a}±0.27	20
Kolla	0.3^{a}±0.09	20

N = Number of households; SE = Standard error; Means with the same superscript letter within a column are not significantly different (P>0.05)

Table 51. Total number of sheep death and percentage in the different agro-climatic zones of Burie Woreda within the six months

Agro-climatic zone	Total number of sheep dead (No.)	% death	Total number of sheep at the beginning of study
Dega	7	4.0	177
Woina Dega	10	7.2	139
Kolla	5	3.5	142
Total	22	4.8	458

5. SUMMARY AND CONCLUSIONS

Assessment of the small ruminants production systems were conducted in Burie Woreda to assess the management practices, identify and prioritize the constraints of the traditional small ruminants production systems. For this study four representative rural kebeles were selected purposively and the study was conducted in these selected kebeles in the woreda. These selected kebeles are Woheni Durebetie (*Dega*), Woyenema Ambaye (*Woina Dega*), Denbun (*Woina Dega*) and Boko Tabo (*Kolla*). The study was carried out through informal and formal surveys. The body weight of animals was measured using hanging scale in the field. The purpose of sheep production by farmers in the study area was for cash income and home slaughter on festivals. Farmers on average had 3.7±2.46 heads of sheep (n = 127) per HH. There were two sheep breeds in the study kebeles, Washera and Horro. There was also a local crossbred sheep (Horro X Washera) called *Anfet* in Amharic. Farmers crossbreed Washera sheep with Horro sheep to make the breed more disease tolerant. About 59% of the respondents said that Horro sheep is more disease tolerant than Washera and the crossbred sheep. From the current survey result, it was evident that there were more Washera sheep (98%) in Woheni Durebetie Kebele and more Horro sheep (92%) in Boko Tabo Kebele. In Denbun and Woyenema Ambaye kebeles, the two breeds together with the crossbred sheep exist with different proportions. There is a difference in the distribution of the sheep breeds among the different agro-climatic zones (χ^2 = 1031.9, P<0.05). About 69.5% of the sheep in the flock are females and the remaining 30.5% are males. There is a possibility of inbreeding in the sheep flock in the area as male animals are sold, castrated or slaughtered at a very young age.

The main feed resources for sheep in the area are natural pasture and stubble grazing. In addition, most farmers supplement salt and *atella* (a local beer residue) to their animals. The communal grazing lands are small in area and they are overgrazed. There is feed shortage problem both during the dry and rainy seasons. In addition, the quality of the available feed resources is poor in nutritive value. The CP content of most of the available feeds is below maintenance requirement. Based on feed production and feed requirement per HH per year for the available livestock, there is a deficit of 0.7 ton DM per HH per year in the highland kebeles. According to farmers' evaluation, the veterinary service

provision is not adequate. There is high mortality and morbidity rate of sheep in the highland kebeles. Sheep death and morbidity rate increases during feed shortage periods. The cause of high mortality and morbidity rate may be due to feed shortage and inbreeding in the sheep flocks in the study area. One household on average sold 1.1±1.40 heads of sheep (n = 127) per year. Farmers sell sheep mainly during Easter, New Year and Christmas. On average, there was a market price of 10.8 Birr per kg of BW during the study. Farmers and traders bring sheep for sale into the woreda from neighbouring woredas and region. Among the constraints identified in sheep production, sheep diseases, lack of adequate veterinary service and feed and nutrient shortage are the main ones. Generally, there are better sheep breeds in the study area. To bring improvements in sheep production in the area adequate feed supply, better vet service provision and better breeding system should be given emphasis. This makes the animals more productive and the system more sustainable.

Farmers in the study area also rear goats for home slaughter and cash income. One household on average had 4.8±3.33 heads of goats (n = 75). From the current study, about 75% of the goats in the flock are females and the remaining 25% are males. The main feed resources for goats are browse species that are found in natural pasture and crop lands. In addition, farmers usually supplement their goats with common salt and *atella*. Maize grain and beans are usually supplemented to fattening goats. Generally, there is feed shortage problem for goats during the dry and rainy seasons. When goats get sick, farmers in the highland kebeles usually take sick goats to the nearest public veterinary clinics. On the other hand, the lowland farmers buy drugs from the market and treat their animals themselves. On average, one household sold 1.7±1.72 heads of goats (n = 75) per year. Goats from the neighbouring woredas and region enter into the woreda for marketing. Goat market prices are low during certain months of the year. During the study there was a market price of 10.3±2.32 Birr (n = 153) per kg BW of goat sold. Among the constraints identified in goat production during the study, goat diseases, feed (browse) shortage and predators were the main ones. Generally, poor feed resource, diseases, predator and low market prices are making the goat production less sustainable.

The on-farm feeding trials were conducted in Arebesi, Tiya Tiya and Sertekez kebeles to evaluate the effect of feeding urea treated wheat straw and concentrate supplementation on BW change of lambs and to estimate the economic feasibility and to assess farmers

evaluation of the feeding practices. The sheep selected and used for the trial were local breeds (Washera, Horro and crossbred) and of male sex. The wheat straw was treated with 5% urea. A completely randomized design was employed. Treatments were allocated to the experimental units randomly using a lottery method. The trial animals were offered 200 g concentrate feed per head per day according to the treatments. The concentrate feed consisted of 75% groundnut cake (150 g) and 25% wheat bran (50 g). Feed offered and feed refusal were weighed and recorded every week. At the end of the feeding trials, farmers' were interviewed individually and in a group to evaluate the results of the feeding trials. Economic analysis was done using partial budget analysis. The trials were conducted for 86 days. The experimental animals consumed almost all the concentrate feed mix offered to them. Their consumption of urea treated and untreated wheat straw was very low (52.8 g vs 7.4 g per day). In the grazing trial, there was a difference ($P<0.05$) on final BW, BW change and daily BW gain between the treatment and the control groups. The sheep in the two groups had a final BW of 21.9 kg and 24.6 kg; a total BW change of 1.1 kg and 3.7 kg; and a daily BW gain of 12.9 g and 43.6 g per day, respectively. Supplementation of grazing animals with concentrate feed (GNC + WB) is feasible biologically (on-farm evaluation), economically (partial budget analysis) and socially based on farmers assessment. In the wheat straw feeding trial, there was no difference ($P>0.05$) on final BW, total BW change and daily BW gain between the treatment and the control group. In general, feeding grazing animals with groundnut cake and wheat bran mix has a high probability of adoption in the area.

Monitoring of sheep flocks was conducted in Woheni Durebetie, Woyenema Ambaye and Boko Tabo kebeles to assess the on-farm birth weight and growth performance and mortality and causes of mortality of lambs. From each study kebele, 20 farmers having 5 or more breeding ewes were selected purposively and participated in the study. In the selected farms, lambs born, date of birth, their sex and type of birth were recorded. The birth weight of the lambs born was taken in the first 24 hours after birth and after that every 2 weeks interval during the study. The study was conducted for 6 months. Birth weight of male lambs (2.6 kg) was greater ($P<0.001$) than female lambs (2.1 kg). The Dega agro-climatic zone lambs were heavier ($P<0.001$) (2.9 kg) than the Woina Dega (2.4 kg) and Kolla agro-climatic zone lambs (1.2 kg) at birth. Washera lambs had heavier ($P<0.05$) birth weight (2.8 kg) than Horro lambs (1.8 kg). There was no difference ($P>0.05$) in growth rate between Washera (108.9 g) and Horro lambs (117.9 g) when the

two breeds are compared at 112 days of age. In addition, there was no difference (P>0.05) in BW between the two breeds at 112 days of age (15.2 kg vs 14.7 kg). These results indicated that Horro lambs had a lower birth weight than Washera lambs, but Horro lambs had similar growth rate with Washera in the first 112 days of age when the two breeds are compared within their respective environments.

Recommendations

To alleviate the possibility of inbreeding and to maintain the productivity and genetic diversity of animals there should be maintenance of more male animals on-farm.
As farmers practice crossbreeding Washera with Horro in the area there should be proper breeding system in the area to maintain and conserve the available breeds.
As there is severe feed shortage problem, especially in the highland kebeles, increasing feed production both in quantity and quality and utilization of the available feed resources efficiently should be given more emphasis as it affects animal health, productivity and survival.

In the goat production, as the market prices for goats are lower improvement in market information and linking the available markets with potential market places in the region through a new market chain, feed supply and predator control should be given more emphasis to make the goat production sustainable.

Adequate veterinary service should be provided to the farmers in the area.

Those farmers who treat sick animals buying drugs from the market should be made aware of the consequence of their activities and should be prohibited.
Generally, to bring improvements in small ruminants production in Burie Woreda, small ruminant diseases, lack of adequate veterinary service and feed and nutrient shortage constraints should be given due emphasis in research and development activities that will be undertaken in the study area.

Supplementation of grazing sheep with concentrate feed mix (75% GNC + 25 % WB at 200 g level) can be extended to the farmers to be widely used in the study area.
To confirm the current results of the on-farm growth performance of lambs further studies are needed involving more animals in the study area.

6. REFERENCES

Abebe Mekoya, Alemu Yami, Mekonnen Hailemariam, 2000. Management of traditional sheep production in Lallomamma Mider woreda, North Shoa, Amhara. Pp. 143 – 153. Proceedings of the 7th annual conference of the Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia, 26 – 27 May 1999, ESAP (Ethiopian Society of Animal Production).

Abule Ebro, 1994. Performance of crossbred calves fed tef straw (*Eragrostis tef*) supplemented with graded levels of cowpea (*Vigina ungiculta*) and Dolicos lab lab (*lab lab purpureu*) hay. An Msc Thesis Presented to the School of Graduate studies of Alemaya University of Agriculture. 178p.

Agajie Tesfaye, Chilot Yirga, Mengistu Alemayehu, Elias Zerfu and Aster Yohannes, 2002. Smallholder livestock production systems and constraints in the highlands of North and West Shewa Zones. Pp. 49 – 71. Proceedings of the 9th annual conference of the Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia, August 30 – 31, 2001, ESAP (Ethiopian Society of Animal production).

Alganesh Tola, Mathewos Belissa and Gizaw Kbede, 2004. Survey on traditional livestock production systems in Manasibu District of West Wallaga, Ethiopia. Pp. 141 – 150. Proceedings of the 11th annual conference of the Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia, August 28 – 30, 2003, ESAP (Ethiopian Society of Animal production).

Alemayehu Mengistu, 2002.Forage production in Ethiopia: A case study with implications for livestock production. Ethiopian Society of Animal Production (ESAP), Addis Ababa. 112p.

Alemayehu Mengistu, 2005. Feed resources base of Ethiopia: Status and opportunities for integrated development. Pp. 377 – 386. Proceedings of the 12th Annual Conference of the Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia, August 12 – 14, 2004, ESAP (Ethiopian Society of Animal Production).

Amir P. and Knipscheer H.C., 1989. Conducting on-farm animal research: procedures and economic analysis. Winrock international institute for agricultural development and IDRC - (International Development Research Centre), Morrilton, Arkansas, USA and Ottawa, Canada. 244p.

AOAC (Association of Analytical Chemists), 1980. Official Methods of Analysis, 12th ed. Association of Official Analytical Chemists, Arlington, VA, USA. 957p.

ARARI (Amhara Regional Agricultural Research Institute), 2005. Diagnosis- Training notes prepared for the diagnostic and planning workshop. July 24 – August 5, 2005. ARARI (Amhara Regional Agricultural Research Institute), Bahir Dar.

Asnakew Awuk, 2005. Feedlot fattening performance and carcass characteristics of intact male Hararghe highland goats fed different levels of hay to concentrate ratios. An Msc thesis presented to the school of graduate studies of Alemaya University. 65p.

Azage Tegegne, 2005. Improving productivity and market success of Ethiopian farmers. ESAP Newsletter, Issue No. 11. ESAP (Ethiopian Society of Animal Production), Addis Ababa.

Belachew Hurrissa and Jemberu Eshetu, 2003. Challenges and opportunities of livestock marketing in Ethiopia. Pp. 1 – 13. Proceedings of the 10th annual conference of the Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia, August 22 – 24, 2002, ESAP (Ethiopian Society of Animal Production).

BOFED (Bureau of Finance and Economic Development), 2008. The Amhara National Regional State Bureau of Finance and Economic Development 2006/ 2007 Budget Year Annual Statistical Bulletin. Bureau of Finance and Economic Development, Bahir Dar.

Charry, J., J.M. Humbert and J. Leuif, 1992. Manual of sheep production in the humid tropics of Africa. CAB International, UK. 187p.

Chenost, M. and C. Kayouli, 1997. Utilization of treated forages to achieve modest production rates. Roughage utilization in warm climates. FAO Animal Production and Health Paper 135, pp. 41 - 77.

CSA (Central Statistics Authority), 2006. Agricultural Sample Survey 2005/ 2006 (1998 E.C.). Volume II, Report on livestock and livestock characteristics. Addis Ababa, Ethiopia.

CSA (Central Statistics Authority), 2008. Statistical Abstracts 2007. Addis Ababa, Ethiopia.

Daniel Keftasa, 1996. Research on the integration of forage legumes in wheat-based cropping systems in Ethiopia: A review. pp. 57 – 61. In: Ndikumana, J. and Peter de Leeuw (eds). Sustainable feed production and utilization for smallholder livestock enterprises in Sub-Saharan Africa. Nairobi, Kenya. 6 – 10 December 1993, African Feed Resources Network (AFRNET).

