ON-FARM PERFORMANCE EVALUATION OF INDIGENOUS SHEEP AND GOATS IN ALABA, SOUTHERN ETHIOPIA

M. Sc. THESIS

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A THESIS SUBMITTED TO THE

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DEDICATION

To my mother Hezete Ersumo and my uncle Temamo Talore.

DECLARATION

I declare that this thesis is my original work and that all sources of material that are used for this thesis have been duly acknowledged. This thesis is submitted in partial fulfilment of the requirements for an MSc degree at Hawassa University and is deposited at the university library to be made available to borrowers under rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the awards of any academic degree, diploma, or certificate.

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LIST OF ABBREVATIONS

ADG	Average daily gain
AFP	Age at First Parturition
ANOVA	Analysis of Variance
BCS	Body Condition Score
BoA	Bureau of Agriculture
BWT	Birth Weight
CCPP	Contagious Caprine Pleuropneumonia
CSA	Central Statistics Agency
CV	Coefficient of Variation
EARO	Ethiopian Agricultural Research Organization
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization of the United Nations, Rome
Kg	Kilogram
Ha	Hectare
ILCA	International Livestock Centre for Africa
ILRI	International Livestock Research Institute
IPMS	Improving Productivity and Market Success of Ethiopian Farmers
M a.s.l.	Meters above sea level
MoARD	Ministry of Agriculture and Rural Development of Ethiopia Government
OoARD	Office of Agriculture and Rural Development (Alaba Special Woreda)
PA	Peasant Association
PLW	Pilot Learning Woreda
PI	Parturition Interval
SARI	Southern Agricultural Research Institute
SAS	Statistical Analysis System
SNNPR	Southern Nations Nationalities and Peoples Region
SPSS	Statistical Package for Social Sciences
USD	United States Dollar
WWT	Weaning weight

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ON-FARM PEROFRMANCE EVALUATION OF INDIGEONOUS SHEEP AND GOATS IN ALABA, SOUTHERN ETHIOPIA

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ABSTRACT

A flock monitoring study on 60 households was undertaken from October 2008 to September 2009 to measure productive and reproductive performances; determine socio-economic benefits and husbandry practices; and identify production barriers and suggest intervention options in Alaba Special Woreda. The Woreda was stratified on the basis of sheep and goat densities and the respective sites and households were selected using multi-stage (purposive and random) sampling techniques. Mean land holding per household was 1.5 ha. On average, a household owned 6.5 cattle, 6.1 sheep, 4.5 goats, 1.15 equines and 4.2 chickens. Hot pepper, teff and chat are the major cash sources for farmers. Small ruminant are mainly kept for income generation. Males were sold or slaughtered before attaining puberty. 'Afelama', a local bylaw and punishment rule, restricts movement of sheep and goats during cropping period. Sale, death, home slaughter, share holding, gifts out and predator contributed for 60.5, 13.8, 11.0, 5.2, 1.4, and 5.7% exits, respectively, in sheep flocks while the corresponding values for goats were 41.5, 17.8, 16.1, 5.9, 11.9, and 2.5%. Sheep and goats are mainly sold to purchase agricultural inputs (fertilizer and improved seeds) and is the major reason for the reported exits. Home born, purchase, shareholding, and gifts back constituted 87.1%, 10.1, 1.7 and 1.1% entries, respectively, for sheep while for goats the values were 94.4, 2.1, 2.8 and 0.7%, respectively. Most lambing and kidding occurred between March and June, the apparent peak being in May. Mean birth weight (BWT)(kg), weaning weight (WWT)(kg), Average daily gain to weaning (ADG, g), litter size, age at first parturition and parturition interval (months) for sheep were 2.30±0.03, 10.35±0.19, 89.24±1.98, 1.52±0.04, 12.43±0.1, and 9.19±0.08, respectively. The corresponding values for goats were 2.34±0.03, 9.85±0.29, 82.34±3.18, 1.47±0.04, 11.95±0.13, and 9.05±0.08 respectively. Sex, parity, litter size and season significantly (P<0.05) affected BWT in sheep whereas birth type affected 90 day weight, ADG and 120 day weight. Similarly, season influenced 30 and 120 day weights significantly (P<0.05). All fixed factors except sex significantly (P<0.05) affected BWT in goats whereas birth type and season significantly affected weight at 30, 60, 90 days and ADG consistently while other factors affected weight at specific ages; however, the trends were not consistent. Pre-weaning mortality rate of 13.89% and 10.66% were found for sheep and goats, respectively. Mean milk yield (morning milk) of does was 150±56.03 ml. Offtake rates of sheep and goats were 41.18 and 30.37%, respectively. Small ruminant enterprise contributes 52.32% of the net total cash income obtained from livestock rearing and 24.23% of the net total agricultural cash income. The major problems for small ruminant production in the area are poor veterinary services, water and feed shortage, seasonal market fluctuations and lack of overall extension supports. Higher rate of abortions and mortality could offset the higher prolificacy of kid and lamb crops obtained. To utilize the current emerging market opportunities, attempts should be made to improve veterinary services and forage development to alleviate the losses due to co-occurrence of high parturitions during critical feed shortage time. Efforts should also be made to optimize female reproduction and increase lamb and kid output. To select outstanding males from the local genotypes, breeding strategy should be devised. Further study is needed to identify the milking potential of the Does and cost-effective feeding strategy from locally available feeds for finishing animals in the area.

Key words*: on-farm, performance, husbandry, dynamics, economics, Alaba, Ethiopia*

1. INTRODUCTION

Livestock production is an important enterprise in Eastern Africa where about 56 % of Africa's livestock wealth is maintained. Small ruminants make a substantial contribution to the well being of the people in the region and Sub-Saharan Africa (SSA) (Winrock International, 1992; de Leeuw and Rey, 1995).

Small ruminants are widely reared in a crop-livestock farming systems and are distributed across different agro-ecological zones of Ethiopia. Sheep and goats production is an important activity for smallholders, particularly for resource poor farmers in many parts of the country. They provide their owners with a vast range of products and services such as immediate cash income, meat, milk, skin, manure, risk spreading/ management and social functions (Adane and Girma, 2008). They are also sources of foreign currency (Berhanu *et al*., 2006).

Sheep and goats, with their higher reproductive capacity and growth rates, are ideally suited to production by resource-poor smallholders (Devendra, 1999; Tibbo, 2006). Indigenous goats are resistant to diseases and parasites, good flocking instinct, ability to walk long distances in search of feed, high tolerance to adverse climatic conditions, endurance to droughts and to low and fluctuating nutrient availability (Kosgey *et al*., 2008). They require smaller investments, have shorter production cycles and greater environmental adaptability, and hence have a unique niche in smallholder agriculture.

Ethiopia has about 25 million sheep and 21.9 million goats (CSA, 2008). The relative importance of these resources and their products varies from region to region and are largely determined by ecological and economic factors. Traditionally keeping large number of small ruminants was considered as an expression of status in the rural community. However, with ever-increasing human population and drastically shrinking farmlands, sheep and goat production is becoming a means of survival particularly for the landless youth and female headed households in the rural areas. As a result, the contribution of small ruminants is increasing whereas sustaining large ruminants is facing difficulty during season of critical feed shortage (Desta and Oba, 2004; Legesse *et al.*, 2008). Furthermore, roles and functions of the animals undergo changes as the systems face continuous changes in resource availability.

Although diverse sheep and goats resources are found in Ethiopia, their productivity is low; the sector has not received a great deal of attention from scientists, administrators and legislators (Girma *et al.,* 2000). The research approach has not also invited the end users for active participation. Improvements were too slow due to lack of identifying the actual on-farm situations and weighting the socioeconomic and cultural benefits of the animals for the poor farmers. Farmers do make decisions not only from the point of view of profitability, but also security, income generation and cultural values (Ayalew *et al,* 2003; Tatek *et al.,* 2004). Sheep and goats are characterized by low productivity in terms of growth rates, meat and milk production, which can be attributed to overcrowding, poor nutrition and associated resultant stress that provide a rich atmosphere for disease and serious production losses (Lemma, 2002). Feed shortage in quality and quantity (Mengistu, 2003) contributes for the reduced productivity. Poor veterinary services further worsen the situations. Information is lacking on the pattern and causes of mortality to improve

survival. It has been argued that reductions in lamb mortality can be achieved only by identifying and targeting the specific causes and further identifying the underlying factors of mortality on a farm (Tibbo, 2006).

Performance recording is an important tool to suggest the breeding policy for a given area. However, recording in general is hardly practiced in any livestock species in the country, to identify the performance and management gaps (Awigichew, 2000; Tibbo, 2006). Reproductive and productive performances are important early indicators of adaptability and management adequacy (Abegaz *et al*, 2002; Getahun, 2008). It needs a strategic post-survey recording and documentation of the performances of the animals in their native environment under farmer's condition. Thorough monitoring of the productive, reproductive and economic performance of small ruminants and their existing level of integration with crop production and other livestock keeping is required to capture a full picture of their contribution and thereby verifying possible intervention areas (Getahun, 2008). Very often, the results obtained from on-station research are of little relevance to traditional production systems and may not contribute much towards understanding of the specific adaptation of animals to farmer's conditions **(**Rey *et al.*, 1992). However, on-farm performance assessment concerned with the whole farm environment; cover all components of the farm environment; identify factors limiting production within the system. One further attraction of on-farm performance study is that it provides information in location specific production conditions that could lead to breed improvement options that are appropriate to the system (ILCA, 1987; Rey *et al.*, 1992). However, unlike on-station experiments, on-farm study is influenced by many factors which could not be controlled.

According to CSA (2008), Alaba Special Woreda has about 63,463 goats and 52,630 sheep populations, may belong to Arsi-bale breeds/ populations (Solomon, 2006; Tesfaye *et al*., 2006). Preliminary results on production system were reported on sheep and goats of the same Woreda (Tsedeke, 2007). However, the study did not include on-farm performance results. This study was hence designed to fill the gaps through on-farm recording of biological and socio-economic parameters, and has the following specific objectives.

i. To document the husbandry practices of sheep and goats in the area
ii. To measure productive and reproductive performances of sheep and goats under farmers management conditions
iii. To determine the socio-economic benefits of sheep and goats in the area
iv. To identify factors influencing the performances of sheep and goats in the area.

2. LITERATURE REVIEW

2.1 Significance of sheep and goats for livelihood of smallholders in Ethiopia

2.2.1 Role of small ruminants in crop-livestock mixed farming system

Small ruminants are kept by smallholders as an integral part of the livestock sub-sector. Sheep and goats contribute significantly to the subsistence, economic and social livelihoods of a large human population in low-input, smallholder production systems in developing countries (Workneh, 2000; Tibbo, 2006). They are important to the socio-economic well being of people in developing countries in the tropics in terms of nutrition, income and intangible benefits (e.g., savings, insurance against emergencies, cultural and ceremonial purposes). They are regarded as a quick source of cash by millions of keepers in Ethiopia. They also serve as an insurance against crop failure and death of large ruminants (Ayalew *et al.*, 2002, Getahun, 2008; Kosgey *et al.*, 2008). They play an immense role in the livelihoods of rural farms and serve as a living bank for many farmers, and closely linked to the social and cultural life of resource poor farmers (Workeneh, 2000; Degefu, 2003; Tibbo, 2006), particularly youths and women headed households. Increasing human population, urbanization and incomes, coupled with changing consumer preferences are creating more demand for these animals and their products (Kosgay *et. al.*, 2008).