Demissie Tiyo, Kassahun Awgichew and Yohannes Gojjam, 1989. Comparison of castrated and entire Horro male lambs for growth and fattening ability under various feeding regimes. Pp. 74 – 77. Proceedings of the second national livestock improvement conference. Addis Ababa, Ethiopia, 24 – 26 February 1988, Institute of Agricultural Research.

Deneberu Teferra, 2003. Sheep price pattern and factors affecting price variations in the highland markets of North Shewa, Ethiopia. An MSc Thesis Presented to the Faculty of Graduate Studies, University of Jordan. 99p.

Desta Hamito, 2001. Research methods in forestry principles and practices with particular reference to Ethiopia. Larenstein University of Professional Education, Deventer. 682p.

Dixon, J. and A. Gulliver with D. Gibbon, 2001. Farming systems and poverty: Improving farmers' livelihoods in a changing world. FAO and World Bank, Rome, Italy and Washington D.C., USA. 412p.

EARO (Ethiopian Agricultural Research Organization), 2001a. Small ruminant research strategy. EARO (Ethiopian Agricultural Research Organization), Addis Ababa. 59p.
EARO (Ethiopian Agricultural Research Organization), 2001b. Feeds and nutrition research strategy. EARO (Ethiopian Agricultural Research Organization), Addis Ababa. 40p.

EARO (Ethiopian Agricultural Research Organization), 2001c. Wheat research strategic plan. EARO (Ethiopian Agricultural Research Organization), Addis Ababa. 40p.

EARO (Ethiopian Agricultural Research Organization), 2001d. Executive Summary of Livestock Research Strategy. EARO (Ethiopian Agricultural Research Organization), Addis Ababa. 31p.

FARM-Africa, 1996. Goat types of Ethiopia and Eritrea – Physical description and management systems. Published jointly by FARM-Africa, London, UK and ILRI (International Livestock Research Institute), Nairobi, Kenya. 76p.

Fentie Bishaw and Solomon Melaku, 2008. Effect of supplementation of Farta Sheep fed hay with sole or mixs of noug seed meal and wheat bran on feed intake, digestibility and body weight change. *Tropical Animal Health and Production 40 (8): 597 – 606.*

Gatenby, R.M., 1986. Sheep production in the tropics and sub-tropics. Longman Group Limited, London and New York. 351p.

Gatenby, R.M., 1991. Sheep. Macmillan education LTD, London and Basingstoke, The Technical Centre for Agricultural and Rural Co-operation (CTA). 154p.

Gemechu Gedeno, Legesse Dadi and Asfaw Negassa, 1991. Intercropping Rhodes grass and desmodium in maize in farmers' fields around Bako. pp. 127 – 128. Proceedings of the third national livestock improvement conference. Addis Ababa, Ethiopia. 24 – 26 May 1989, Institute of agricultural Research.

Getahun Kebede, 2006. Effect of urea treatment and Leucaena (*Leucaena leucocephala*) supplementation on the utilization of wheat straw by sheep. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University. 66p.

Getnet Berhanu, 1998. Performance of Somali Goats supplemented with different proportions of groundnut cake and wheat bran. An MSc thesis presented to the school of graduate studies of Alemaya University of Agriculture, Alemaya. 85p.

Getnet Berhanu, Alemu Yami and Mekonnen Hailemariam, 2000. Performance of lactating Somali Does supplemented with different proportions of groundnut cake and wheat bran. Pp. 197 – 211. Proceedings of the 7th annual conference of the Ethiopian society of animal production (ESAP). Addis Ababa, Ethiopia, 26 – 27 May 1999, ESAP (Ethiopian Society of Animal Production).

Getu Kitaw, 2006. Replacement of formulated concentrate mix with vetch (*Vicia dasycarpa*) hay to lactating crossbred dairy cows fed on urea treated wheat straw. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University. 74p.

Gibson, J., Gamage S., Hanotte O., Iñiguez L., Maillard J.C., Rischkowsky B., Semambo D. and Toll J., 2006. Options and strategies for the conservation of farm animal genetic resources: Report of an international workshop (7 – 10 November 2005, Montpellier, France). CGIAR Sytem-wide Genetic Resources Programme (SGRP)/ Bioversity International, Rome, Italy. 53p.

Girma Abebe and Alemu Yami, 2008. Sheep and goat management. Pp. 33 – 56. In: Alemu Yami and R.C. Merkel (eds). Sheep and goat production handbook for Ethiopia. Ethiopian sheep and goat productivity improvement program.

IBC (Institute of Biodiversity Conservation), 2007. Domestic animal genetic resources of Ethiopia. Web-site (http://www.ibc-et.org/ibc/dpt/animal/domestic_animals.html)

ILCA (International Livestock Centre for Africa), 1990. Livestock System Research Manual. Working Paper No. 1, Vol. 1. ILCA, Addis Ababa. 287p.

ILRI (International Livestock Research Institute), 1995. Livestock Policy Analysis. ILRI training manual 2. ILRI, Nairobi. 264p.

ILRI (International Livestock Research Institute), 2008. The CGIAR Systemwide Livestock Program Sub-Saharan Africa Feed Composition Database (ILRI Lab Data). Web-site (http://www.vslp.org)

IPMS (Improving Productivity and Market Success of Ethiopian Farmers), 2007. Burie pilot learning woreda diagnosis and program design: Final draft. 95p.

IPMS (Improving Productivity and Market Success of Ethiopian Farmers), 2008. Burie Woreda IPMS Office.

Kassahun Awgichew, 2000. Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding conditions. A PhD thesis presented to Humboldt University of Berlin. 130p.

Kassahun Awigchew, Getachew Gebru, Zelalem Alemayehu, Negussie Akalework and Ian Fletcher, 1991. Small ruminant production in Ethiopia: Constraints and future prospects. Pp. 37 – 48. Proceedings of the third national livestock improvement conference. Addis Ababa, Ethiopia. 24 – 26 May 1989, Institute of agricultural Research.

Kassahun Awgichew and Solomon Abegaz, 2008. Breeds of sheep and goats. Pp. 5 – 26. In: Alemu Yami and R.C. Merkel (eds). Sheep and goat production handbook for Ethiopia. Ethiopian sheep and goat productivity improvement program.

Kebreab, E., T. Smith, J. Tanner and P. Osuji, 2005. Review of undernutrition in smallholder ruminant production systems in the tropics. Pp. 3 – 94. In: Ayantude A.A., Fernandez-Rivera S. and McCrabb G. (eds). Coping with feed scarcity in smallholder livestock systems in developing countries, Animal sciences group, Wageningen UR, Wageningen, The Netherlands, University of Reading, Reading UK, eth (Swiss Federal Institute of Technology), Zurich, Switzerland and ILRI (International Livestock Research

Institute), Nairobi, Kenya, 306p.

Low, Allan R.C., 1989. Allan Low Agricultural Development in Southern Africa, farm-household Economics and the food crisis. James Currey, UK. 217p.

Lulseged Gebrehiwot and Hailu Kenno, 1985. Studies on the carrying capacity of natural pasture using crossbred cattle and local sheep. *Ethiopian Journal of Agricultural Sciences*. 7(1): 35 – 48.

Markos Tibbo, 2006. Productivity and health of indigenous sheep breeds and crossbreds in the central Ethiopian Highlands. PhD thesis, Swedish University of Agriculture, Uppsala. 76p.

McDonald, P., R.A. Edwards, J.F.D. Greenhalgh and C.A. Morhan, 2002. Animal Nutrition. 6th edition. Prentice Hall, London. 693p.

Mettrick, Hal, 1993. Development oriented research in agriculture. An ICRA Textbook. ICRA (The International Centre for Development Oriented Research in Agriculture). Wageningen, The Netherlands. 291p.

MOA (Ministry of Agriculture), 2000. Agro-ecological Zones of Ethiopia. Natural resources management and regulatory department, Ministry of Agriculture, Addis Ababa. 129p.

Montgomery, C. Douglas, 2001. Design and analysis of experiments. 5th edition. John Wiley and Sons, Inc., New York. 684p.

Muturi, Stachys N., Julius K. Kilungo, Kavoi M. Muendo, Zacharia Mairura and Joseph G. Kariuki, 2001. Marketing of smallholder produce: A synthesis of case studies in the highlands of central Kenya. RELMA Technical paper series 26. Regional land management unit (RELMA), Swedish International Development Cooperation Agency (SIDA). Nairobi, Kenya. 53p.

OoARD (Office of Agriculture and Rural Development), 2007. Burie Woreda Office of Agriculture and Rural Development

Osuji, P. O., I.V. Nsahlai and H. Khalili, 1993. Feed evaluation. ILCA Manual 5. ILCA (International Livestock Centre for Africa), Addis Ababa. 40 pp.

Owen, E., A. Kitalyi, N. Jayasuriya and T. Smith, 2005. Livestock and Wealth Creation. Nottingham University Press, Hampshire. 601p.

Perry, T.W., Arthur E. Cullison and Robert S. Lowrey, 2003. Feeds and Feeding. 6th edition. Prentice Hall. 675p.

Pond, W.G., D.C. Church and K.R. Pond, 1995. Basic Animal Nutrition and Feeding. John

Wiley and Sons, New York. 615p.

Preston, T.R., 1986. Better utilization of crop residues and by-products in animal feeding: Research guidelines. FAO, Italy. 154p.

Ranjhan, S.K., 1997. Animal Nutrition in the Tropics. 4th revised edition. Vikas Publishing House PVT LTD, New Delihi. 553p.

Roeleveld, A.C. and A. Van den Broek, 1996. Focusing livestock systems research. Royal tropical institute, Amsterdam. 150p.

Sansthan, L.P. and Ilse KÖhler-Rollefson, 2005. Indigenous breeds, local communities: Documenting animal breeds and breeding from a community perspective. Mudra, India. 66p.

Seyoum Bediye and Zinash Sileshi, 1989. Feeding value of some Ethiopian Feedstuffs. Pp. 179 – 185. Proceedings of the second national livestock improvement conference. Addis Ababa, Ethiopia, 24 – 26 February 1988, IAR (Institute of Agricultural Research).

Simret Betsha, 2005. Supplementation of graded levels of peanut cake and wheat bran mix on the utilization and carcass parameters of Somali Goats. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University. 60p.

Sisay Lemma, 2002. Phenotypic classification and description of indigenous sheep types in Amhara National Regional State of Ethiopia. An Msc Thesis Presented to the University of Natal. 106p.

Solomon Abegaz and Gemeda Duguma, 2002. Level and effect of inbreeding in a flock of Horro sheep at Bako Research Center. *Eth. J. Animal production* 2(1):59 – 70.

Solomon Abegaz, Gemeda Duguma, Takele Kumsa, Birhanu Soboka, Dereje Bacha, Bizunesh Mideksa, Fayo Dubiso, Ulfina Galmessa and Birhan Feleke, 2005. On-farm verification of sheep finishing technology in Eastern Wollega Zone. Pp. 241- 246. Proceedings of the 12th annual conference of the Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia, 12 – 14 August 2004, ESAP (Ethiopian Society of Animal Production).

Solomon Gizaw, 2008. Sheep resources of Ethiopia: Genetic diversity and breeding strategy. A PhD Thesis Presented to Wageningen University. 145p.

SPSS (Statistical Package for Social Sciences), 2003. SPSS 12.0 for Windows, SPSS Inc.

Tekleyohannes Berhanu and Worku Jima, 2000. The effect of undersowing barley with forage legumes on grain and straw fields and herbage yield of forage legumes in the highlands of Bale. Pp. 241 – 246. Proceedings of the 7th annual conference of the

Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia, 26 – 27 May 1999, ESAP (Ethiopian Society of Animal Production).

Teferra Gebre Meskel and Abaye Tedla, 1995. Development opportunities in animal agriculture. Pp. 91 – 110. Proceedings of the second annual conference of the Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia, 26 – 27 May 1993, ESAP (Ethiopian Society of Animal Production).

Tesfaye Hagos, 2007. Supplementation of Afar Rams with graded levels of mixs of protein and energy sources: Effects on feed intake, digestibility, live weight and carcass parameters. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University. 82p.

Tilley, J.M. and R.A. Terry, 1963. A two-stage technique for the *in-vitro* digestion of forage crops. *J. Br. Grassland Soc.* 18:104-111.

Tingshuang, G., Manuel D. S., Guo P. Y., 2002. Animal production based on crop residues: Chinese experiences. FAO, Rome. 210p.

Upton, M., 1979. Farm management in Africa: The principle of production and planning. Oxford University Press, Great Britain. Pp. 282 – 298.

Van Soest, P.J., and J.B. Robertson, 1985. Analysis of forages and fibrous foods. A Laboratory Manual for Animal Science 613. Cornel University. 202p.

Zinash Sileshi and Seyoum Bediye, 1991. Utilization of feed resources and feeding systems in the central zone of Ethiopia. pp. 129 – 132. Proceedings of the third national livestock improvement conference. Addis Ababa, Ethiopia. 24 – 26 May 1989, Institute of agricultural Research.

7. APPENDICES

7.1. APPENDIX TABLES

Appendix Table 1. Key to sub agro-ecological zones in Burie Woreda

Name of the Sub agro-ecological zone	Altitude range (masl)	Mean annual temperature (ºC)	Mean Annual rainfall (mm)	Estimated mean annual evapotranspiration (mm)
M1-4	1000 – 2000	16 – 28	600 – 1600	1500 – 2000
M2-5	2000 - 3600	11 – 16	1000 – 1800	1300 – 1850

Source: MOA (2000)

Appendix Table 2. Number of individuals interviewed per study kebele in Burie Woreda during the sheep informal survey

Name of kebele	Number of individuals interviewed	Number of key informants interviewed	Number of individuals present in the group interview
Woheni Durebetie	3	2	8
Woyenema Ambaye	3	2	10
Denbun	3	2	7
Boko Tabo	3	2	9

Appendix Table 3. Number of individuals interviewed per study kebele in Burie Woreda during the goat informal survey

Name of kebele	Number of individuals interviewed	Number of key informants interviewed	Number of individuals present in the group interview
Woheni Durebetie	2	2	5
Woyenema Ambaye	2	2	5
Denbun	2	2	5
Boko Tabo	2	2	5

Appendix Table 4. Total area, crop land area and grazing land area in the study kebeles in Burie Woreda

Type of Area	Woheni Durebetie	Woyenema Ambaye	Denbun	Boko Tabo
Total area of kebele (ha)*	1412	1622	2465	1675
Crop land area (ha)*	1237	1352	2114	845
Grazing land area (ha)*	122	124	320	50
Number of households per kebele**	1264	1252	1116	488
Communal grazing land area per household (ha)	0.097	0.099	0.287	0.102

**Source: IPMS (2007)

*Source: Kebele development agents

Appendix Table 5. Human population of the study kebeles in Burie Woreda

Kebele	Total human population	Males	Females	No. of households	Average family size
Woheni Durebetie	8950	4375	4575	1150	5
Woyenema Ambaye	9181	4054	5127	1209	6
Denbun	7556	4231	4325	1108	4
Boko Tabo	2667	1765	902	332	6

Source: Kebele development agents

Appendix Table 6. Sheep and goat population of the study kebeles in Burie Woreda

Kebele	Sheep population	Goat population
Woheni Durebetie	2394	242
Woyenema Ambaye	4455	463
Denbun	1101	292
Boko Tabo	1566	2460

Source: IPMS (2008)

Appendix Table 7. Mean body weight of sheep in the different age groups in the study Kebeles of Burie Woreda

Estimated age (year)	Name of kebele	Mean BW (kg)	Std. Deviation	N
	Woheni Durebetie	14.5	4.94	158
	Woyenema Ambaye	14.4	5.77	165
< 1	Denbun	17.1	6.16	185
	Boko Tabo	14.9	6.82	172
	Total	15.3	6.08	680
	Woheni Durebetie	23.7	3.35	25
	Woyenema Ambaye	23.1	2.87	24
1 - 2	Denbun	29.5	4.83	24
	Boko Tabo	28.8	6.53	41
	Total	26.6	5.65	114
	Woheni Durebetie	27.8	3.48	53
	Woyenema Ambaye	25.7	4.75	23
2	Denbun	28.9	4.41	17
	Boko Tabo	32.8	5.72	26
	Total	28.6	5.01	119
	Woheni Durebetie	28.9	4.38	8
	Woyenema Ambaye	28.0	3.92	21
3	Denbun	30.3	6.09	15
	Boko Tabo	33.7	4.96	23
	Total	30.6	5.35	67
	Woheni Durebetie	31.3	3.92	59
	Woyenema Ambaye	28.5	5.26	67
> 3	Denbun	33.1	6.17	59
	Boko Tabo	34.3	6.21	46
	Total	31.6	5.82	231
	Woheni Durebetie	21.2	8.50	303
	Woyenema Ambaye	20.1	8.31	300
Total	Denbun	22.6	9.20	300
	Boko Tabo	22.5	10.90	308
	Total	21.6	9.34	1211

Appendix Table 8. Mean body weight of the sheep breeds by age group in the study kebeles of Burie Woreda

Breed of the animal	Estimated age (year)	Mean BW (kg)	N	Std. Deviation
Washera	< 1	15.9	279	5.52
	1 - 2	24.8	42	4.34
	2	27.9	58	3.66
	3	29.2	17	4.39
	> 3	30.7	98	5.22
	Total	21.5	494	8.28
Horro	< 1	14.0	233	6.77
	1 - 2	27.5	49	5.82
	2	31.1	35	6.27
	3	31.8	30	5.77
	> 3	31.9	77	5.87
	Total	21.5	424	10.50
Crossbred	< 1	16.0	168	5.72
	1 - 2	28.4	22	6.74
	2	26.9	26	4.65
	3	29.9	20	5.24
	> 3	32.7	55	6.60
	Total	22.0	291	9.30
Unknown	1 - 2	23.0	1	.
	> 3	27.4	1	.
	Total	25.2	2	3.11
Total	< 1	15.3	680	6.08
	1 - 2	26.6	114	5.65
	2	28.6	119	5.01
	3	30.6	67	5.35
	> 3	31.6	231	5.82
	Total	21.6	1211	9.34

Appendix Table 9. Mean body weight of goats in different age and sex groups in the study kebeles of Burie Woreda

Estimated age (year)	Sex of the animal	Mean BW (kg)	N	Std. Deviation
< 1	Male	13.8	44	5.53
	Female	11.2	65	4.59
	Total	12.3	109	5.12
1	Male	19.0	1	.
	Total	19.0	1	.
1 to 2	Male	24.6	7	7.37
	Female	22.9	21	3.06
	Total	23.3	28	4.42
2	Male	36.5	2	2.12
	Female	26.4	27	5.21
	Total	27.1	29	5.67
3	Male	41.5	4	3.87
	Female	28.5	19	6.80
	Total	30.7	23	8.09
> 3	Male	39.3	4	9.36
	Female	31.3	54	4.34
	Total	31.8	58	5.12
Total	Male	19.2	62	11.20
	Female	22.3	186	9.75
	Total	21.6	248	10.20

Appendix Table 10. Mean body weight of goats in different age groups in the study kebeles of Burie Woreda

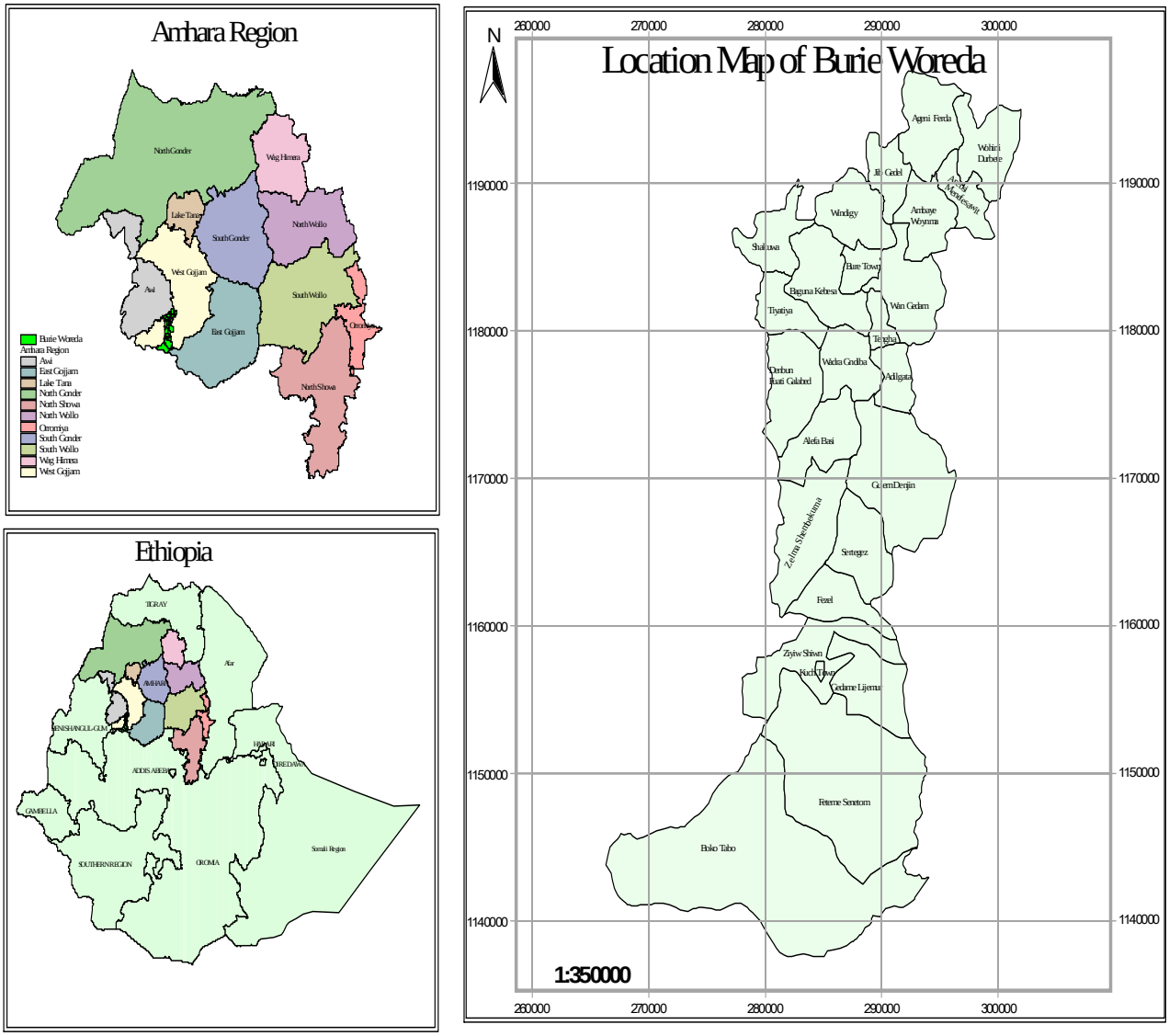
Estimated age (year)	Name of kebele	Mean BW (kg)	N	Std. Deviation
< 1	Woheni Durebetie	13.6	15	6.14
	Woyenema Ambaye	12.1	29	5.47
	Denbun	12.0	29	3.84
	Boko Tabo	12.1	36	5.41
	Total	12.3	109	5.12
1	Woheni Durebetie	19.0	1	.
	Total	19.0	1	.
1 to 2	Woheni Durebetie	25.1	8	5.08
	Woyenema Ambaye	24.5	10	1.96
	Denbun	20.8	6	6.08
	Boko Tabo	20.5	4	2.52
	Total	23.3	28	4.42
2	Woheni Durebetie	29.0	3	5.29
	Woyenema Ambaye	30.7	3	7.51
	Denbun	28.5	14	4.80
	Boko Tabo	23.1	9	5.13
	Total	27.1	29	5.67
3	Woheni Durebetie	27.9	9	8.62
	Woyenema Ambaye	32.0	6	8.25
	Denbun	33.0	8	7.37
	Total	30.7	23	8.09
> 3	Woheni Durebetie	30.5	25	6.93
	Woyenema Ambaye	32.1	14	3.25
	Denbun	33.5	6	2.88
	Boko Tabo	33.2	13	2.59
	Total	31.8	58	5.12
Total	Woheni Durebetie	25.0	61	9.49
	Woyenema Ambaye	21.4	62	10.42
	Denbun	21.2	63	10.27
	Boko Tabo	18.7	62	9.80
	Total	21.6	248	10.20

Appendix Table 11. Conversion factor of different livestock species into Tropical Livestock Unit (TLU)

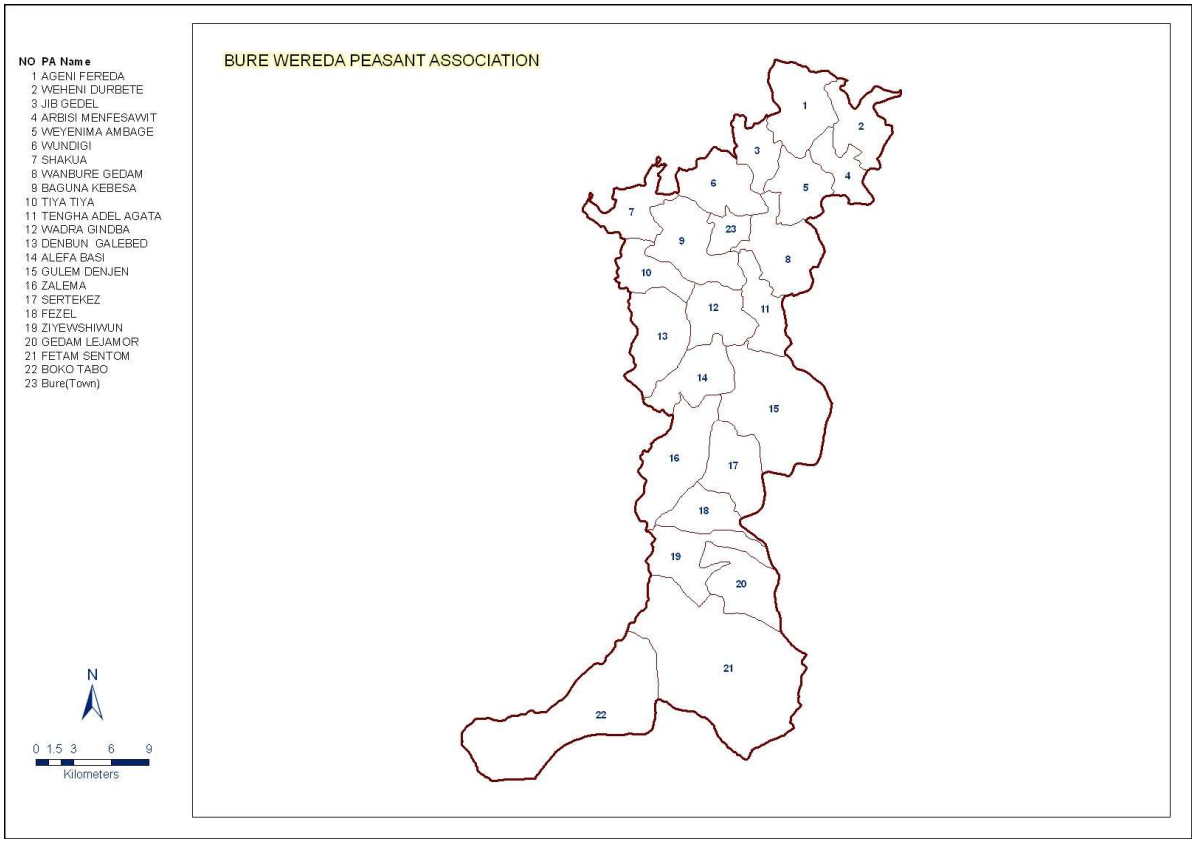
Livestock species	Conversion factor (head TLU)
Cattle	0.7
Sheep	0.1
Goats	0.1
Horses	0.8
Mules	0.7
Donkeys	0.5