Their smaller body size as compared to cattle allows easy integration of small ruminants into different farming systems. There is a strong complementary relationships between small ruminant keeping and cropping since the staple foods for farmers in a mixed farming

systems of Ethiopia are either cereals (eg. teff, barley, wheat, maize) or horticultural crops (eg. enset, sweet potato, Irish potato, etc). The integration of these commodities is common as the income from crops can be used to buy small ruminants while the sale of sheep and goats can be used for financing cropping inputs like fertilizers and improved seeds. There is also a linkage through manure since the manure of small ruminants is commonly used to fertilize home gardens and crop lands ((Legesse *et al.,* 2008)). Low capital requirements for starting or expanding small ruminants production means that risks are low and the enterprise is well suited to low-input systems (Tibbo, 2006).

2.1.2 Contribution of small ruminants for food and national economy

Food production in the form of meat, milk and other livestock products constitute a major group of livestock outputs. About 14% of the total value of livestock output was contributed by small ruminants (Degefu, 2003). Sheep and goats provide about 12% of the value of livestock products consumed and 48% of the cash income generated at farm level, 25% of the domestic meat consumption and 46% of the value of national meat production. Sheep and goats, respectively, contribute 20.9% and 16.8% of the total ruminant livestock meat output or about 13.9% and 11.2% of the total domestic meat production, with a live animal and chilled meat export surpluses. Per capita consumption of sheep and goat meat (kg/person per year) in Ethiopia is 8 kg while the global average is 38kg (104g/day) (Ameha, 2008). They are the major suppliers of meat for rural communities, especially during periods of public festivals (Tsedeke, 2007). The share of small ruminants to the total milk output is estimated at 16.7% with the major production coming from goats (ILCA, 1991).

Small ruminants provide 58% of the value of hide and skin production, 40% of fresh skins and hides production and 92% of the value of semi-processed skins and hides (ILCA 1993). MoA reported an estimated sheep skin output of 8.3 million in the year 2000. The total annual output of 10.1 million sheep skins and 7.4 million goat skins based on 33% and 35% off-take rate, respectively (Girma Mekonnen, 2003). The offtake was increased in three years period, estimated to be about 35% for sheep and 38% for goats (Workneh, 2006). Sheep and goats, respectively, contribute 77 and 62 thousand metric tons from mutton and goat meat production, respectively (Ameha, 2008). The amount of skins reported might be underestimated because it may exclude the undocumented sheep and goats skins utilized locally.

2.2 Production system and husbandry of small ruminants in Ethiopia

2.2.1 Small ruminant production system

Livestock production system of Sub-Saharan Africa (SSA) in general and Ethiopia in particular was classified by many authors using different context. Livestock production system of SSA was classified into two major types, namely traditional and modern production systems (Ibrahim, 1998; Tibbo, 2006) distinguished mainly through the three production factors (land, labour and capital).

Zinash *et al*. (2001) identified three types of livestock production systems in Ethiopia; extensive pastoralism in arid and semi arid rangelands, integration of animals with cropping in rain-fed and irrigated areas and systems associated with perennial tree crops.

Based on input-output flow, Tibbo (2006) reported sheep and goat production system of Ethiopia into two major categories and three different production systems. The first and the most common system is the traditional smallholder management system. Sheep and goats are kept as an adjunct to other agricultural activities along with other livestock species. The second, which is limited in scope and area coverage, is the private commercial and parastatal production system. When closely examined, these two broad categories could be further classified as three major different production systems; highland sheep-barely, mixed crop-livestock and pastoral and agro-pastoral production systems(Tibbo, 2006; Solomon *et al.,* 2008) characterized by different production goals and priorities, management strategies and practices, and constraints (Lebbie *et al.,* 1999).

Based on the prevalent agricultural activity, Getahun (2008) reported four production system categories; small ruminant in annual crop-based systems (Northern, North-Western and central Ethiopia), small ruminant in perennial crop-based systems (mainly southern and south-western highlands), small ruminant in cattle-based systems (agro-pastoral and arid areas), and small ruminant dominated systems (pastoral and arid eastern and North-eastern areas).

Zeleke (2009) reported enset-coffee-cereal-livestock production system from the central southern region (Wolaita zone), though some studies describe this system simply 'enset-coffee' system. Crop/livestock mixed farming system is the predominant agriculture in Belesa Woreda of Amhara region. Livestock is one of the major livelihoods of the farming community of the Woreda (Tessema *et al.,* 2003). Samuel (2005) reported livestock production system of Ethiopia into two broad categories; mixed crop-livestock production system in the highlands and pastoral production system in the low lands.

Sheep and goats are reared in mixed crop-livestock and pastoral systems of southern region. However, the production system referring specifically for small ruminants was not reported. Adilo Woreda of Kambata Tambaro zone, Badawacho Woreda of Hadiya zone and Alaba Special Woreda are sharing similar farming system and are generally categorized under the mixed crop-livestock production system of the central mid and highlands of southern region (Getahun, 2008). There are still micro-level differences under the broad categories of each farming system. On-farm recording aids to consider those differences in the production system.

2.2.2 Small ruminant husbandry

Farmers are practicing animal husbandry in different production systems and agro ecologies. In a mixed farming systems, small ruminants are confined and tethered in a wooden hut during the night and are only allowed grazing and browsing during the day under the supervision of a herdsman, particularly young men or women. The enclosure of livestock in huts or kraals is done mainly to protect them from theft and predation (Webb and Mamabolo, 2004; Tsedeke, 2007). Until crops harvested, flocks are usually tethered and maintained under nutritional stress. During dry season almost all owners release their animals to roam around while during the rainy season animals are herded or tethered; tethering being more frequent for goats than for sheep (Jaitner *et al.*, 2001). Tethering in dry season and herding in wet season is reported for Goma Woreda of Oromia region (Belete, 2009). A sort of individual herding or hiring a person for an individual family or a group of families was reported for western part of the country (Alganesh *et al*., 2003).

Sheep fattening is a common practice in different parts of the country, though the degree of fattening and resource base differs markedly. Less than 39.0 % of the farmers owning small ruminants practice some form of fattening before marketing and majority of the farmers sale their animals early before attaining optimum market weight (Solomon *et al*, 2005; Getahun, 2008).

The major management practice used to obtain stability of structure is selling or slaughtering of males not required for other production functions, for home consumption and/or performance of rituals (Webb and Mamabol, 2004) and selling stock, supplementation and maintenance feeding as a strategy of management during drought (Alemu, 2008). Usually one or two bucks or rams are retained in the flock for breeding. In the central highlands of Ethiopia, pregnant ewes were housed separately during the last few weeks of pregnancy until about 2-4 weeks postpartum. Rams not required for breeding would be sold or castrated before puberty (Taye *et al.*, 2009); usually taken out of service for castration or for sale at the eruption of the second pair of permanent incisors, unless the rams are exceptionally good (Agyemang *et al*., 1985).

2.3 Flock ownership, composition and dynamics

Flock structure is defined as the proportion (in terms of head) of the flock of sheep or goats, which is formed by different age and sex classes of animals. Flock composition in terms of age and sex classes has been taken as an indicator of the management objectives for the owner and the production (reproductive, mortality and off-take rate) of the flock. Due to large variations in performance among indigenous breeds and their unique attributes, there are great variations within and between regions and farming system as do

management practices, ownership patterns and production objectives (Ayalew *et al.*, 2002). Livestock ownership varies depending on the wealth status and the overall farm production objectives. In the highlands, sheep are kept in small flocks of about 5 sheep per household by nearly 40 % of all smallholders. However, at higher altitudes (2800-3000 m) one can find flocks with 30 to more than 100 sheep (Awigichew, 2000; Samuel, 2005). An average flock size of sheep and goats of Alaba area are 5.0 and 6.5, respectively (Tsedeke, 2007), while goats of Dale Woreda is 5.98 (Endashew, 2007). High percentage of single ownership was reported from traditional sector of Ethiopian highlands (Agyemang *et al.*, 1985), which gives guarantee for testing technological innovations. The owner and care taker relationship was also reported.

The ownership of goats confers prestige and they have a place in local custom and religion (Webb and Mamabolo, 2004). Reports indicated that in many African countries culture dictates that women are subordinates to men and hence are socially marginalized. Women own sheep and goats but they are often not allowed to sell the animals in the absence of their husbands, who generally work as migrant labourers. The versatile role of women in livestock related activities was also reported (Tsedeke, 2007). Women and children had higher responsibility in managing small stocks. Usually owners keep different mix of species like cattle, sheep, goats, and equines. They do have their own reason of keeping a mix of different species.

CSA (2008) reported 73.38% females and 26.62% male sheep and 69.84% female and 30.16% male goats for the country. Agyemang *et al.* (1985) reported 74.8 per cent female, 22.4 per cent entire males and 2.8 per cent castrates for Menz sheep in the traditional sector of Ethiopian highlands, whereas breeding female constituted 54.74% of the flock (Lemma,

2002). Flocks of Washara sheep constituted 81% females, 17.3% intact males and 1.7% castrates in traditional system in Amhara region (Mengistie, 2008). Endashew (2007) reported 53.5% breeding females, 10.6% and 8.8% suckling female and male, respectively, 13.8% intact males and 13.4% castrates and fattening males in southern region. Similarly, 39.3% breeding ewes, 39.4% breeding does, 22.8% kids and 27.6% suckling lambs and 3.6% sheep and 3.1% goat's castrates and fattening males were reported for Alaba Special Woreda of southern region (Tsedeke, 2007).

There is high possibility for sheep and goats to exit from and entry to the flocks, as they are small in size and some times considered as a 'hedge to cattle' and food grains. The major routes of exits reported were sale, slaughter, deaths, shareholding and gifts/exchanges. Getahun (2008) reported that exit through commercial offtake accounted for 104.3% through sale, 2.9% through slaughter and 6.8% exited as gifts. Workeneh (2000) also reported 35.7% exits of goats through sale and 15.2% through slaughter in Eastern Ethiopia. From flock monitoring, Belete (2009) reported that the total exits as sale (69.4%), death (46.3%), slaughter (28.8%), predator (33.3%), theft (5.63%) and share arrangements (3.13%) from Western Ethiopia. Tsedeke (2007) also reported exits of 21.7% sheep and 25.3% goats in Alaba, Southern Ethiopia, due to mortality mainly associated with diseases and predators.

Birth constituted about 54.9% in sheep and 63.3% in goat flocks of Alaba. Purchase, gifts from family and relatives and share holding, respectively, contributed 18.5%, 14.2% and 12.4% of the total sheep acquisitions, while 15.6%, 10.5% and 10.5% for goats (Tsedeke, 2007).

However, there are a few literatures assessed the entry-exit relationships of sheep and goats in Ethiopia. A 2-year study in Southwest Nigeria indicated that birth was the predominant reason for entry, accounting for 94% of new entries whereas the main reasons of exits were deaths (52%), ceremonial and festival slaughter (17%), and sales (15%) (Armbruster and peters, 1993). Mean herd size was increased by 2.2 animals in this 2-yr study period. Ndlovu *and* Simela (1996) reported 61% of exits caused by lost kids and predation. Mortality of 28.1% in lambs before weaning age, higher in multiple births (25%) than single births (18.9%) whereas annual losses in adult sheep average 12.5% (Armbruster *et al.,* 1991). Reports indicated that most male kids or lambs removed from the flocks before nine months of age (VanneKeirek and Pimentel, 2004) so that females outnumber males.