Source, ILCA (1990)

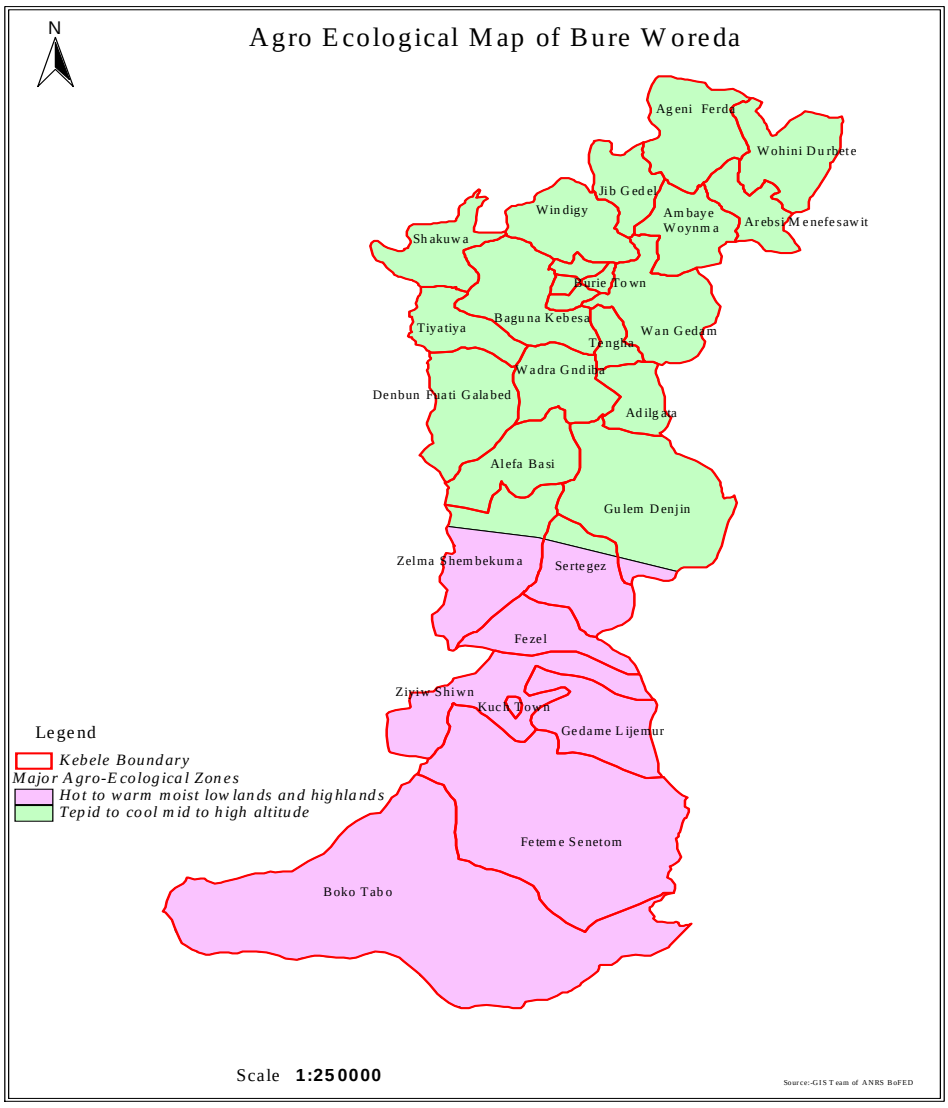
7.2. APPENDIX FIGURES



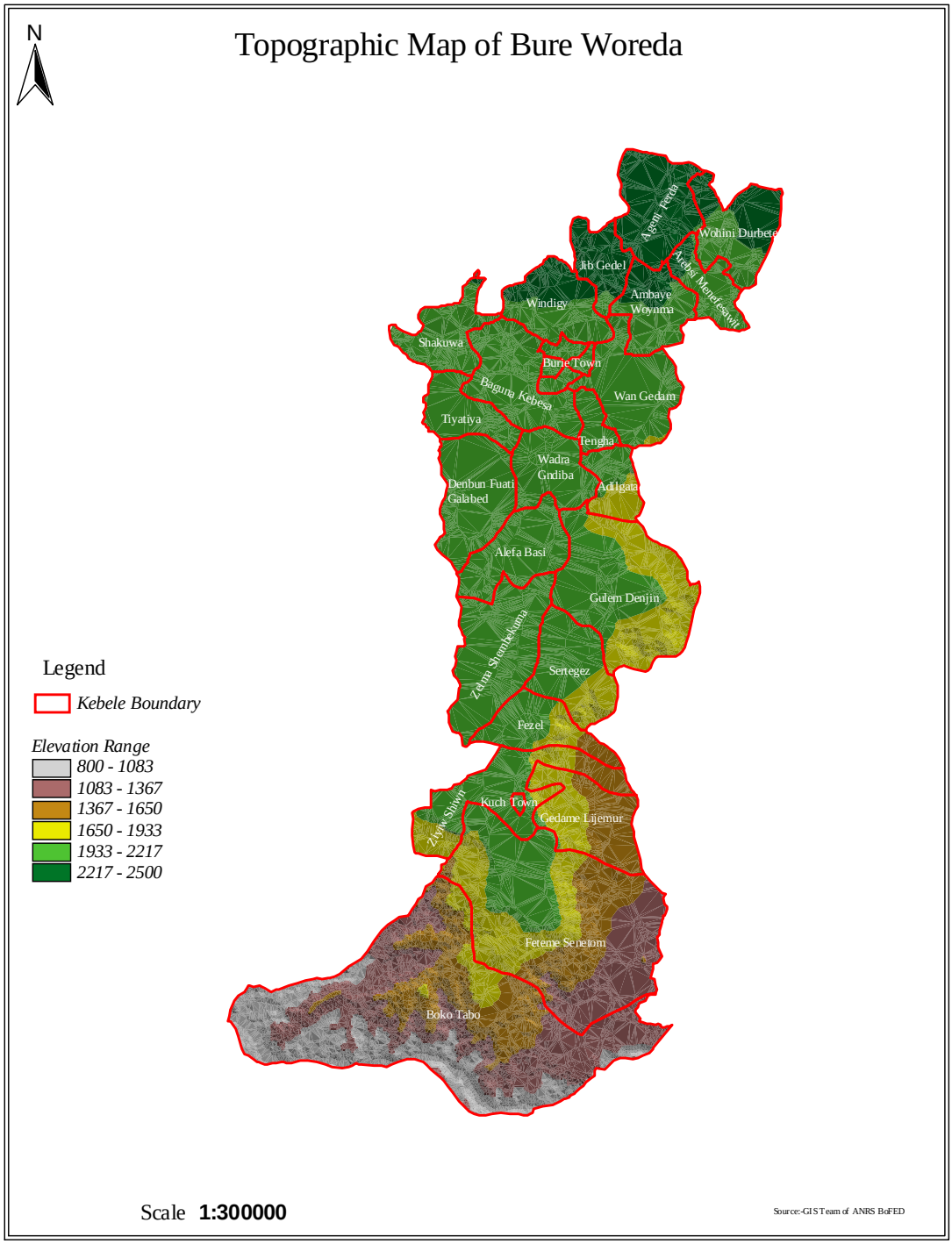
Appendix Figure 1. Map showing location of Burie Woreda in Ethiopia and Amhara National Regional State



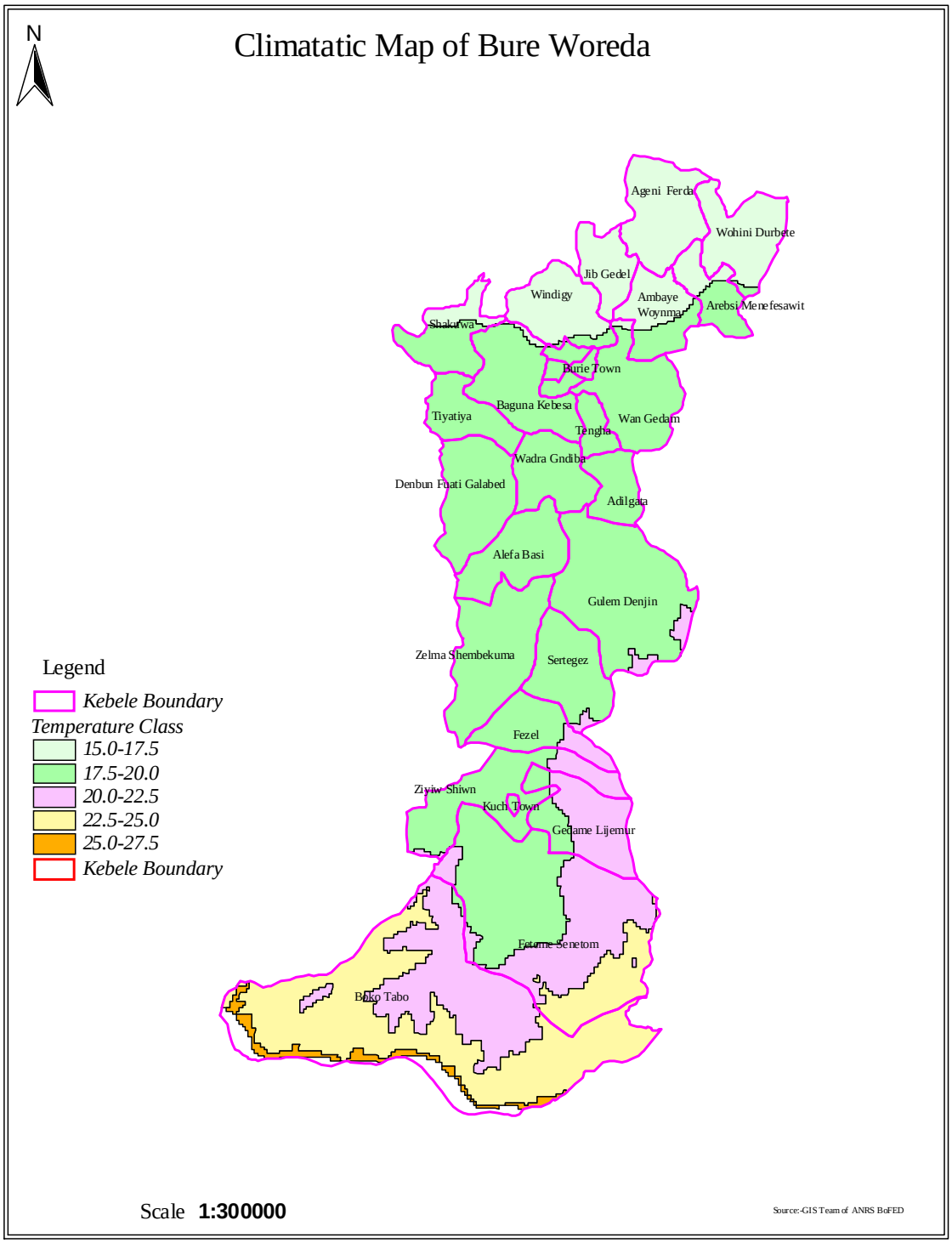
Appendix Figure 2. Map of Burie Woreda showing location of kebeles



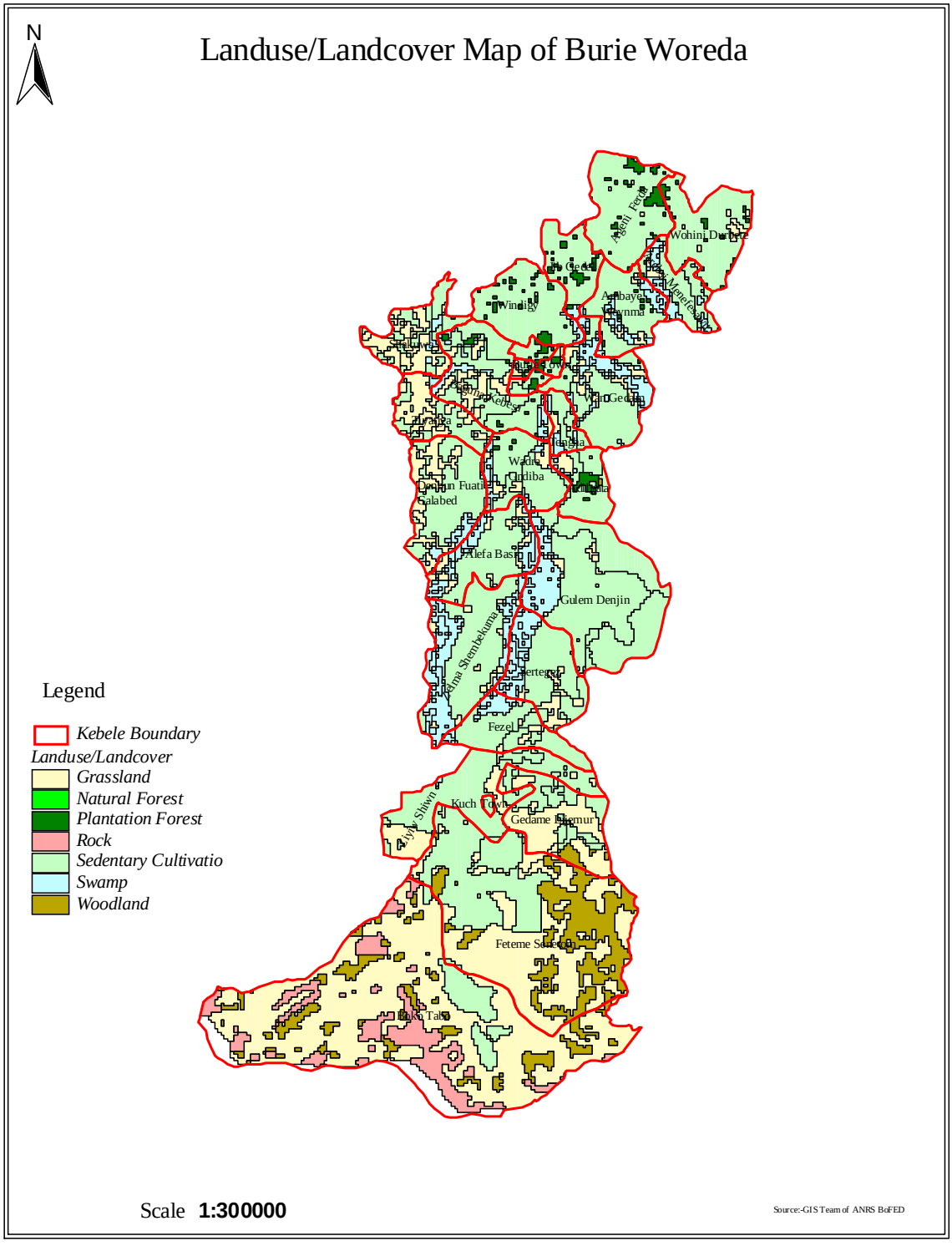
Appendix Figure 3. Sub agro-ecological zones in Burie Woreda



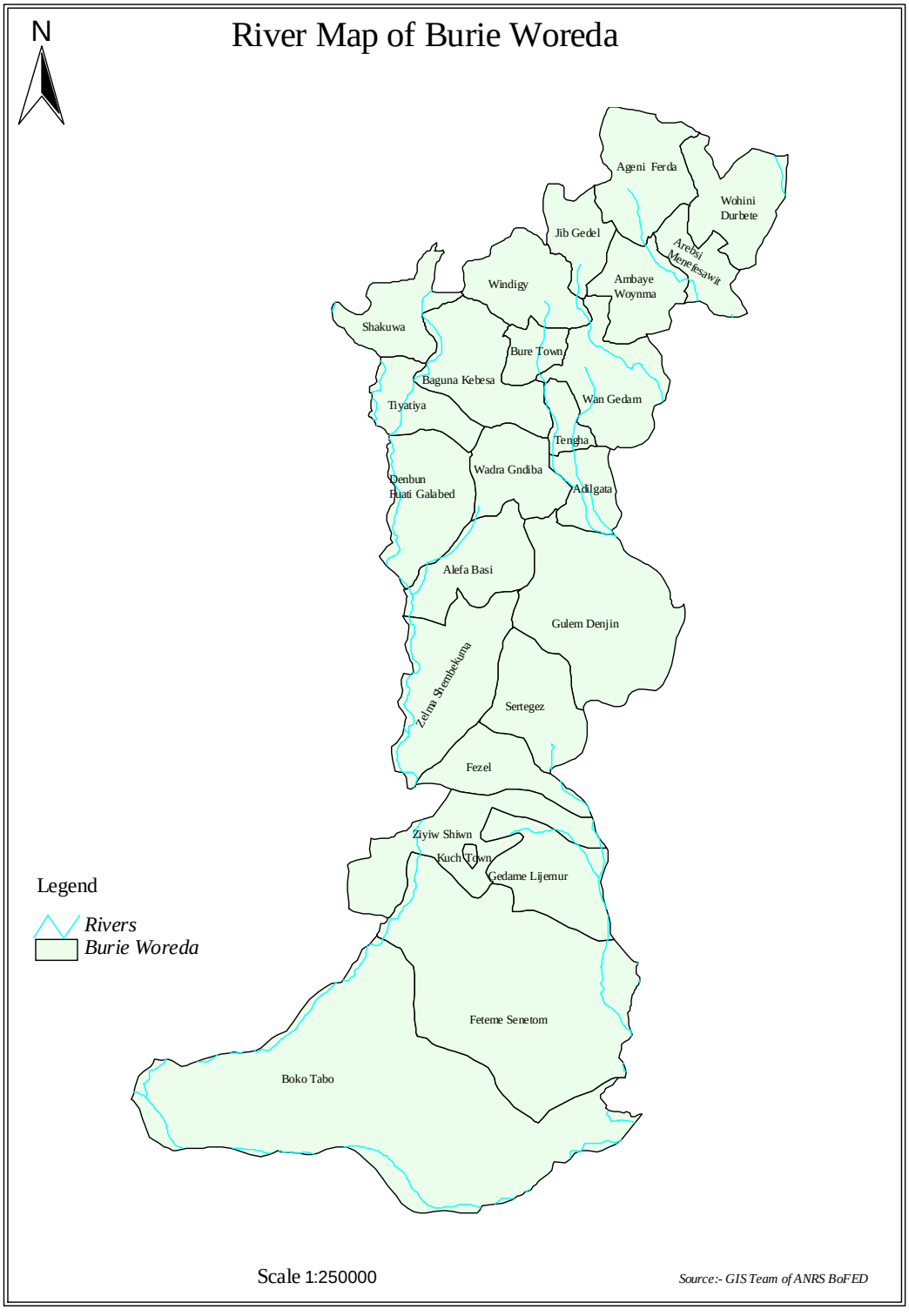
Appendix Figure 4. Map showing altitude range (in masl) of kebeles in Burie Woreda



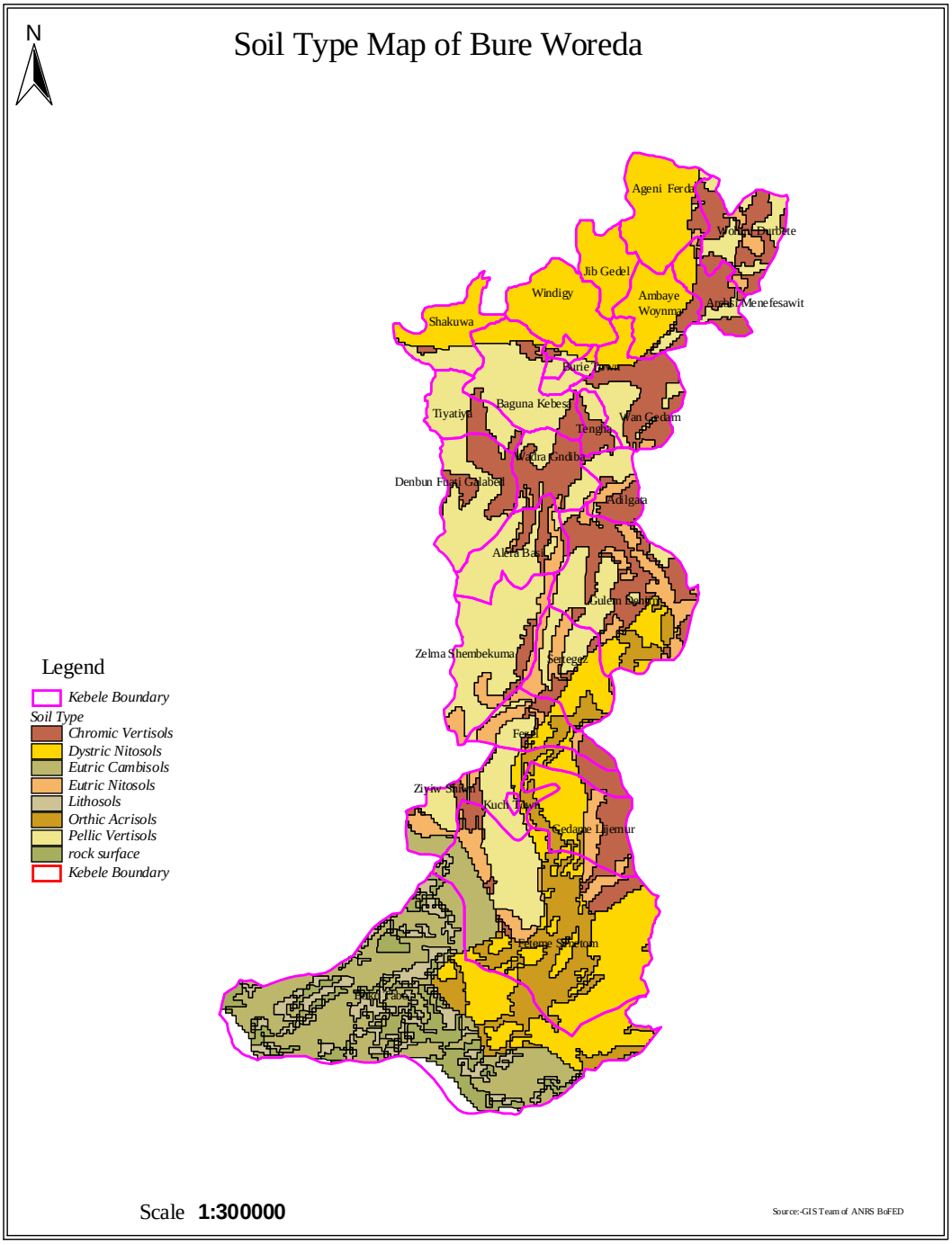
Appendix Figure 5. Map showing temperature class of kebeles in Burie Woreda



Appendix Figure 6. Map showing land use of kebeles in Burie Woreda



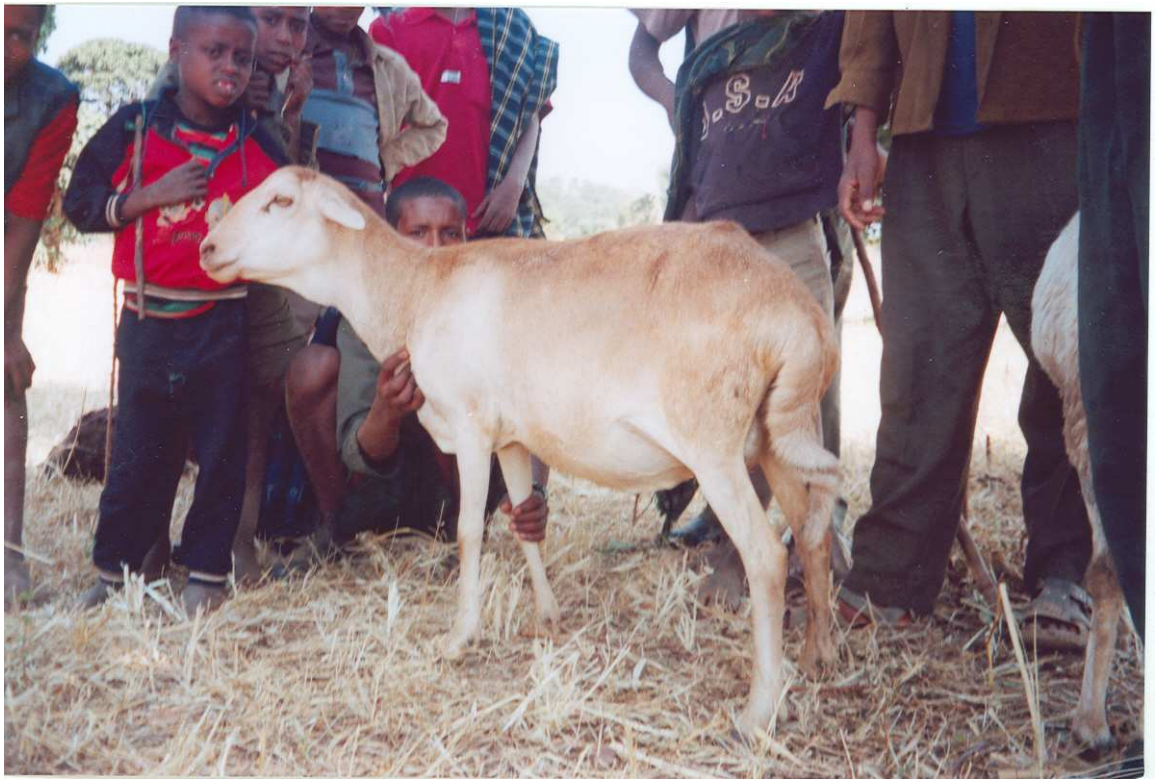
Appendix Figure 7. Map showing rivers in Burie Woreda