2.4 Offtake rate

The indigenous sheep and goats are year round breeders and mating is not controlled. Annual lambing and kidding rates are only 1.2 and 1.5 respectively. Annual off-take rate for sheep is estimated at 33% (EPA, 2002) with an average carcass weight of about 10 kg, which is the second lowest amongst sub-Saharan African countries (FAO, 2004). The low offtake means that sheep and goats are kept for an average of over 3 years (Martzer, 1995).

Getahun (2008) reported the offtake rate of sheep of Adilo and Kofele as 114% and 78.4%, respectively. Most of the offtake (104%) in Adilo, which is adjacent to Alaba Woreda, is due to commercial purposes (sales for generation of income) for household needs. Similarly, Tsedeke(2007) reported the need of sheep and goats to generate an immediate cash income. Belete (2009) also reported that sales accounted for 27.5% and 19.7% of the off-take for sheep and goats, respectively. The same author indicated that slaughtering

during festivals and other reasons accounted for 26.6% and 15.8% off-take for sheep and goats, respectively.

2.5 Reproductive performances of small ruminants

Reproductive performance is a prerequisite for any successful livestock production programme. Where farm resources are severely limited as it is often the case in SSA, reproduction failure is the first sign of decreased productivity (Mukasa Mugerwa *et al.*, 2002). Reproductive traits are difficult to measure and are strongly influenced by management decisions, but are also of paramount economic importance (Notter, 2000). Flock reproductive rate also affects selection intensity and consequently the rate of genetic improvement in all traits under selection. Reproductive rate can be influenced by conception rate, litter size, young mortality and interval between parturitions (Ndlovu and Simela, 1996).

The traditional free roaming management system allows year round breeding, with minimal purchased inputs (Kosgey *et al*, 2008). This creates a good environment for bucks and rams to service does or ewes any time, which is not a case in a controlled system under on station. On the contrary, uncontrolled breeding is complicated by diseases transmission and inbreeding when the bucks and rams are small in number. Poor reproductive performances of Ethiopian sheep and goats can be associated with genetic factors, poor management, seasonal fluctuations in feed resources and diseases (Mukasa-Mugerwa *et al*., 2002). Season had significant effect on most reproductive traits including fertility, lambing rate and weaning rate. Age at first mating (puberty) affects reproductive efficiency. The age at which puberty is attained is determined largely by genotype and

environmental factors like nutrition, season and climate (Getahun, 2008; Girma, 2008). In Most sheep and goat breeds, achieving 40-70% of the mature body weight is satisfactory for attainment of puberty. There are large variations in mean age at puberty between and within breeds, resulting from the genotype and post weaning nutrition.

2.5.1 Age at first parturition (AFP)

Age at first parturition (AFP) can be recorded easily in a farmers stock. There is a big variation among production system and breeds for this trait (12-24 months). These variations could be due to genetic and environmental differences (Getahun, 2008; Girma, 2008). Abegaz *et al.* (2002) reported age at first lambing of Horro ewes at 64.6-85% of their mature body weight. Most scholars, however, reported age at first parturition in months. Age at first parturition (months) of some of the Ethiopian indigenous sheep and goats studied under different management conditions is shown in Table 1.

Table 1: Age at first parturition and parturition interval of Ethiopian sheep and goats under different management conditions

spp	*breed*	*Management type*	*Age at 1st pariturition (months)*	*Lambing/kidding interval (months)*	Source
sheep	Adilo	Traditional	14.6	na	Getahun, 2008
	Arsi-bale	Traditional	12.7	7.8	Tsedeke, 2007
	Bonga	Traditional	13	8	Belete, 2009
	Menz	Traditional	14-16	7-10	Dibissa, 2000
	Menz	Station	15	8.4	Mukasa and Lahalou, 1995
	Washara	Traditional	15±14	9±0.5	Mengistie, 2008
Goats	Adilo	Traditional	12.9	na	Getahun, 2008
	Arsi-Bale	Traditional	12.1	6.9	Tsedeke, 2007
	Arsi-Bale	Traditional	na	8.07	Tatek *et al.*, 2004
	Arsi-Bale	Station	na	11.6	Mehlet, 2008
	Arsi-bale	Traditional	13	na	Samuel, 2005
	Boka Abaya	Traditional	14.88±0.3	8.6+0.2	Endeshew, 2007
	Keffa	Traditional	12.5	7.9	Belete, 2009

na=not available

2.5.2 Parturition interval (PI)

Parturition interval (Lambing/ kidding interval) refers to the number of days between successive parturitions. Reproductive efficiency is related to the length of parturition interval; i.e. doe/ewe with long kidding/lambing interval has lower reproductive efficiency (Ibrahim, 1998). At least three times kidding or lambing is expected per two years under normal circumstances (Girma, 2008). To attain this lambing or kidding interval should not exceed 8 months (245 days). There are reports on the possibility of attaining three parturitions from indigenous small ruminants in two years (Getahun, 2008) though PI of

the traditionally managed sheep was influenced by various factors including previous litter type, parity and lambing season (Dibissa, 2000). Table 1 above shows literature review on parturition interval of Ethiopian sheep and goats.

2.5.3 Prolificacy /Litter size/

Litter size is a combination of ovulation rate and embryo survival, number of lambs or kids born per parturition. There is a positive relationship between litter size and age and litter size and parity (Getahun, 2008; Girma, 2008). An increase in ewe or doe weight (prior to mating) by 1 kg over the mean of the population results in an increase of about 3.8% in litter size (LS). Litter size varies between 1.08 and 1.75 with average of 1.38 for tropical breeds (Devendra and Burns, 1983; Girma, 2008). Twin born ewes tended to produce more and heavier lambs than did those born single. Peak prolificacy generally achieved between 4 and 8 years of age (Notter *et al.,* 2000). The incidence of single, twin, triplet and quadruplet of 54.8, 39.8, 5.1 and 0.3%, respectively, was reported for goats of India (Devendra and Burns, 1983). Litter size is significantly affected by year of lambing, parity and weight of ewes at mating (Abegaz *et al.,* 2002; Gemeda *et al.,* 2002a; Berhanu and Aynalem, 2009). Table 2 shows litter size of Ethiopian sheep and goats under different management conditions.

Table 2: Litter size of Ethiopian small ruminants under different management condition

spp	*Breed*	*Management type*	*Litter size*	Source
Sheep	Adilo	Traditional	1.42	Getahun, 2008
	Arsi-bale	Traditional(Kofele)	1.24	Getahun, 2008
	Arsi-bale	Traditional (Alaba)	1.70	Tsedeke, 2007
	Bonga	Traditional	1.4	Belete, 2009
	Horro	Station	1.34	Abegaz *et al.*, 2000
	Menz	Traditional	1.11	Dibessa, 2000
	Menz	Station	1.12	Mukasa and Lahalou, 1995
	Washara	Traditional	1.11	Taye *et al.*, 2009
Goats	Adilo	Traditional	1.24	Getahun, 2008
	Arsi-bale	Station	1.34	Mehlet, 2008
	Arsi-bale	Traditional (Alaba)	1.75	Tsedeke, 2007
	Arsi-bale	Traditional	1.21	Tatek *et.al.*, 2004
	Boka Abaya	Traditional	2.07	Endeshew, 2007
	Keffa	Traditional	1.7	Belete, 2009

2.5.4 Seasonality in breeding

Local breeds of sheep and goats in tropical conditions are either non-seasonal breeders or exhibit only a weak seasonality of reproduction (Mukasa-Mugrewa *et al.,* 2002; Girma, 2008). Reports indicated that 46% of sheep and 52% of goats exhibit uncontrolled mating in smallholder systems of Kenya (Kosgey *et al.*, 2008). Conception peaks are observed in response to feed flushes or when crop residues are available. Lack of synchrony between the supply of, and demand for, nutrients can depress ewe or doe productivity.

Sheep lamb year-round with a peak in October and November in traditional sector of Ethiopian highlands. Most conceptions take place in June and July, which is the beginning of the major rainy season and most lambs are born in November and December (Agyemang *et al.,* 1985; ILCA, 1989). Devendra and Burns (1983) reported the highest (67.3%) kidding in April and the lowest in November (17.4%).

A study conducted on reproduction and productivity of Horro and Menz ewes in the highlands of Ethiopia in different seasons indicated that ewes which lambed in the wet season had significantly higher weaning rate than those that lambed in the dry season (Mukasa Mugrewa *et al.,* 2002). Mating of ewes in the dry season led to higher fertility than those mated in the wet season, probably because ewes came from the previous wet season with enough body reserves. Lambing in the subsequent wet season further enhanced their weaning rates and productivity due to better grazing during lactation. There are reports for peak conceptions of ewe/ doe in response to feed flushes and when crop residues are available (Mukasa *et al.,* 2002; Tatek *et al.,* 2004). Mehlet (2008) reported the lowest mating during May, July, October and November while kidding during May-Sept, May being the highest for Arsi-Bale goats. Mengistie (2008) reported the peak lambing at August and February for Washera sheep.

Tsedeke (2007) identified two possible breeding seasons, between November to January (major breeding season), and between April to June (minor breeding season), when relatively adequate nutrition is available for reproduction and access to breeding males, as rams and bucks roam freely.

2.6 Growth performances of sheep and goats

Growth is an important trait for meat production which determines the overall productivity of the flock and the economic return from small ruminants' enterprises. Growth rate of lambs or kids, particularly during the early stages of growth, is strongly influenced by breed (genotype), milk yield of the ewe or doe, the environment under which the animals are maintained including the availability of adequate feed supply in terms of both quantity and quality (Awgichew, 2000; Mengistie, 2008). Parity, pre-mating weight of the dam, type of birth, sex, season and month of birth also contributes for growth performances of small ruminants.

2.6.1 Birth weight and pre-weaning growth performances

Birth weight of animals is one of the most important factors influencing the pre-weaning growth of the young and has a positive correlation between birth weight and subsequent live body weight development (Awgichew, 2000). Birth type and sex are sources of variation in lamb pre-weaning growth rate (Taye *et al.,* 2009). Kids or Lambs which are heavier at birth are usually singles or are those produced by ewes or does with larger body sizes and good feeding conditions. The indication is that lambs heavier at birth have larger adult weight and higher growth capacity (Awgichew, 2000; Taye *et al.,* 2009). Parity can also affect pre-weaning growth rate, from birth to 30 days of age. Lambs from second and third parity dams grew better than first and fifth parities (Abebe, 1999; Awgichew, 2000; Tibbo, 2006; Taye *et al.,* 2009). Genotype showed significant difference on birth weight of

lambs' and kids. Growth performances of lambs and kids under different conditions are compiled on Table 3.

2.6.2 Weaning (90-day) weight and pre-weaning Average Daily Gain (ADG)

Weaning weight is a trait of great economic importance in meat sheep production since it has influence on growth rate and survival (Taye *et al.,* 2009). Different values of weaning weight were reported by different authors. Thus, weaning weight and post-weaning growth rate of lambs is as important as the pre-weaning growth performances, mainly when the objective is producing meat through lamb and kid production. Seasonal variation in growth rate is observed in tropics because feed supply varies remarkably (Awigichew, 2000). Because of weaning shock, lower growth rate was observed at weaning time (Taye *et al.,* 2009).

Significant effect of season on post-weaning weight was reported on lamb's growth (Tibbo, 2006; Taye *et al.,* 2009) while there was non-significant effect of sex and birth type (Taye *et al.,* 2009). Other studies found the significant influence of type of birth (Yilmaz *et al.,* 2007) and sex (Awgichew, 2000; Tibbo, 2006) on post-weaning growth rate. The literature assessed on birth weight, weaning weight, pre-weaning Average Daily Gain (ADG) is presented in Table 3.