Appendix Figure 8. Map showing soil types in Burie Woreda

Appendix Figure 9. Washera Sheep in Woheni Durebetie Kebele in Burie Woreda

Appendix Figure 10. Horro Sheep in Boko Tabo Kebele in Burie Woreda



Appendix Figure 11. Crossbred sheep in Denbun Kebele in Burie Woreda

Appendix Figure 12. Sheep grazing on the overgrazed natural pasture in Woyenema Ambaye Kebele in Burie Woreda

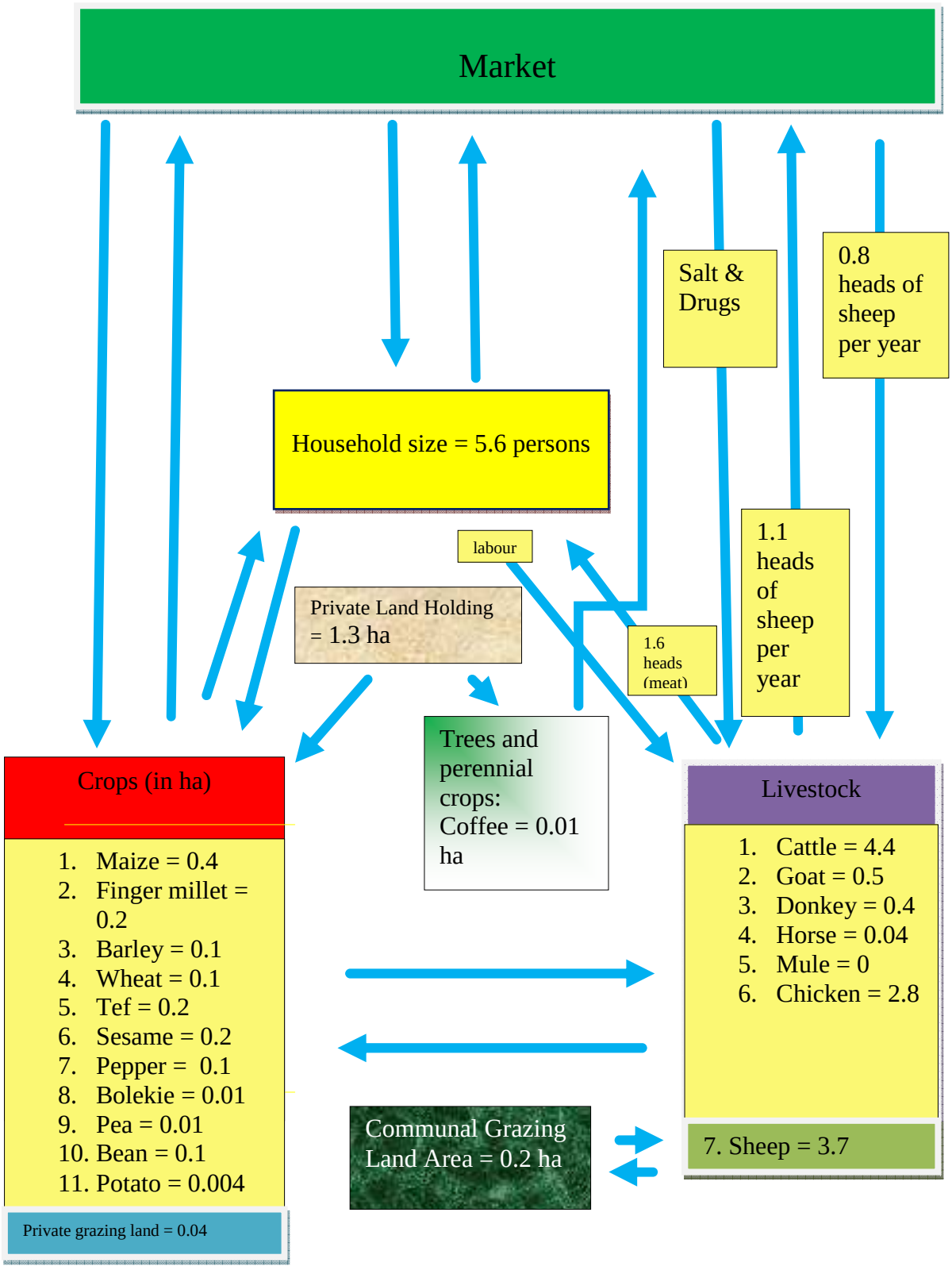
Appendix Figure 13. Sheep grazing on the overgrazed natural pasture in Woheni Durebeite Kebele in Burie Woreda

Appendix Figure 14. Goat types in Woheni Durebetie Kebele in Burie Woreda

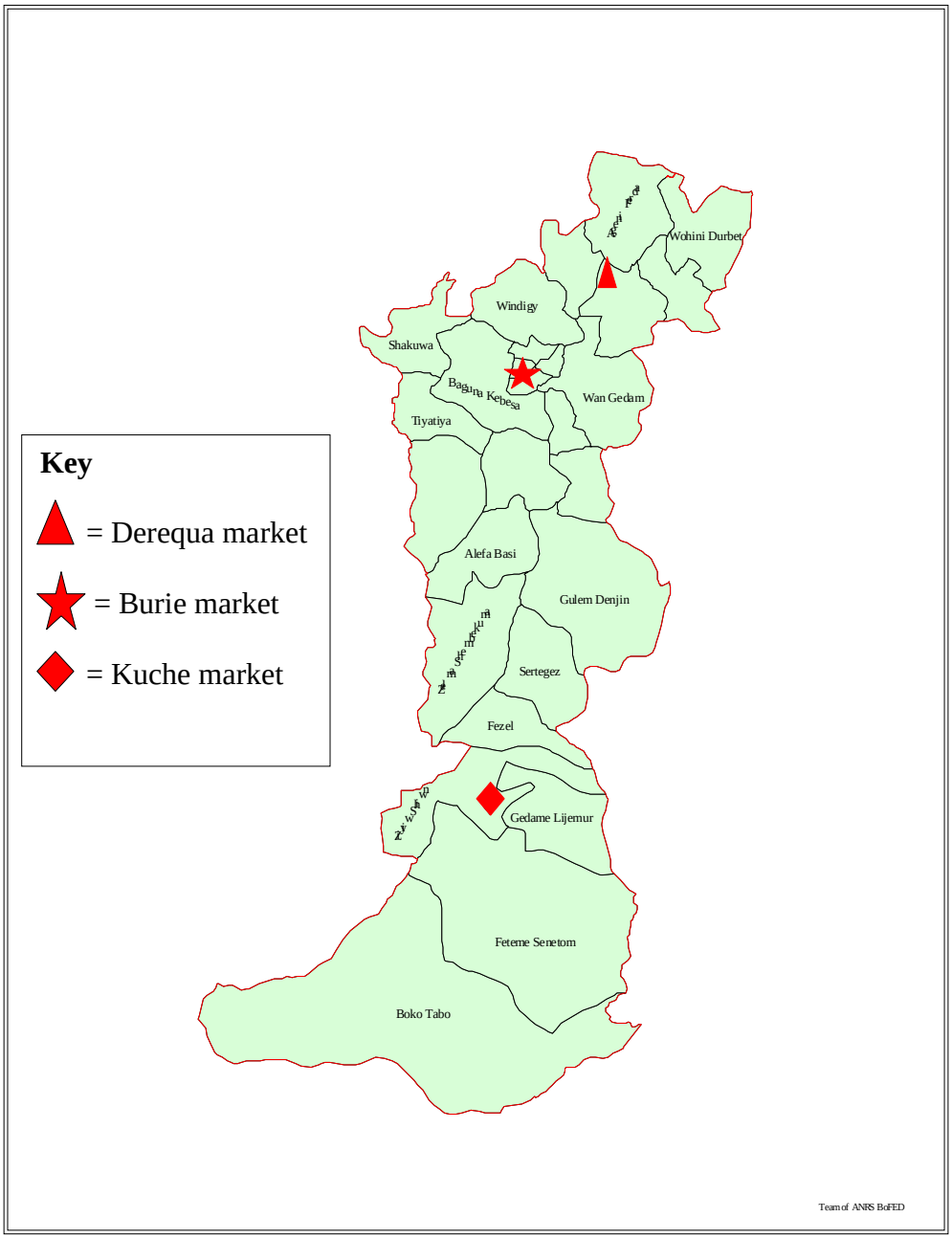
Appendix Figure 15. Goat types in Woyenema Ambaye Kebele in Burie Woreda

Appendix Figure 16. Goat types in Denbun Kebele in Burie Woreda

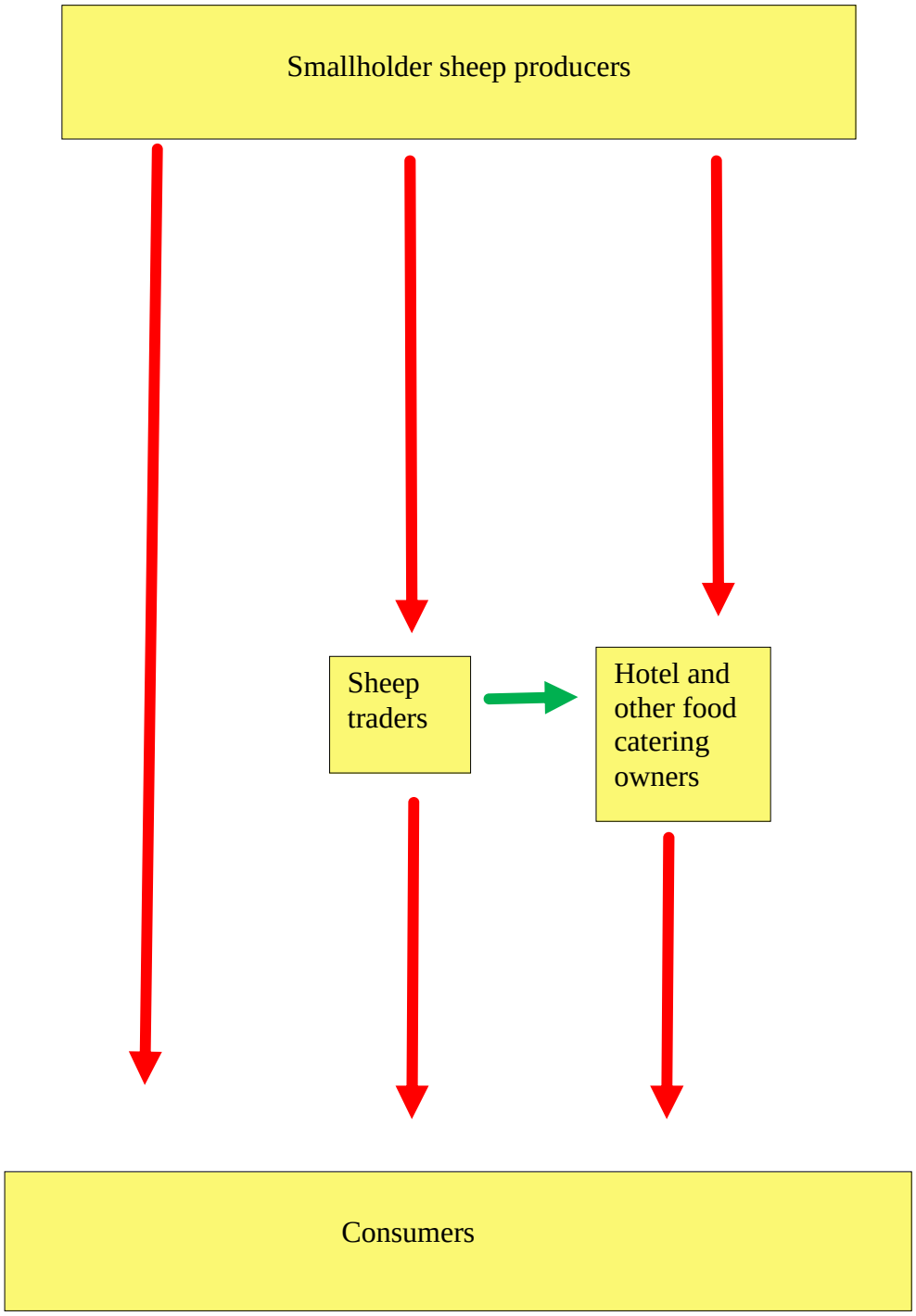
Appendix Figure 17. Goat types in Boko Tabo Kebele in Burie Woreda



Appendix Figure 18. Model of the farming system in Burie Woreda



Appendix Figure 19. Approximate location of small ruminant market places in Burie Woreda



Appendix Figure 20. Marketing channels in sheep marketing in Burie Woreda

Appendix Figure 21. Map showing location of woredas of Amhara National Regional State

Appendix 3. Checklist used for the informal survey study

A. Personal data

1. Date ----------
2. Name of kebele ----------
3. Name of respondent ----------
4. Type of respondent ----------
5. Sex ----------
6. Age ----------
7. Educational level ----------
8. Marital status ----------
9. Religion ----------
10. Number of years he has lived in the kebele ----------