Table 3: BWT, WWT and ADG of Ethiopian sheep and goats under different management conditions

spp	breed	Manamgent type	Birth weight (Kg)	WWt (Kg)	ADG (gm/day)	Source
sheep	Adal	Station	2.5	13	na	Gallal, 1983
	Adilo	Traditional	2.29	11.18	98.77	Getahun, 2008
	Arsi-bale	Traditional(K)	2.89	12.23	102.01	Getahun, 2008
	Arsi-bale	Station	2.8	13.5	na	Brannang *et al*., 1987
	Bonga	Traditional	2.86	11.6	na	Belete, 2009
	Horro	Station	2.4	9.48	78	Tibbo, 2006
	Horro	Station	2.6	12.0	100.4	Abegaz *et al.,* 2002
	Horro	Station	2.2-2.9	9.8-10.9	na	Yohannes *et al*., 1998
	Horro	Station	2.9	15.0	134.4	Gojjam et al., 1998
	Menz	Station	2.06	8.64	72.6	Tibbo, 2006
	Menz	Traditional	2.90	14.38	105	Hassen *et al.,* 2004
	Menz	Station	2.5	9.5	78	Demeke *et al*., 2004
	Menz	Station	2.0	8.6	na	Mukasa and Lahalou, 1995
	Menz	Field	2.4	8.3	na	Niftalem D., 1990
	Washara	Traditional	2.7	11.9	59.1	Taye *et al.,* 2009
Goats	Adilo	Traditonal	2.19	8.44	69.43	Getahun, 2008
	Abergelle	Station	2.6-2.4	6.0-8.9	33-55	Birhane andEirk, 2006
	Arsi-bale	Station	2.45	9.2	71.76	Mehlet, 2008
	Arsi-bale	Traditional	2.28	8.39	72.21	Tatek *et.al.,* 2004
	BokaAbaya	Traditional	2.52	9.56	na	Endashew, 2007
	Keffa	Traditional	2.78	9.0	na	Belete, 2009
	Somali	Station	3.19	11.67	61.25	Zeleke, 2007
	TGxAB	Station	2.57	9.43	na	Girma, 2002

BWT=birth weight, WWT= weaning weight, ADG= pre-weaning average daily gain, K= Kofele, A= Alaba, TGxAB=Toggenberg and Arsi-Bale crosses, na= not available

2.6.3 Survival (Mortality) rate of sheep and goats

Reproductive losses during pre-weaning period due to poor milking ability of dam, poor management and pneumonia are very high. As assessed from literature results compiled in Table 4, lamb losses before one year of age vary from 6.4 % to 45%. This could be a major influencing factor of productivity of a flock (Mukasa-Mugerwa, 1995; Awigichew, 2000; Abegaz *et al.,* 2002). Lamb mortality rate varies from one flock to another depending mostly on management level (Awigichew, 2000).

Slow growth rate associated with mortality has been limiting factors for profitability of the indigenous sheep breeds (Mukasa-Mugerwa *et al*., 1994). More than half of the causes of mortality were similar and attributed to pneumonia as reported from the study on Horrro and Menz sheep of Ethiopian highlands (Mukasa-Mugrewa *et al*., 2002; Tibbo, 2006).

Significant effect of season, flock size and sex of animals on survival was reported (Gemeda *et al.,* 2002a) for Horro sheep. The same author reported that coughing (23.8%) and diarrhoea (23.5%) are among the major clinical signs for mortality of sheep. Belete (2009) reported similar events for Keffa goats and Bonga sheep of south western Ethiopia. Birhan and Van Arendonk (2006) reported significant age and seasonal effect on mortality rate. Mortality rate was higher for lambs born in dry season, compared to those born in the wet season. ILCA (1989) reported mortality rate of 39% from on-farm monitoring of Menz sheep. There is a paucity of information on genetic variability for growth rate and mortality in indigenous sheep breeds of Ethiopia. Pre-weaning mortality of Ethiopian sheep and goats are presented on Table 4.

Table 4: Pre-weaning mortality of Ethiopian sheep and goats under different management conditions

spp	Breed/populations	Management type	Pre-weaning mortality rate (%)	Source
sheep	Adilo	Traditional (A)	19.5	Getahun, 2008
	Arsi-Bale	Traditional (K)	20	Getahun, 2008
	Arsi-bale	Traditional	28.4	Tsedeke, 2007
	Bonga	Traditional	20.87	Belete, 2009
	Horro	Station	25.3	Tibbo, 2006
	Horro	Station	24.3	Awigichew, 2000
	Menz	Station	8.8	Tibbo, 2006
	Menz	Station	15	Mukassa and Lahalou, 1995
	Menz	Traditional	27	Mukasa *et al.*, 2002
	Menz	Station	10.6	Awigichew, 2000
	Washara	Traditional	6.4	Mengistie, 2008
Goats	Adilo	Traditional (A)	20.4	Getahun, 2008
	Arsi-Bale	Station	31.43	Mehlet, 2008
	Arsi-Bale	Traditional	12.2	Tsedeke, 2007
	Arsi-Bale	Station	25	Hailu *et al*., 2006
	Borena	Traditional	45	Hailu *et al*., 2006
	Keffa	Traditional	22.58	Belete, 2009
	Somali	Station	11.7	Abebe, 1996

K=kofele, A=Adilo

2.7 Milk yield

Goat milk production is appreciated by nutritionists and consumers. The small dimensions of fat globules and casein micelles make it particularly digestible, suitable for direct consumption and cheese making (Carnicella *et al.,* 2008). Compared to cow milk, goat milk is richer in vitamins and minerals, so particularly appropriate for the diet of the elderly, the sick and children (Devendra and Burns, 1983; Getahun, 2008). Goat provides milk mainly for the resource poor farmers. In central rift valley, in eastern, south-eastern and north-eastern part of the country, goat milk is consumed by farming community (Abule, 1998; Workneh *et al.,* 2004).

Very few researches have assessed the on-farm performances of dairy goats in southern region. Farm Afrcia (1995) reported that mean milk yield of Somali breeds and their crosses with Anglo-Nubian at on-station and on-farm trials was 329.9 and 837.1 millilitres ,respectively, while mean lactation length was 3.6 and 2.5 months, respectively.

2.8 Production constraints of sheep and goats

2.8.1 Feed shortage

Many authors described the seasonal feed shortages, both in quality and quantity, and the associated reduction in livestock productivity in different parts of the country (Tessema *et al.,* 2003; Tibbo, 2006; Tsedeke, 2007, Getahun, 2008; Yeshitila, 2008). Feed shortage problem is similar throughout the country, being serious in high human population areas

where land size is diminishing due to intensive crop cultivation and soil degradation. The better use of available feeds and the use of non-conventional feeds for supplementation is growing (Yishitila, 2008; Belete, 2009) to alleviate the problem. Similar reports suggested feed shortages in crop-livestock mixed farming areas (Endrias and Tsedeke, 2006; Tessema *et al.,* 2003) and rift valley areas (Abule, 1998) as a limiting factor for small ruminant productivity. The adoption and use of improved forages is very limited throughout the country (Alemayehu, 1998).

2.8.2 Disease and predators

Diseases and parasites are also contributing for higher production losses, particularly in young stocks. Respiratory Disease Complex (RDC) (Tibbo, 2006) is among the most important diseases and associated complexes in small ruminants' husbandry and management. Poor Management is creating a favourable environment for disease incidences. Early mortalities (as high as 50% in lambs) are among the most important losses associated to managements like cold stress, starvation, mis-mothering, etc. (Tibbo, 2006). Predators such as foxes and hyenas are also contributing for the losses of young stocks, i.e. kids and lambs (Tsedeke, 2007; Belete, 2009).

2.8.3 Water shortages

Water shortages is a common problem for both human and livestock consumption in most rift valley parts of the country. It has been reported to be a limiting factor for animal productivity in most mid and lowland areas of Alaba, Dale, Boricha and Kindo Koisha Woredas of Southern region. In eastern, north-eastern and south-eastern part of the country

there is also critical shortage of water; however, there are breeds adapted to lowland agro-ecologies through their physiological adaptation mechanisms (Abule, 1998; Belete, 2009). Restrictions of water may result in poor nutrition and digestion, because there is a relationship that exists between water intake and consumption of roughages, particularly during dry season (Hadjigeorgioua *et al.,* 2000). Tsedeke (2007) reported the problem of water shortage in mixed flock and goat dominating areas of Alaba Woreda. The same author reported the long distance travel of small and large ruminants searching for water. This in turn has implications on the productivity of the flocks.

2.8.4 Market access and information

The major problems in traditional management system is that the system is not market oriented, underdeveloped marketing and infrastructure system, and poor financial facility, etc. (Azage *et al.*, 2006, Berhanu *et al*., 2006). Long market chain is an important barrier for producers and inhibits them from direct benefiting through sell of their animals without involvement of brokers (Endrias and Tsedeke, 2006). Poor marketing information and problems of credit facilities (Berhanu *et al.*, 2006; Endrias and Tsedeke, 2006) reduced the benefit gained by the smallholders. Inadequate infrastructure like road accessibility and marketing facilities are also contributing for the reduced benefit made from the sale of animals by the producers (Tibbo, 2006).

3. MATERIALS AND METHODS

3.1 The study area

Alaba Special Woreda is situated in South Nation, Nationalities and peoples region (SNNPR), 310 kms South of Addis Ababa and 85kms Southwest of Hawassa, the regional capital city. The Woreda is located in 7 17' N latitude and 38^{o} 06' E longitudes. Altitude of the Woreda ranges from 1554 to 2149 m a.s.l with the majority found at about 1800 m a.s.l. Agro-ecologies of the area are classified as dry to moist *Woina Dega*. The annual rainfall varies between 857 to 1085mm and in a bimodal pattern with small rains between March and April and main rains from July to October. There are three distinct seasons; dry, small rainy and big rainy seasons. The annual mean temperature varies from 17^{o} C to 20^{o} C with a mean of 18^{o} C (IPMS, 2005).

Table 5: Mean annual temperature, rainfall and elevation of the study area

	Min	Max	Range	mean	STD
Rainfall, mm	857	1085	228	986	214
Temperature, ^{0}c	17	20	3	18	1
Elevation, m	1554	2194	640	1852	94

Source: IPMS (2005)

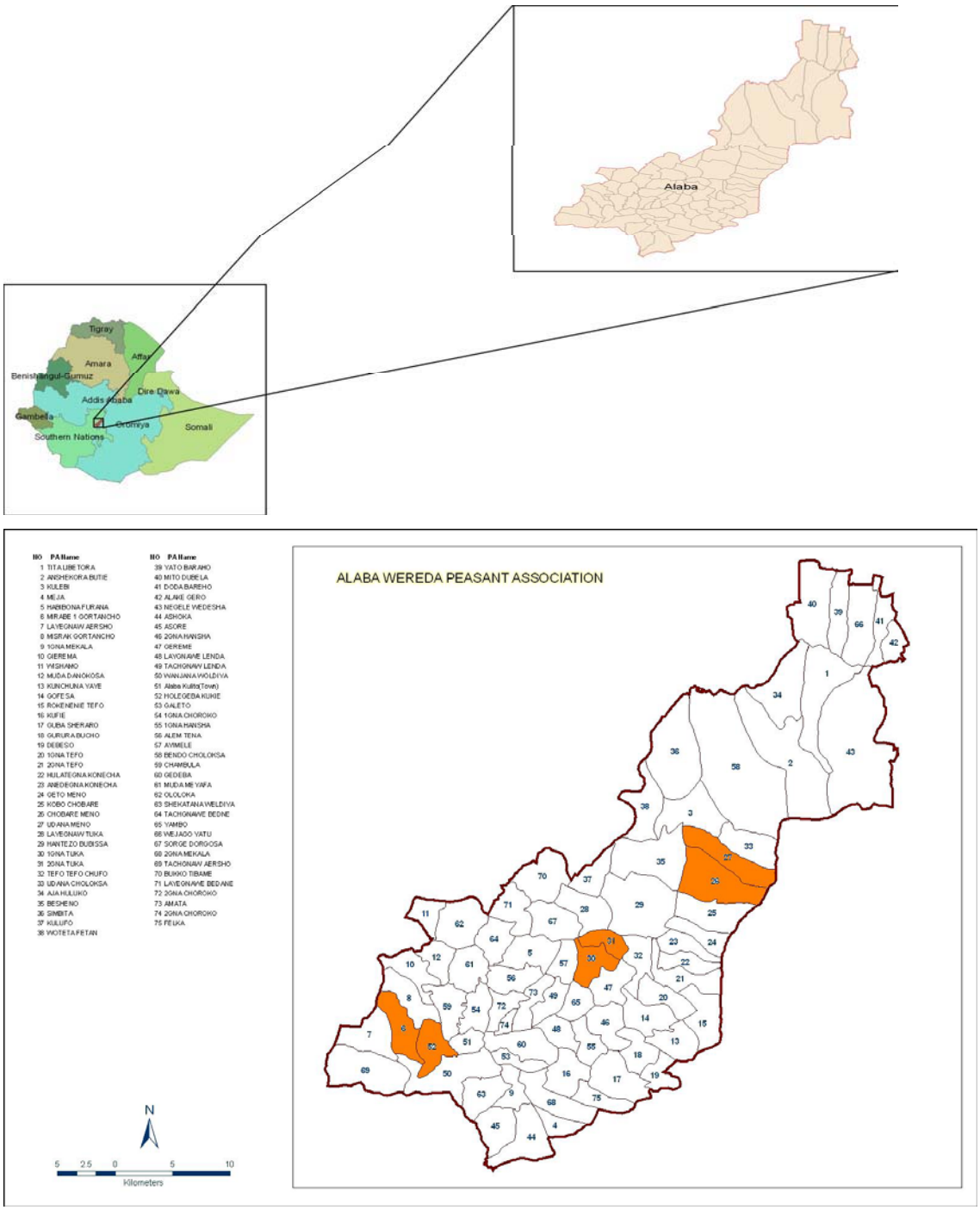


Figure 1: Location of Alaba Special Woreda and the study sites (PAs)

3.2 Sampling and data collection

3.2.1 Flock monitoring

Flocks of 60 households were monitored between October 2008 and September 2009. Prior to sampling, previous survey results and secondary data from the Office of Agriculture and Rural Development (OoARD) on overall agricultural production, socioeconomics and crop-livestock integrations were reviewed, and experts of animal husbandry consulted. Field visits were also made to gather pre-information and select the study kebeles, villages and thereby the households.

A stratified sampling technique was employed in the study. Kebeles, which can represent the production system and sheep and goat distributions, were stratified. There is a clear pattern of sheep and goat density depending on the size of land holding and other commodity based farming systems. Accordingly, based on the flock distribution, the study areas were stratified into sheep dominant site (SDS), goat dominant (GDS) and sheep-goat mixed flock sites (MFS).

Sampling of households was done by setting criteria; minimum flock size for the sites (two animals for SDS, three animals for MFS and three animals for GDS), having at least one year experience in small ruminant's husbandry and willingness to participate. As the flock size is small in sheep dominating site, (2 Kebeles from 37 Kebeles), larger sample size (i.e. 30) was decided to be monitored. Others distribution is similar and proportionally 15 goat holders (2 Kebeles from 28 Kebeles) in goats dominating areas and 15 mixed flock holders (1Kebele from 8 Kebele) in mixed flock areas were selected listing all the holders of the

target commodity. Three adjacent villages from SDS, three from GDS and two from MFS, with dry road accessibility were purposefully selected. All participants who own sheep and goat were identified and listed. From the list of households that fulfilled the criteria, 60 households were selected using random sampling methods.

For each flock density group one enumerator was recruited from the respective locality (3 for the whole study). All the data collectors are 10^{th} and or 12^{th} graduates and able to speak local language and Amharic. Training and demonstration was undertaken before commencement of the study. All animals were ear tagged at the start of the study and all additions to the flock were ear tagged on entry into the flock. Colour, wattles, and other phenotypic traits were also used for identification. At the start of the study, animal age was determined from dentition (Okeyo *et al*., 1991; Girma *et al.,* 2008) backed up by farmers recall of animals born in the flocks.

Reproductive data (age at first parturition, parturition interval, and litter size), productive (birth weight, weaning weight, milk yield and growth rate) and mortality data were recorded (Appendix I). Within 24 hours of the new born; date of birth, birth weight, type of birth, sex of kid/lamb and dam parity were taken. Weaning weight was recorded on 90^{th} day. Weights were taken every 15 days using spring balance scale (50 kg capacity with 100g precision). Milk yield recording was done on a weekly basis. Milk recording started a week after postpartum and recording was done in the morning as the owners do. Milk yield was recorded using measuring cylinder (250ml capacity with 25ml precision). Condition scoring was done as described by Girma *et al.* (2008) for the ewes and does at different physiological stage (dry, late gestation, early (<1 month), mid (1-2 months) and late lactation (2-3 months); and at two major seasons, late dry and big rainy.

Farms were visited fortnightly to record animal numbers, entries, and exits from the flocks, reasons for changes, and animal weights. Very few ram and buck fattening practices were recorded in the study site and the data were insufficient for meaningful analysis. Entries were recorded as births, purchases, and other reasons, which included loans to farmer, returns from loans made earlier to other farmers, and gifts. Exits were recorded as deaths, sales, shareholding, return to owner (gifts back), slaughter for festivals and ceremonies, and any other reason such as slaughter for home consumption, and theft or loss.

3.2.2 Case Histories

To get adequate information on the parameters like age at first parturition, parturition interval, abortions and udder problems, case histories of breeding females was taken (Appendix II). This is because the monitoring time was still short to record these events. The breeding females whose histories were recorded were those that gave birth at least once. Case histories were done giving priority for older females assuming that they were more informative. 220 case histories were recorded, 120 were on breeding ewes and the remaining 100 were on breeding does.

3.2.3 Economic efficiency evaluation

Economic data was collected throughout the year using longitudinal survey and also strengthened using questionnaire (Appendix III). Income and expenditures related to small ruminant rearing were recorded to estimate the efficiency and relative contribution of sheep and goat enterprises. The components of operating costs (feed, water, veterinary and other miscellaneous) were summed up and averaged for the households of the area. Fixed

costs like labour of the family were valued using procedures of Zegaye *et al*.(2007) and Staal *et al.* (1993) and adopted by Getahun (2008). The period of the time (hour) spent by the family members related to small ruminant husbandry was recorded for children and adults separately. This time (hour) spent was converted to man-equivalent hours. The wage rate during the study period was ETB 15 per day. The causal rural wage works for about 8 hours in a day. The resulting amount was multiplied by the estimated hourly wage rate of ETB 1.875 that prevailed in the area during the continuous surveying period to reflect the opportunity cost of the labour. According to Staal *et al.* (2003) and adopted by Getahun (2008), adult family members were valued as 50% of the causal rural wage, whereas children labour was valued 25% of the causal rural wage (Zegaye *et al.,* 2007). Total value of production, revenue, is the sum of sale of sheep and goats and non-market value of animals slaughtered (including skin sale) or given away during the year of investigation. Average sale prices obtained from the 12 months monitoring were used to compute the total value of the home slaughtered animals (Lemeke *et al.,* 2007). An interest rate of 4% in the Ethiopian banks during the study period, representing the market rate of the capital, was used to reflect the opportunity cost of capital pertaining to investment in small ruminants. Capital is defined as the average value of the flock per household, irrespective of whether the flock is mixed or of a single species (Panin *et al.,* 1997). Capital value of stock= (number of sheep in the flock X average of purchase and sale price of a sheep) + (number of goats in the flock X average of purchase and sale price of a goat).

The formula for budgeting of sheep and goat enterprises are:

Net enterprise profit= (Revenue) - (operating cost+ value of family labour + interest on capital)

Net total cash income of a given agricultural enterprise = (total value of sales of the enterprise) - (value of purchased inputs) - (fixed costs excluding depreciation)

3.4 Data analysis

The collected data were organized, summarized and analyzed using SPSS statistical package (SPSS, 2006 ver 15.0). For data involving frequencies, descriptive statistics were employed and Pearson chi-square were used to compare variables across the small ruminant density groups, whereas quantitative variables were analyzed using analysis of variance procedure and Tukey test was used to separate group means when the F test declared significant differences. Reproductive and growth data were subjected to PROC GLM procedure of Statistical Analysis System (SAS, 2002 ver 9.). Fixed effects fitted in the model included the effects of location (Site 1, 2 and 3); sex (male, female); parity (1-≥5); birth type (Single, multiple) and season of birth (dry, small rainy and big rainy season). Excel 2003 was used to plot selected graphs.

The statistical model is explained as follows:

$Yinlmjo=\mu + Li + Xn + Pl + Bm + Sj + eijlmno'$

Where

Yinlmjo =Weights and ADG (pre-weaning) of the n^{th} *lamb/kid*

μ *=the overall mean*

Li = the fixed effect of the i^{th} *location*

Xn = the fixed effect of n^{th} *sex*

Pl = the fixed effect of l^{th} *parity*

Bm = the fixed effect of m^{th} *type of birth*

Sj = the fixed effect of j^{th} *season*

einlmjo=the random error

To estimate mortality, reproduction and offtake of the flocks monitored for one year, the following formulas were used.

Overall mortality rates for particular age and sex structure of flocks (per sheep and goat):

$$\text{Mortality rates (\%)} = \frac{\text{Number of deaths per structure x 100}}{\text{Number of stock within each structure}}$$

$$\text{Overall mortality rates (\%)} = \frac{\text{Total deaths x 100}}{\text{Total number of animal in flock}}$$

$$\text{Fertility} = \frac{\text{Number of females that gave birth x100\%}}{\text{Number of females exposed to males/mated}}$$

$$\text{Litter size/prolificacy} = \frac{\text{Number of offspring produced}}{\text{Number of females that given birth}}$$

$$\text{Weaning rates} = \frac{\text{Number of offspring weaned x 100\%}}{\text{Number of females given birth}}$$

$$\text{Lamb/kid survival rate (\%)} = \frac{\text{Number of offspring weaned x100\%}}{\text{Number of offspring produced}}$$

$$\text{Gross offtake rate (\%)} = \frac{\text{Gross offtake x 100}}{\text{Total flock size}}$$

Acquisition = Sum of purchases + exchanges or gifts

Gross off-take in period (t) = sum of sales + slaughters + exchanges + gifts (t)

4. RESULTS AND DISCUSSION

4. 1 General production system and socioeconomic characteristics

4.1.1 General production system

Mixed crop-livestock production system is the dominating system and is similar to most parts of the central southern region. The major crops grown include maize, sorghum, teff, finger millet, wheat, hot pepper, chat and haricot bean. Maize is a major crop grown throughout the study sites. Other crops are grown at different intensity in different sites of the study area. Cereal and haricot bean based livestock farming and hot pepper based livestock farming are the dominant type of farming system in the area. Cropping is totally dependent on rainfall. The area is reported for its moisture stress. Prolonged dry season and uneven distribution of rainfall during the study period have been observed to put pressure on cropping and feed development.