B. General farm data

1. Land holding per HH in the kebele (Crop land)
2. Trends in size of crop land owned per HH? And causes for the trend?
3. Crops grown and area allocated for each crop per HH (ranked by area & species grown)
4. Which varieties are recently introduced?
5. Which recently introduced varieties are expanding?
6. Soil types in the area and their local name
7. Trend in soil fertility and its causes
8. Measures taken to increase soil fertility
9. Main constraints in crop production
10. Type of livestock species reared in the area and number of livestock per HH,
11. Trends in livestock production and productivity (number, yield per animal, and reproduction). Causes for the trend?
12. Feed resources for livestock (in dry and wet season)
13. Trends in feed availability (size and yield of natural pasture)
14. Where do they buy and sell livestock?
15. Main constraints in livestock production

16. Water sources:
    a. Human consumption
    b. Livestock watering
17. Sources of cash income (ranked by degree of importance)
18. Off-farm activities in the area

C. Breeds and breeding of sheep/ goat

1. For what purpose do they rear sheep/ goat?
2. How many sheep/ goat do they own per HH?
3. Breed/ type of sheep/ goat in the area (type and local name)
4. Are they recently introduced or reared for a long time?
5. Which ones are recently introduced?
6. Do they practice selection of breeding animals (male, female or both)?
7. Which phenotypic characteristics do they prefer? (male, female)
8. Do they practice culling of undesirable animals?
9. Castration of animals
10. Productivity of animals currently (size, condition and reproduction compared to the previous ones)

D. Feed resources and feeding sheep/ goat

1. Feed resources for sheep/goat in each season:

No.	June – Aug.	Sep. - Nov.	Dec. – Feb.	Ma. – May
1				
2				
3				
4				
5				

2. Types of grazing area present in the area (private, communal)

3. Area of natural pasture and its current status, causes for its present status
4. Do they have private grazing land?
5. If so, for what purpose do they use it (for grazing or hay making)?
6. Feed scarcity period (months) in the area
7. What do they do to overcome the feed shortage problem
8. Feed abundance period
9. Do they grow improved forages
10. If yes, which ones (list)
11. If no, why?
12. Do they feed improved forages to their sheep/ goat? What, When and how?
13. Do they feed their sheep/ goat concentrates? If yes, what, when, how and how much?
14. Major crop residues used for sheep/ goat feeding?
15. What do they feed kids/ lambs before weaning?
16. Feeding of kids/ lambs after weaning
17. Do they fatten sheep/ goat?
18. If so, in which season?
19. Feeds used and amount offered per head per day?
20. Type of animal used for fattening (age and sex)

a. Anthelminitics before fattening
b. Castration before fattening
c. Selection of animals for fattening
d. Purpose of fattening (sale or home consumption)
e. Constraints encountered in fattening

21. Source of water for animals

a. dry season
b. Are the sources permanent or seasonal
c. Distance of watering points from the farmers residence
d. Is there water shortage problem in the area
e. If yes, in which season?
f. How do they overcome the water shortage problem?
g. Frequency of watering animals per day (dry season)
h. Who is responsible for watering of animals

E. Housing of animals

1. Type of house used for sheep/ goat in the area
2. Do they house animals according to age and sex groups?
3. What are the types of materials used for house construction?
4. Cleaning of sheep/ goat houses

F. Disease and disease control

1. What are the common sheep and goat diseases in the area?

No.	Disease (local name)	Symptoms	Age groups mostly affected	Season of occurrence
1				
2				
3				
4				
5				

2. What do they do when their sheep/ goat get sick?
3. Do they get their animals vaccinated? If so, against what diseases?
4. If no, why?
5. Locally used medicine for sheep and goat (for which disease and what type of traditional medicine)
6. Is there veterinary clinic in the kebele?
7. Do they take sick animals to the vet clinic?
8. If no, why?
9. Do the veterinary clinics have enough:

a. personnel

b. drugs, etc

G. Milking of Animals

1. Do they milk sheep/ goat in the area?
2. If so, for what purpose?

H. Animal slaughter per HH

1. In which occasions do they slaughter animals?
2. Which type of animals do they slaughter (age and sex)?
3. Preferred colour?
4. How many sheep/ goats do one HH slaughter per year?
5. Are they home reared or purchased from the market?

I. Herding of animals

1. Do they herd their animals?
2. Purpose of herding the animals
3. If so, how long per day?
4. Is there communal or individual herding?
5. Do they herd their animals year-round?
6. If no, in which months do they herd their animals? Why?
7. Who is responsible for herding?

J. Marketing

1. List of the markets and market days in their area
2. Distance from the farmers residences (km/ hr)?
1. Do they sell sheep and goats?
2. Means of transportation
3. How many animals do they sell per year per HH?
4. In which season do they mostly sell? Why?
5. Where do they sell their animals?
6. Where do they buy animals for breeding or for home slaughter?
7. Who is responsible for the sell of sheep/ goat?

8. Categories of animals mostly sold (age and sex group)
9. Why do they sell these age groups mostly?
10. Price fluctuation during the year (high and low price seasons)
11. Problems encountered in marketing sheep/ goat

K. Constraints

1. What are the major sheep/ goat production constraints in the area?
2. Priority of the constraints in the area (rank: based on area coverage and degree of severity)?
3. What are the main causes for these constraints?
4. In which season the constraints occur

L. Solutions to constraints

1. What do they think are the possible solutions to alleviate the major sheep/ goat production constraints in the area?

Appendix 4. Questionnaire used for the sheep/ goat production system study (Formal survey study)

A Questionnaire Prepared for Farmers' Interview for IPMS Financially Supported Sheep/ Goat Production System Study in Burie Woreda

Note to the enumerator*: Before filling the questionnaire, please ask the interviewee for his convenient place and time for the interview. In addition, during filling the questionnaire, please do it calmly, listen attentively and write legibly. Finally, before leaving the interviewee please check out that all questions have been asked and answered fully. In this questionnaire last year means the time b/n 01.12.1999 to 30.12.2000 E.C.*

I. Data collection

1. Name of enumerator ----------
2. Date of data collection ----------
3. Starting time for data collection ----------
4. Ending time for data collection ----------
5. Questionnaire number ----------

II. Household Data

1. Name of the interviewee ----------
2. Sex 1. Male 2. Female
3. Age ----------
4. Educational status a. illiterate b. literate /1 – 4 / c. literate /5 – 8 / d. literate /9 – 12 / e. other /specify/ _____
5. Religion a. Orthodox Christian b. Muslim c. Protestant d. other (specify) ----------
6. Ethnic group a. Amhara b. Oromo c. other (specify) ----------
7. Kebele ----------
8. Gote ----------

9. List of family members (including household head)

No.	Name of family member	Sex 1. Male 2. Female	Age	Educational status 1. Illiterate 2. Literate /1 – 4/ 3. Literate /5 – 8 / 4. Literate /9 – 12 / 5. Other (specify)	Relationship with household head 1. Household head 2. Wife 3. Child 4. Relative 5. Non-relative
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

III. General Household Data

1. Do you have land for crop production? a. yes b. no
2. If your answer is yes, how much land do you own? (In *Gemed*) ----------
   ----
3. From the above mentioned total amount of land, do you have rented land? a. yes b. no
4. If your answer is yes, how much is the area of the rented land? (In *Gemed*)
   ----
5. From the above mentioned total amount of land, do you have sharecropped land? a. yes b. no

6. If your answer is yes, how much is the area? (In *Gemed*) ----------
   ----
7. From the above mentioned total amount of land, how much is the area of your private land? (in *Gemed*) ----------
8. Do you have private grazing land from your privately owned land area?
   a. yes b. no
9. If your answer is yes how much is the area of your private grazing land? (in *Gemed*) ----------
10. What type of crops do you grow in your own land, please specify?
    (Please start from the more land devoted crop to the less land devoted crop in 2000/ 2001 E.C. Production year)

No.	Type of crop grown	Area of land allocated for the crop (in *Gemed*)	Variety grown
1			
2			
3			
4			
5			

11. What type of livestock species do you rear currently?

No.	Livestock species	Total number	Male	Female
1	Cattle			
1.1	Calf			
1.2	Bullock			
1.3	Heifer			
1.4	Ox			
1.5	cow			
2	Sheep			
3	Goat			
4	Horse			
5	Mule			
6	Donkey			
7	Chicken			
8	Bee colonies			

12. Please describe the characteristics of the sheep you currently own?

No.	Colour of sheep	Sex of sheep 1. Male 2. Female	Age of the sheep	Breed of the sheep 1. Washera 2. Horro 3. Crossbred
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

IV. Breeds and breeding of sheep

1. For what purpose do your rear sheep? a. for home slaughter b. for sale and cash income c. other (specify) ----------
2. From where did you get the first sheep you rear now?
   a. purchased from the market b. gift from parents/ relatives c. other (specify) ----------
3. Which type of sheep breed do you prefer to rear most? a. Horro b. Washera c. Crossbreds
4. Why? ----------
5. Do you have ram in your home currently? (If the answer is no go to question number 8) a. yes b. no

6. If you have ram(s), how many? ----------
7. If you have ram(s), please specify their characteristics?

No.	Colour of the ram	Age of the ram	Breed of the ram a. Washera b. Horro c. Crossbred
1			
2			
3			
4			
5			

8. Have you ever castrated male sheep in your home? (If the answer is no, go to question number 12) a. yes b. no
9. If you practice castration, for what purpose do you castrate male sheep?
   a. for fattening b. for culling c. other (specify) ----------
10. If you practice castration, at what age do you castrate male sheep? ----------
    ----
11. By what method do you castrate male sheep?
    a. modern method b. traditional method c. both methods (using traditional and modern methods)
12. Do you practice docking female sheep? a. yes b. no
13. If your answer is yes, at what age do you dock female sheep most of the time? (in months) ----------
14. If your answer is no, why? a. the sheep I own are Horro breeds b. the sheep I own are crossbreds c. other (specify) ----------
15. Do you cull female sheep which you consider are not fit for breeding? (If the answer is no go to question number 17). a. yes b. no

16. If your answer is yes, females with what characteristics are culled? Please specify?

No.	Criteria	Please check if used as a criteria	Your un-preferred characteristics
1	Colour		
2	Height		
3	Condition		
4	Reproduction		
5	Age		
6	Other (specify)		

17. Do you cull male sheep which you consider are not fit for breeding? (If the answer is no, go to question number 19) a. yes b. no
18. If your answer is yes, males with what characteristics are usually culled? Please specify?

No.	Criteria	Please check if used as a criteria	Your un-preferred characteristics
1	Colour		
2	Height		
3	Condition		
4	Tail type		
5	Other (specify)		

19. Do you select female sheep for breeding? (If the answer is no, go to question number 21) a. yes b. no

20. If your answer is yes, which sheep types are you selecting? Please specify?

No.	Criteria	Please check if used as a criteria	Your preferred characteristics
1	Colour		
2	Height		
3	Condition		
4	Reproduction		
5	Age		
6	Other (specify)		

21. Do you select ram for breeding? (If the answer is no, go to question number 23) a. yes b. no
22. If your answer is yes, which type of ram do you select?

No.	Criteria	Please check if used as a criteria	Your un-preferred characteristics
1	Colour		
2	Height		
3	Condition		
4	Age		
5	Other (specify)		

23. Have you ever bought rams from the market for breeding? a. yes b. no
24. From the following which breed do you think resist diseases best?
    a. Washera b. Horro c. Crossbreds (Washera X Horro) d. all are the same
25. From the following which breed gives birth to twins most of the time?

a. Washera b. Horro c. Crossbreds (Horro X Washera) d. all are the same

26. From the following which breed has the shortest lambing interval?
    a. Washera b. Horro c. Crossbreds (Horro X Washera)
27. From the following which breed resists feed shortage best?

a. Washera b. Horro c. Crossbreds (Horro X Washera) d. all are the same

V. Feed resources and feeding

1. What type of feeds do you feed your own sheep in different seasons?

Sep - Nov		Dec - Feb		March - May		June - August	
Main feed	Feed supplements	Main feed	Feed supplements	Main feed	Feed supplements	Main feed	Feed supplements
1. Natural pasture 2. Stubble	1. Maize grain *2. Atella* 3. Food leftover 4. Other (specify)	3. Natural pasture 4. Stubble	5. Maize grain *6. Atella* 7. Food leftover 8. Other (specify)	5. Natural pasture 6. Stubble	9. Maize grain *10. Atella* 11. Food leftover 12. Other (specify)	7. Natural pasture 8. Stubble	13. Maize grain *14. Atella* 15. Food leftover 16. Other (specify)

2. Do you feed crop residues to sheep? (If the answer is no, go to question number 4) a. yes b. no
3. If your answer is yes, which type of crop residues do you feed to your sheep? (Possible to give more than one answer) a. tef straw b. finger millet straw c. wheat straw d. others (specify) ----------
4. Have you ever encountered feed shortage for your sheep? a. yes b. no
5. If your answer is yes, in which months do you encounter feed shortage?
    a. dry season ----------
    ----

b. rainy season ----------

6. Is there natural pasture in your residence kebele? a. yes b. no
7. If your answer is yes, what is the trend of the area of the grazing land? a. it is decreasing b. it is increasing b. the same as before
8. Have you ever practiced sheep fattening? a. yes b. no
9. If you practice sheep fattening, in which months do you start sheep fattening usually? ----------
10. In which months do you usually finish sheep fattening? ----------
11. Which type of feeds do you supplement to your fattening sheep? ----------
12. How much supplement do you give per head per day? ----------
13. At what age of the sheep do you start fattening? (in months) ----------
14. Do you castrate the sheep to be fattened? a. yes b. no
15. For what purpose do you usually fatten sheep? a. for home slaughter b. for sale c. other (specify) ----------
16. Do you give anthelminitics to the sheep to be fattened? a. yes b. no
17. Do you practice selection of the sheep to be fattened? a. yes b. no
18. If your answer is yes, which type of sheep do you select for fattening?

No.	Criteria	Please check if used as a criteria	Your preferred characteristics
1	Colour		
2	Height		
3	Condition		
4	Tail type		
5	Other (specify)		

19. Have you ever encountered constraints during sheep fattening? a. yes b. no
20. If your answer is yes, what are the main constraints you encountered during sheep fattening? a. diseases b. feed shortage c. low market prices d. theft e. water shortage f. lack of modern knowledge (on fattening and mgt) g. labour shortage h. other (specify) ----------
21. Do you grow improved forages? a. yes b. no
22. If your answer is yes, please specify which type of improved forages you grow? ----------
23. What is the source of water for your animals during the dry season?
    a. rivers b. well c. spring d. other (specify) ----------
24. How far is the water source from your home? (in hour , in km) ----------
    ----
25. Have you ever encountered water shortage during the dry season?
    a. occasionally b. always c. never
26. If you have encountered water shortage frequently in the dry season, what measures did you take to overcome the problem? ----------
    ----

VI. Sheep houses and sheep house construction materials

1. Where do you shelter the sheep during the night? a. in the main house b. a house attached to the main house c. a separately constructed sheep house d. other (specify) ----------
2. Do you keep some sheep groups separately from the others during the night? a. yes b. no
3. If your answer is yes, which type of sheep are separated during night?
   a. fattening sheep b. rams c. young lambs d. none e. no separation f. other (specify) ----------
4. What is the type of material you used for the roof of your sheep house?
   a. corrugated iron b. grass c. other (specify) ----------
5. What is the type of material you use for the floor of your sheep house during the dry season? a. earth b. stone c. wooden paved d. other (specify) -
   ----

6. What is the type of material you use for the floor of your sheep house during the dry season? a. earth b. stone c. wooden paved d. other (specify) ----------
7. Do you clean sheep houses? a. yes b. no
8. If your answer is yes, how frequently do you clean sheep houses per week during the dry season? a. daily b. l time c. 2 times d. 3 times e. other (specify) ----------
9. If your answer is yes, how frequently do you clean sheep houses per week during the rainy season? a. daily b. 1 time c. 2 times d. 3 times e. other (specify) ----------

VII. Sheep diseases and disease control

1. What are the main sheep diseases you encountered during sheep rearing? Please specify?

No.	Name of the disease	Symptoms of the disease	Season of occurrence	Age group of sheep affected by the disease
1				
2				
3				
4				
5				

2. What do you do when your sheep get sick? a. get treated at public vet clinics b. I treat them by buying modern drugs from the market c. I treat them using traditional medicine d. sell them e. other (specify) ----------
3. If you treat your sick animals by using modern drugs, where do you get the drugs you use for sheep treatment? a. buy from private vet clinics b. buy

from public vet clinics c. buy from groceries d. other (specify) ----------
---

4. Please list the name of the drugs you buy from the market ----------
---
5. Have you encountered sheep deaths due to disease last year? a. yes b. no
6. If your answer is yes, how many sheep did you lose last year? ----------
---
7. Please describe the characteristics of the sheep you lost last year?
(From Nehassie 1999 to Hamelie 2000 E.C.)

No.	Colour of sheep	Sex of sheep	Age of sheep (in months)	Breed of sheep	Date of death	Symptoms of the disease
1						
2						
3						
4						
5						

10. Do you deworm your sheep? (If the answer is no, go to question number 13) a. Yes b. no
11. If your answer is yes, from where do you buy the drugs? a. groceries b. private vet clinics c. public vet clinics d. other (specify) ----------
12. If you give anthelminitics to ewes, how many times do you give anthelminitics to one ewe per year? a. 1 b. 2 c. 3 d. 4 e. other (specify) ------
---
13. If you give anthelminitics to ewes, in which months do you deworm them most of the time? ----------
14. In which months do the sheep you own get sick usually? ----------
---

15. In which vet clinic do you get your animals get treated when they get sick? ----------
16. How far is the vet clinic from your home (in hour, in km)? ----------
17. When sick sheep get treated what is the trend of their being cured from the disease when it is compared to before? a. mostly they get cured b. most of the time they do not get cured c. the same as before

VIII. Sheep Herding practices

1. Do you tend sheep year-round? a. yes b. no
2. If the sheep you own are not tended year-round, in which months of the year are they tended? ----------
3. During the dry season (from Tir to mid of Genbot) how are the sheep tended? a. in a group b. privately
4. In the rainy season (from mid of Genbot to end of Tahessas) if the sheep are tended how are they tended? a. privately b. in a group
5. What types of predators of sheep are there in your area? a. jackal b. hyena c. *aner* d. monkey e. other (specify) ----------
6. Have you ever encountered labour shortage in sheep tending? (If the answer is no, go to question number 9) a. yes b. no
7. If your answer is yes, in which months of the year do you encounter labour shortage? ----------
8. If you encounter labour shortage in sheep tending, what is the cause of labour shortage? a. children go to school b. the children I have are very young to tend the animals c. we adults spend our time in crop production d. other (specify) ----------
9. Have you encountered sheep loses due to predator last year? a. yes b. no
10. If your answer is yes, how many sheep have you lost due to predator last year? ----------
11. If you have encountered sheep loses due to predator, by which type of predator have the sheep been attacked? a. jackal b. hyena c. *aner* d. monkey e. other (specify) ----------

IX. Sheep meat consumption

1. Have you slaughtered sheep in your home last year? (If the answer is no, go to question number 6) a. yes b. no
2. If you have slaughtered sheep in your home, home many sheep have you slaughtered? ----------
3. From the total number of sheep you have slaughtered last year, how many were purchased from the market? ----------
4. From the total number of sheep you have slaughtered, how many were home produced? ----------
5. Please describe the characteristics of the sheep you slaughtered (home produced only)

No.	Colour of sheep	Sex of sheep	Age of sheep	Breed of sheep	Month in which the sheep was slaughtered
1					
2					
3					
4					
5					

6. Which type of sheep do you prefer to slaughter at home?

No.	Criteria	Please check if used as a criteria	Your preferred characteristics
1			
2			
3			
4			
5			
6			
7			

7. What type of sheep do you avoid to slaughter at home?

No.	Criteria	Please check if used as a criteria	Your non-preferred characteristics
1			
2			
3			
4			
5			
6			
7			

X. Sheep Marketing

1. From which market place do you buy sheep usually? a. Burie b. Kuche c. Derequa d. Ashefa e. Agute f. Agamessa g. Amure h. other (specify) --------
   ---
2. In which market place do you sell sheep most of the time? a. Burie b. Kuche c. Mankussa d. Shendi e. Derequa f. Other (specify) ----------
   ---
3. Have you sold sheep last year on market? (If the answer is no go to question number 6) a. yes b. no
4. If your answer is yes, how many sheep have you sold on market last year? -
   ---
5. Please describe the characteristics of sheep you sold on market?

No.	Colour of sheep	Sex of sheep	Age of sheep	Breed of sheep
1				
2				
3				
4				
5				

6. Have you sold sheep last year in your residence area? a. yes b. no
7. If your answer is yes, how many sheep have you sold in your residence? ---
   ---

8. Please describe the characteristics of sheep you sold in your residence area?

No.	Colour of sheep	Sex of sheep	Age of sheep	Breed of sheep
1				
2				
3				
4				
5				

9. If you sold sheep in your residence area, for whom did you sell most of the sheep? a. to local farmers b. to sheep traders c. other (specify) ----------
---
10. In which occasions, do you most of the time sell male sheep on market?
a. on Easter b. on New Year c. on Christmas d. Other (specify) ----------
11. Have you ever bought sheep from the market? a. yes b. no
12. If your answer is yes, what problems have you encountered in sheep buying on market? a. buying sick sheep b. trickery (one persons sells the sheep and another persons comes and claims as the owner of the sheep) c. high market prices d. distant market places e. other (specify) ----------
13. What problems have you encountered on market when you sell sheep?
a. forged Birr b. low market prices c. distant market places d. other (specify) ----------
14. Have you bought sheep last year? a. yes b. no
15. If the answer is yes, how many sheep did you buy last year? ----------
---

16. Please specify the characteristics of the sheep you bought last year?

No.	Colour of the sheep	Sex of the sheep 1. Male 2. female	Age of the sheep (in months)	Breed of the sheep 1. Washera 2. Horro 3. crossbred	Purpose of sheep purchase 1. For home slaughter 2. For breeding 3. Other (specify)

17. What materials do you buy from the market for your sheep?
    a. common salt b. anthelminitics c. Noug seed cake d. other (specify) -------
    ----
18. How far is the market place you usually go for sheep selling from your home residence? (in hour, in km) ----------

XI. Sheep production constraints

1. What are the main sheep production constraints you have encountered in sheep rearing? (Possible to give more than one answer)
    1.1. Disease
    1.2. Predator (Jackal, hyena, aner, monkey, etc)
    1.3. Feed shortage
    1.4. Lack of adequate vet service (lack of personnel and vet clinics nearby)
    1.5. Leech
    1.6. Distant sheep market places
    1.7. Low market prices
    1.8. Lack of money

1.9. Lack of labour

1.10. Theft

1.11. Water shortage

1.12. Lack of modern sheep production knowledge (on mgt and fattening)

1.13. Others (specify) ----------

---

2. From the constraints you have encountered in sheep production, please list five of the main ones according to their priority of importance
   (Please start from the most severe and go to the less severe constraint)

   2.1. ----------

   2.2. ----------

   2.3. ----------

   2.4. ----------

   2.5. ----------

Thank you very much for your cooperation and devotion of your time in giving us this information!

Appendix 5. Sheep Marketing Questionnaire (For sheep/ goat sellers)

Date _____

Name of market place _____

Name of Data collector _____

A. General Data

1. Name of the sheep/ goat seller _____
2. Sex _____
3. Age _____
4. Name of woreda he came from _____
5. Name of kebele _____
6. Total number of sheep he brought to the market for sale _____

No.	Sex	Breed	Age (in months)	Colour
1				
2				
3				
4				
5				

7. What is the origin of sheep he brought for sell? a. home reared b. purchased/ for trading
8. For what purpose do you sell the sheep you brought to the market? a. for replacing with other sheep b. for home expenditure c. for trading/ for profit d. other(specify)_____ _____
9. What is your livelihood? a. agriculture b. livestock trading c. other (specify)_____

10. Have you got market price information before coming to the market?
    a. yes b. no
11. If you got market price information, from whom did you get this information?
    a. from neighbours b. from traders c. I assessed the market price myself before coming to the market d. other (specify) _____
12. How far is your residence kebele from the market place in hours (on foot) _____ in km _____
13. What is the means of transportation when you bring sheep to the market? _____
14. What problems have you encountered whenever you bring and sell sheep on market? a. low market prices b. forged birr c. other (specify) _____

Appendix 6. Sheep Marketing Questionnaire (For sheep/ goat buyers)

1. Name of the sheep/ goat buyer _____
2. Sex _____-
3. Age _____
4. Name of woreda he came from _____
5. Name of kebele _____
6. Total number of sheep he bought from the market _____

No.	Sex	Breed	Age (in months)	Colour
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

7. For what purpose did you buy the sheep? a. for slaughter c. for trading/ profit d. other (specify) _____
8. If the sheep you bought are for slaughter purpose, for what type of consumption did you buy them? a. for home b. for hotel c. other (specify) _____

9. If the sheep are bought for trading/ profit, in which market place are you going to sell them?
   b. Name of the market place _____
   c. Name of woreda in which the market place is found _____
   d. Distance of the market place in hours (on foot) _____ in km _____

10. What is your livelihood? a. agriculture b. livestock trading c. civil servant d. trader/ hotel owner, etc e. other (specify) _____
11. Have you got market price information before coming to the market?
    a. yes b. no
12. If you got market price information, from whom did you get this information? a. from neighbours b. from traders c. I assessed the market price myself before coming to the market d. other (specify) _____
13. How far is your residence kebele from the market place in hours (on foot) _____ in km _____
14. If you are a sheep trader, what is the means of transportation when you take the sheep to the selling market place? a. on foot/ trekking b. by car c. other (specify) _____
15. If the sheep you bought are being trekked to the selling market place, how long does it take on foot from your home to the selling market place? _____
16. If you use car for sheep transportation, how much do you pay per head for transportation? (from your kebele up to the selling market place)_____
17. What problems did you encounter whenever you buy sheep? a. high market prices b. buying sick sheep c. trickery (one person sells and another person comes and claims as the owner of the sheep purchased) d. other (specify) _____

B. Sheep market price data

1. Male sheep

No.	Sheep price	Body weight of the sheep (kg)	Heart girth of the sheep (cm)	Age of sheep (months)	Colour of the sheep	Breed
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

2. Female sheep

No.	Sheep price	Body weight of the sheep (kg)	Heart girth of the sheep (cm)	Age of sheep (months)	Colour of the sheep	Breed
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						