Cattle, goats, sheep, donkeys and poultry are the major livestock species found in the Woreda. They are an integral part of the farming system. Livestock production is carried out integrated with crop production, from where major household food comes from. Farmers in the area are trying to intensify the system, by using higher level of inputs (fertilizer, improved seeds and herbicides) since factors like fast growing human population, land degradation and the emerging marketing opportunities are pushing them towards higher intensification. Resources (land and labour) allocations differ depending on the season and demand rising at different period. From livestock species, cattle are mainly kept for milk and draft power, and sheep and goats for income generation. The ever-

increasing human population leads to expansion of cultivated area, and consequently diminishes a natural grazing area which in turn puts nutritional stress on livestock. Sheep is more favoured in the system, because they are relatively easy to manage with the exiting situations, and depends on marginal feeds. According to the monitored farmers, discussants and key informants, however, there is an overall declining trend of goat population in the area associated with scarcity of browse species due to continuous changes in the system.

4.1.2 Socioeconomic characteristics

From the total of 60 household heads that participated in the flock monitoring, 88.3% were male headed households whereas 11.7% were female headed households. Almost all the participants (98.3%) were Muslim and all belong to the Alaba ethnic group. The mean age of the participants in the study area was 43.6 years. Mean family size is 7.4 and ranged for 1-16. Of the average family size (7.4), 50.8% were less than 15 years, 48.5% were in age range of working group or in age between 15 to 60 years and 0.68% were above 60 years. From the monitored households, 18.33% were able to read and write; of which 2.98% of them are at educational level of grade 7-12. Most of (73%) the participants who are able to read and write are found in sheep dominant site. Participants in the other sites had less access for education and most of them were not able to read and write. Some household members in sheep dominant and mixed flock sites are also engaged in off-farms activities, as a sideline to cropping and livestock rearing.

4.1.3 Land and livestock holding

Livestock holding and land size of the area is shown in Table 6. Farmers of the study area keep a mix of species; cattle, sheep, goats, equines and chicken, integrated with crop farming and also engaged in off-farm activities. The overall mean landholding in the area is 1.5ha. Significantly larger ($p<0.05$) total land holding (2.26ha) and grazing lands (0.46 ha) were found in goat dominant site than sheep dominant and mixed flock areas. This is attributed to sparse human population per unit area in goat dominating site of the Woreda. Some communal grazing areas are also found in goat dominant site. The overall mean grazing area in the study was 0.27 ha. Most of the individual grazing areas are found in front to the residential house of the farmers, and farm boundary. Tsedeke (2007) also reported the presence of relatively larger (0.37 ha or 17.2%) grazing land around the homestead in the same area. The lower grazing land size obtained in this study compared to the previous one might be the encroachment for cropping and or land redistribution, and the current result is more accurate than previous report because the results were recorded from land ownership certificate. Mean holding of the cattle kept in the study area is 6.5($\pm$0.52). Higher number of cattle was reported in goat dominating site than either of the two sites (Table 6), primarily due to large grazing areas. Most of the households monitored kept cattle irrespective of the resource base the areas have. Milking cows and draft oxen constitute the major proportion of the cattle owned by the participants.

Table 6: Mean (±SE*) land (ha) and livestock holdings (n) per HH in the study area

particulars	SDS	GDS	MFS		Test	
	Mean (SE)	Mean (SE)	Mean (SE)	Overall	F-value	P value
Total land (ha)	1.19 (0.84)[b]	2.26(0.17)[a]	1.36(0.14)[b]	1.50 (0.88)	21.115	.000
Grazing land (ha)	0.19 (0.25)[b]	0.46 (0.06)[a]	0.24 (0.04) [b]	0.27(0.02)	15.454	.000
Cattle	5.77 (0.76)	8.20 (0.97	6.30(0.91)	6.50(0.52)	1.951	.151
Sheep	7.30 (0.69)	4.50(1.8)	5.10(0.62)	6.10 (0.60)	2.382	.102
Goats	1.53(0.62)[b]	11.27(1.79)[a]	3.73 (0.47)[b]	4.50(0.75)	26.114	.000
Equines	0.63 (0.13)[c]	1.53(0.24)[b]	1.80(0.3)[a]	1.15(0.13)	10.458	.000
Chicken	2.50(0.42)[b]	9.60(0.95)[a]	2.30 (0.42)[b]	4.20 (0.52)	48.230	.000

[a, b, c]: Different superscripts denote significant differences at P<0.05 between means within rows, *SE= standard error, n=average number, HH=household

Mean sheep holding was 6.1±0.60 and did not differ significantly (p>0.05) among the study sites. However, it was observed that there were higher numbers of sheep population in sheep dominating site than either of the two sites. The sheep to goat ratio of sheep dominant, mixed flock and goat dominant sites were 5.5:1, 1:1.05 and 1:2.26, respectively. The non-significant mean sheep holding across the study sites is partly due to the depletion of browse for goats in all the study sites, and farmer's preference of sheep to goats. Farmers in the study area prefer sheep to goat, because sheep are easy to manage and depend on marginal feeds (farm boundary, valley bottoms, road side, etc) than goats. According to the monitored farmers, given an opportunity, goats are more comfortable when fed on browses than other feeds.

Statistically significant ($P<0.05$) number of equines, particularly donkeys, were kept in mixed flock site than goat dominant site. Likewise, significantly ($P<0.05$) higher number of donkeys were kept in goat dominant site than sheep dominant site. The higher number of donkeys in mixed flock site is partly due to the presence of off-farm activities and need of transporting water from distant areas. The absence of other transport means for bringing agricultural and other products to market could also be the reason for increased number of donkeys in mixed flock and goat dominant sites. Farmers valued these groups of animals because they contribute a lot for transporting commodities and water from distant areas for human as well as livestock consumption.

4.1.4 Cropping pattern

Maize is the major crop grown throughout the study area, contributing much more for the household food and cash income (Table 7). There was non-significant ($P>0.05$) differences across the sites with regard to land allocation for maize cropping, revealing its importance throughout the study sites, whereas land allocation for sorghum and wheat differs significantly ($P<0.05$) between goat dominant site and other sites. Higher adaptation of sorghum for moisture stress areas might be the reason for its higher production. Some key informants suggested that land allocated for teff is increasing to exploit the higher market price opportunities emerging locally and regionally. Hot pepper is mainly produced in the mixed flock site. It is an important cash crop in the area and the land allocated to it is often the highest ($P<0.05$) in the mixed flock site.

Table 7: Mean (±SE) land size (ha) allocated for major crops per HH in the study area

particulars	SDS(n=30)	GDS(n=15)	MFS(n=15)	(n=60)	Test	
	Mean (SE)	Mean (SE)	Mean (SE)	overall	F-value	P-value
Maize	0.88(0.07)	0.82(0.06)	0.78(0.11)	0.84(0.04)	.384	.683
Sorghum	0.20(0.02)[b]	0.39(0.06)[a]	0.14(0.03)[b]	0.23(0.02)	10.771	.000
Finger millet	0.18 (0.03)[a]	0.10 (0.02)[a]	0.05(0.02)[b]	0.08(0.01)	3.651	.032
Teff	0.48(0.05)[a]	0.20(0.08)[b]	0.25(0.08)[b]	0.35(0.04)	5.705	.006
Wheat	0.00(0.0)[c]	0.65 (0.09)[a]	0.25(0.06)[b]	0.22(0.04)	49.819	.000
Hot pepper	0.10 (0.03)[b]	0.07(0.04)[b]	0.35(0.11)[a]	0.16(0.03)	6.135	.004
Haricot bean	0.15(0.04)[a]	0.00(0.0)[b]	0.05(0.03)[a]	0.08(0.02)	5.889	.005
Chat	0.12(0.02)[a]	0.03(0.02)[b]	0.05(0.02)[b]	0.08(0.01)	5.232	.008

[a, b, c]: Different superscripts denote significant differences at P<0.05 between means within rows; SDS=sheep dominant site, GDS=goat dominant site, MFS= mixed flock site, n=number of participants, HH=households

Farmers in group discussion suggested that price of teff increased two to threefold in the last two years while there were fluctuations in hot pepper price. Accordingly, the land allocated for the predominant cash crop in the area, hot pepper, declined due to its declining market price during the study period. They also suggested that land allocation is dependent on the importance of the crops. This reveals that directly or indirectly farmers are trying to target their production in line with the emerging market opportunities.

4.2 Small ruminant production and management

Feeding

Small ruminants are fed either herded in communal and individual lands or tethered just in front of the residential house or farm boundary. In sheep dominant and mixed flock sites, sheep and goats are herded together with cattle as the grazing areas are in a short distances. Sheep are kept around the homestead, whereas cattle and goats are trekked over long distances in the goat dominant site. Group herding is a common practice of managing the animals in the goat dominating site, forming a group of 10-15 farmers. This is because river and other watering points are far from the residential house; and travelling everyday and other day herding few numbers of animals to the grazing areas and water points is labour intensive. Group herding practices or group hiring the herdsman was also reported from other parts of the country (Alganesh *et al.,* 2003).

Small ruminants, particularly sheep, are tethered around homestead as cattle and goats are trekked over long distances searching for water in goat dominant site. Sometimes goats are kept with sheep tethered at around home, provided that they are few in number. Tethering is to reduce risks of crop damage, protect from predators, and save labour. More than half of the farmers monitored tethered their small ruminants for certain periods over the year; i.e. 71.4% in sheep dominant site, 66.67% in mixed flock site and 33.33% in goat dominant site used tethering their sheep and goats from April to October, for about 7 months in a year. Sheep and goats were fed with fillers and tillers, weeds, green residues of crops and grasses in wet season. There are local bylaws and binding rules that restrict the movement of animals and avoid damage to crops by small ruminants, particularly goats,

during cropping season. As a result, sheep and goats are tethered at homestead under nutritional stress, particularly in sheep dominant and mixed flock areas. During tethering period, there is a limited chance for the selective feeding behaviour of goats. The local bylaw and binding rule (which is locally called *'Afelama'*) punishes a person who lets his (her) animal damage the crops of the others. Depending up on the extent of damage, elders in the community punish the one who release his (her) animal(s) and damage crops.

Similar local punishment rules were reported at Damot Gale Woreda of Wolaita Zone (Fikre, 2009). Legesse *et al*.(2008) also reported the management techniques such as tethering, herding and overnight enclosure in Adilo and Kofele areas to keep small ruminants out of the fields during crop growing season. On the contrary, the majority (79.4%) of the respondents suggested that they used to practice free grazing in south west Ethiopia during wet season (Belete, 2009).

When all the crops were harvested, small ruminants roam freely across the villages during the dry season. The free wandering flocks have an opportunity for mating as one flock might not have an intact male while the other have. This period is a favourable time for feeding upon crop residues (aftermath, stubbles, grain leftovers, weeds, and boundary protected areas), leaves of browse trees and shrubs. During the early dry period (November–December), sheep and goats are in a better body condition and it is an appropriate time for breeding. Accordingly, by conceiving during this period, high rate of parturitions is recorded in April to June. However, from the end of dry season (February-March) to mid of small rainy season (May-June), critical feed shortage is observed in the Woreda. The present results agree with Tikunesh (2009) in Gondar Zuria Woreda of Amhara region, who reported critical feed shortage during the end of dry season. However,

the current result disagrees with many reports generalizing the whole dry season as a feed shortage period. Rather feed shortage was in its maximal during the end of dry to mid of small rainy season. To alleviate the problem, it was observed that the owners break leaves of browse trees and shrubs which are found at inaccessible heights to supplement their animals.

Indigenous trees and shrubs (*Cordia Africana, Melia Azaderech, Accaica species, Eucalyptus tree, Juniperous Procera, Cactus (Opuntia spp), "bedeno*[1]*"* leaves and pods, and mulberry leaves) contribute a great portion of goat feed during dry season. Acacia and 'bedeno' pods are used for supplementing goats. During this period, sheep and goats are also supplemented with roasted grains, chat leftovers ('*garaba*[2]'), residues of local beverages ('*tella* and *areke atella'*), kitchen leftovers, browse leaves and pods, and brewery by-product "*atella'* and salt, etc. The current situations observed are in agreement with reports of Belete (2009) in Goma Woreda and Tsedeke (2007) in Alaba. Yeshitila (2007) also reported the utilization of indigenous browses as feed resources in Alaba Woreda of SNNPR. A growth rate of up to 67 g/day was reported supplementing kids with *Acacia tortilis* pods in smallholder system of South Africa (Ndlovu and Sibanda, 1996). If the animals were not supplemented during dry period, the gain made in the wet season is totally or partially lost in the dry season (Alemayehu, 2003). Some key informant's suggested that goats are feeding up on an unusual browses like (*Juniperous procera species*) and some shrubs, which were not used some 5-10 years ago. The reported change

[1] '*Bedeno'* is an indigenous browse tree whose leaves and pods are fed as a supplement for small ruminants during dry season

[2] *Garaba* is the leftover of chat leaves

in a feeding behaviour of goats during the study period might be due to the overall reduction of the palatable browse species in the area.

Housing

Small ruminants are kept in house during night to protect them from predators, theft and abrupt climatic changes. Sheep and goats are housed together with other livestock in sheep dominant and mixed flock site. In goat dominant site, sheep and goats, and sometimes milking cows are kept in a house whereas other livestock species except poultry are kept in the adjoining corrals. Predator, theft and loss were the highest in mixed flock site. Within human residential house, sheep and goats were tethered on pole or kept in a small protected woodlot since no separate house is built for small ruminants. Pregnant ewes and does at late gestation and new born at early stage of development (2-3 weeks) are kept separately to reduce the risk of physical injuries. Confinement and poor sanitation has created a favourable environment for disease transmission. This was reported in a condition when one animal in the flock was affected by infectious diseases; all the rest in that flock were also affected. This confirms reports by Lemma (2002) that poor housing favours disease and other complexes due to overcrowding in traditional production system.

Diseases and health managements

The major diseases reported in the Woreda are anthrax, smallpox, Peste des petits (PPR), fasciolosis, pasteurellosis and other respiratory diseases. Typical disease symptoms like coughing, sneezing, diarrhoea, bloating, mucus and frowsy mouth and swollen neck were reported before the death of animals. Pneumonia and parasitic diseases were reported in the

area during the early dry season. The high possibility for disease transmission in Alaba flocks while free roaming period might be because many animals do have contact to each other; this creates a favourable environment for disease incidences and transmission. Animals drink contaminated water, coming from different radius, and this also contributes for disease transmission. There was an outbreak of anthrax during the study period, but death in sheep and goats was not reported.

Accesses to veterinary services differ significantly ($p<0.05$) among the study sites of the Woreda (Table 8). An overall mean of 20.2km travel distance to the veterinary services was recorded, of which 5.35Km, 27.1km and 43.1Km travels were in sheep dominant, mixed flock and goat dominant areas, respectively. The poor veterinary access in mixed and goat dominant areas is due to distances of the areas from Kulito Animal Health Clinic and poor veterinary extension coverage in the Woreda.

Table 8: Mean (±SE) distances for veterinary services and water sources

Flock density group	N	Distance to veterinary clinic(km)	Distance (km) to water sources	
			Dry season	Wet season
		LSM ±SE	LSM ±SE	LSM ±SE
Sheep dominant site	30	5.35(±0.28)^{c}	3.97(±0.53)^{b}	2.55(±0.38)^{b}
Goat dominant site	15	43.10(±0.64)^{a}	14.97(±1.53)^{a}	4.33(±0.66)^{a}
Mixed flock site	15	27.10(±1.85)^{b}	5.38(±1.37)^{b}	1.50(±0.28)^{a}
Overall	60	20.20±2.13	7.07(±0.82)	2.73(±0.29)

$^{a, b, c}$: Different superscripts denote significant differences at $P<0.05$ between means within columns, LSM= Least Squares Mean, SE=standard error, N= number of observations

Due to inaccessibility of the modern veterinary services, participants far from veterinary extension sites are making use of ethno-veterinary medicines in traditional way.

Traditional medicines are used by 90% of the participants (Appendix Table 18). The rest (10%) who use modern veterinary services are those located near to Kulito Animal Health Clinic. Treating with '*Tobacco'* leaves mixed with salts and hot pepper to treat diseases associated to bloat and diarrhoea is a common traditional treatment observed during the monitoring time. Soon after treating the animals, small amount of milk (about 100ml) is drenched orally to reduce the adverse effect of the treatments. A tuber which is locally called '*Tula chelego*[3] *or Fersi Belala*", is crushed and grounded and then mixed with salt is used to treat human as well as animal diseases. Farmers suggested that this traditional medicine could be used to treat about 10 different diseases. Markos (2000) in Awassa Zuria and Endrias and Tsedeke (2006) in Waliata and Dauro zones also reported the wide application of ethno-veterinary practices to flocks and herds with health problem. Improvement in the management systems is a necessity to reduce the loss associated with diseases and parasites. Management and hygienic measures were reported as important approaches to reduce high lamb and kid losses in traditional flocks (Wilson, 1989; Armbruster and Peters, 1993).

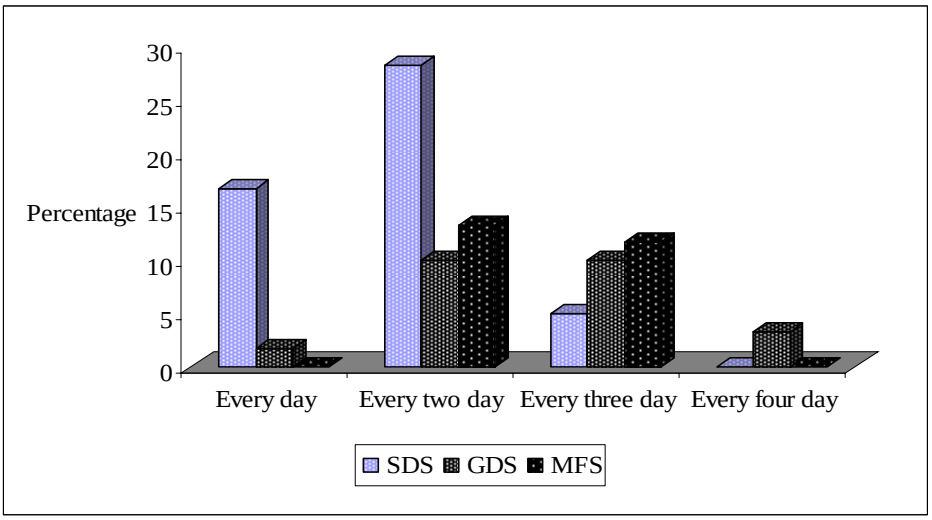
Small ruminants watering

Provision of water is of prime importance in all animal production systems. Water availability is a burning issue in the study Woreda. Rivers, surface water in wet season, pipe and pond water in early dry seasons are the major water sources. Water shortage was reported frequently in the Woreda similar to most parts of the rift valley areas. Participants in sheep dominant site have an easy access to river water and make use of it as they are

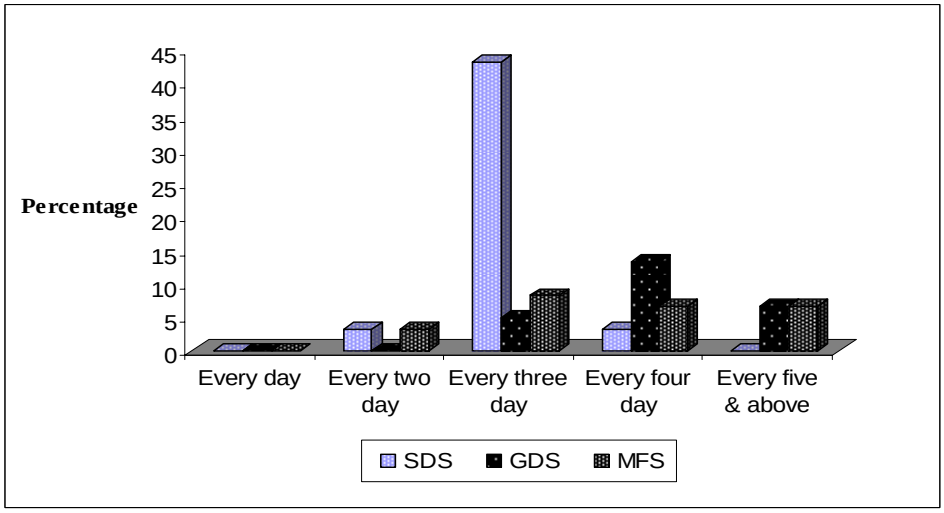
[3] '*Tula chelego'* is a rhizobous type of plant whose tuber is used for treating human and animal diseases

located around the Bilate river. Whereas farmers in mixed flock and goat dominating areas are suffering a lot due to shortage of water for human and livestock consumption. A mean travel distance of about 7.07 kilometres in search of water is a common phenomenon in Alaba (Table 8). Higher and significant ($p<0.05$) travelling distance (15km) to the watering points was recorded in goat dominant site than other sites, particularly during the dry season. Group herding is practiced to reduce the pain of travelling long distances everyday and every other day. Every other day the herdsman travel from down to dusk trekking their animals towards water points. Similar findings were reported on the water shortage in the rift valley areas of Oromia region and the neighbouring zones (Abule, 1998; Tsedeke, 2007). Loss of time and energy while travelling to and from water points was also reported (Samuel, 2005). Reports also indicated that 89.5% of the rural human population use unsafe and polluted water (Tesfaye and Mengistu, 2005). Alaba and the nearby areas under rift valley might take the largest share. Small ruminants are watered at different interval and frequencies in the dry season.

Figure 2 shows the watering frequency of small ruminants in the dry season. Most of the participants (28.3%) in sheep dominant site water their sheep at intervals of two days. In the dry season, about 13.3, 11.7 and 5% of the participants in sheep dominant, goat dominant and mixed flock sites, respectively, water their sheep at intervals of three to four days. Most of the participants (43.3%), 3.3% and 3.3% in the sheep dominant, water goats at intervals of every two, every three and every fours days, respectively, whereas as larger proportion of the participants (26.4%) in goat dominant site water at intervals of every four to five and above days. The respondents suggested that shorter watering frequency is required for sheep since they are more susceptible for water shortage than goats.



(a)



(b)

SDS=sheep dominant site, GDS= goat dominant site, MFS= mixed flock site

Figure 2: Watering frequency of sheep (a) and goats (b) in Alaba Special Woreda

Watering frequency is irregular during wet season as surface water is available and again the animals get water from green feeds. The previous report of the same area indicated that 17.3% of the small ruminant owners water their animals at intervals of five or more days (Tsedeke, 2007), which has significant effect on dry matter intake and thereby animal

productivity. The implications of prolonged interval of watering frequency are reduced feed intake, declined milk yield and other physiological disorders.

Reproduction

A year round mating is practiced in the area as far as rams and bucks are available in the household or in the nearby villages. Farmers in the sites monitored bring ewes or does in heat to rams or bucks in the respective villages, if there is shortages of intact males. Young bucks and rams are sold before attaining the age of puberty. Buck shortage is observed in mixed flock site during monitoring period. This was also supported by the male to female ratio, which was less than the recommended (1:25). The shortage is not only due to lack of the male (buck or ram) but also inaccessibility. Farmers are coping up with the problem by bringing their animals in heat to the nearby villages. Some monitored farmers suggested that for services of few females in the flock, it is not economical to keep males, which is a good strategy. However, selling males before attaining age of puberty without selecting for genetic improvement could have negative consequences in the productivity of the next generation. Rare practice of retention of young male for breeding was also reported by the previous study in the same area (Tsedeke, 2007). The farmer's selection against growth in their sires was also reported in Nigeria (Reynolds and Adediran, 1994), removing fastest growing males first.

Weaning

There is no definite time of weaning the young in both species. However, when the young were able to depend more on roughage feeds, a rope was inserted between the two mandibles tied to the horn, to protect suckling in the sheep dominant site (figure 3).

Separating the young from their dams and smearing the teat with dung are common methods of weaning across the sites. Growth rate is determinant for weaning than age. Some farmers wean before three months and some wean later. Participant farmers indicated that milk of goats was taken up for human consumption when it was more than needs of the kids; when the kids are at better growth. Kids or lambs born from dams with good mothering ability are weaned earlier than from those with bad mothering ability i.e. mothers have poor milk and milk let down.

Figure 3: Weaning method of the young kid (sheep dominant site) of the study area

Castration and finishing

Males were either sold or castrated and kept for finishing. Castration is not recognized as a method of preventing undesired breeding, but as a method of fattening a ram or buck over a year of age. Castrates are fed with concentrate supplements, mainly grains of corn, enset corm, sorghum grain and half boiled haricot bean. Fikre (2009) in his survey also captured

the use of enset corm and boiled corn for fattening sheep in Damot Gale Woreda of Wolaita zone. Castration of the lambs and kids for fattening has been reported from different parts of the country (Solomon *et al*., 2005; Tsedeke, 2007; Belete, 2009). However, finishing process in the area is lengthy, takes a year and half or two, primarily due to poor resource base and less awareness of costly process of fat deposition; and has a great consequence on labour and other variable costs, and thus might not be economical.

Marketing

Selling and purchasing of small ruminants was recorded throughout the year, though peak marketing was observed when high cash demand for agricultural inputs is needed. Participants also sold their animals during public festivals and holidays (Id-Al Maulid, Id-al Adaha (‘*Arafa’*), Id-Al-Fetter (‘Ramadan’), Easter and Ethiopian New Year) to exploit higher prices. It was analyzed from initial flock inventory that younger male lambs and kids were removed, mostly through sales. These trends were also observed from the flock monitoring studies. Long market distances in goat dominant and mixed flock sites forced the producers to sell their animals at farm gate price. Some farmers try to sell their animals after travelling long distances to Adilo market, to get premium price, particularly during holiday markets. Alaba and the nearby zones (Kembata, Hadiya and Wolaita) have certain chain of lamb production and finishing and attracting regional and national market through the Adilo routes, pointing out the need of further targeted study to identify whether the system is profitable, and to improve the efficiency of the system.

Labour division in small ruminant management

All family members are involved in small ruminant management, though their level of involvement varies based on the type of activities. Children were the most responsible (80%) for herding, while women were the most responsible (58.8%) for harvesting grasses, cleaning barn and milking does. Health care and prescribing traditional treatment is carried out by the household head (95%), male and female. Household heads, particularly males, had 96.7% right of selling and 100% decision making on income obtained from the sale of small ruminants. Fikre (2009) reported that male household head, women and children, respectively, are responsible for 49.2%, 38.8% and 12.1% of the tasks related to small ruminant's management.

4.3 Flock ownership, composition and dynamics

4.3.1 Ownership

The average flock size kept by the households and composition by age and sex in the study area is presented in Table 9. The overall flock size per household found in the present study was 6.1 sheep and 4.5 goats. Flock size ranged from 2 to 19 heads of sheep and 1 to 26 goats. In the goat dominant site, sheep and goats ownership of 47 heads per household was recorded and monitored.

The ownership pattern of the present study is in harmony with the reports from different parts of Ethiopia. The current mean sheep holding (6.1) is higher than the previous results, i.e mean sheep holding of 5 reported by Tsedeke (2007), 3.6 sheep (Belete, 2009) and 2.2 sheep (Fikre, 2009), 4.2 sheep (Berhanu,1998) in south and south western part of the

country, 2 in Kombolcha and Gursum (Workenh, 2000), 1 in Debre Zeit (Samuel, 2005), 1.6 in Boricha Woreda (Kebebe *et al.*, 2006), 0.6 goats in west and north Showa zones (Agajie *et al.*, 2002) and 0.8 and 1.6 sheep in Wolaita and Dauro zones (Endrias and Tsedeke, 2005) in respective order. Slightly higher average holding (6.97) per household was reported for areas around Dire Dawa (Aden, 2003).

The mean holding of goats obtained in this study is slightly higher than the reports (4.1) of Fikre (2009) in Damot Gale Woreda while the mean holding of goats reported in the previous report (6.5) (Tsedeke, 2007) in Alaba and 5.98 goats for the former Dale Woreda (Endeshaw, 2007) is higher than the current results. The present study is, however, comparable with the average flock size of goats else where in Africa; average flock size of 4.5 (Ibrahim, 1998) and 4 goats (Ahuya *et al*., 2005) in Kenya, 5 goats in Cameroon (Ndamukong *et al.*, 1989), but lower compared with 7.5 goats per flock in Nigeria (Francis, 1988), 8 goats in Ghana (Turkson, 1992) and 9.9 goats in Gambia (Jaitner *et al.*, 2001).

The ownership of small ruminants depends on the wealth status of the household; i.e. land, labour and feed resource availability. Monitored farmers suggested that '*farmers with high number of livestock are rich*'; while those with '*large land size are not necessarily rich*', revealing livestock number is an indicator of the wealth status in the rural community. Private ownerships, share holding (either share the animal itself or care taker ownership, in which the offspring's are shared), were recorded in the Woreda. In all the studied sites, private ownership predominates, which is thought to be a good opportunity to transfer the technology options. Share holding is not commonly practiced in the study area. However, from the recorded shareholding, relatively larger share was found in sheep dominant site.

Animals are given for shareholding mainly among relatives and relatively better resource endowment areas. There are very few castrates and fattening sheep and goats, thus shareholding of them is not common in the area. The overall smaller shareholdings reported in goat dominant site could partly be attributed to the better land and feed resource endowment in that site and in such a condition the owners are not in need of transferring their animals to other person.

Inheritances from the parents, during marriage, and or other special occasions, and purchasing are the major ways for flock establishment. Purchasing and inheritances from parents contributed to 34.34%, 17.1% and 12.49% initial sheep flock establishment in sheep dominant, goat dominant and mixed flock sites, respectively. Poor farmers establish their flock by obtaining some female animals on a share basis from rich farmers. Overall the higher number of transferred animals recorded in sheep dominant site were primarily because resources (land, labour and feed) are limited for large number of flocks to be kept. Transferring some from the flock for shareholding is a strategy to reduce risks associated with shortage of family labour, space, diseases and feed scarcity.

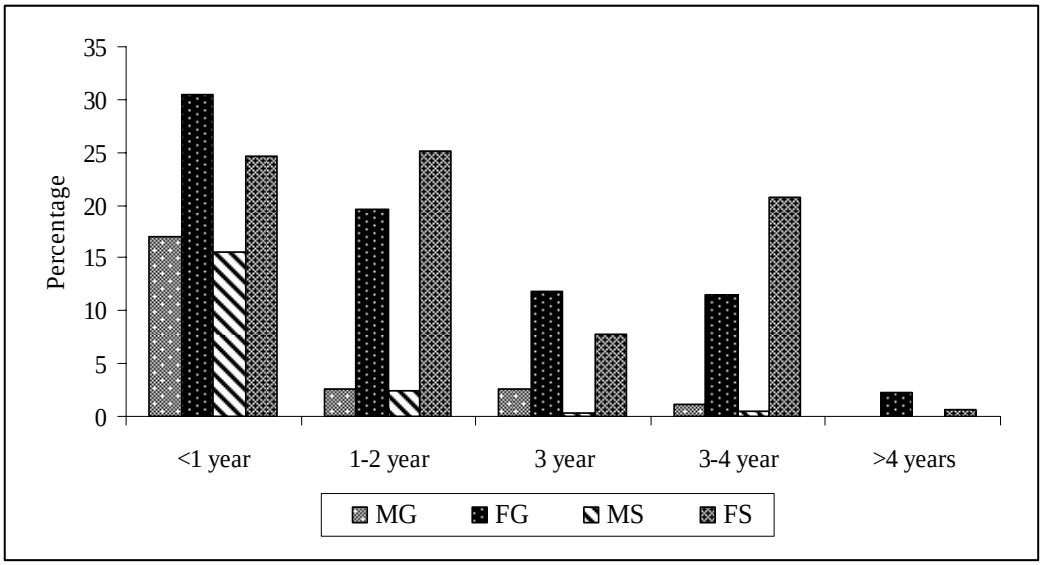
Table 9: Average flock size per household and flock composition by sex and dentition groups in Alaba special woreda

Dentition♣/species	0		1		2		3		3-4		Aged/broken teeth		Overall		AFS*
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Sheep															
Female	90	24.6	36	9.8	56	15.3	28	7.7	76	20.8	2	0.5	288	78.7	
Male	57	15.6	7	1.9	2	0.5	1	0.3	2	0.5	-	-	69	18.8	
Castrates	-	-	-		-		-		9	2.5	-		9	2.5	
Total	147	40.2	43	11.7	58	15.8	29	8.0	87	23.8	2	0.5	366	100	6.1
Goats															
Female	82	30.4	22	8.1	31	11.5	32	11.9	31	11.5	6	2.2	204	75.6	
Male	46	17.0	3	1.1	4	1.5	7	2.6	3	1.1	-	-	63	23.3	
Castrates	-	-	-	-	-	-	3	1.1	-		-	-	3	1.1	4.5
Total	108	47.4	25	9.2	35	13.0	42	15.6	34	12.6	6	2.2	270	100	

*AFS =average flock size per HH; n= number of animals, Dentition♣ 0 = milk teeth, 1= one pair of permanent incisor, 2= two pairs of permanent incisors, 3= three pairs of permanent incisor, 3-4 years= full mouth (Okeyo *et al*., 1991; Girma, 2008).

4.3.2 Flock composition

A total number of 636 sheep and goats, of which 366 sheep and 270 goats, were recorded during flock inventory at the very beginning of the study. From the flock inventory, 54.2% ewes and 45.2% does were above 1 year of age (reproductive age). Young rams and bucks of less than one year were 15.6 and 17%, respectively. This proportion declined to 2.6 and 2.4%, respectively, after a year. Castrates constitute only 2.5 and 1.1% of the rams and bucks, respectively (fig 4).



MG=male goat, FG=female goat, MS= male sheep, FS= female sheep

Figure 4: Distribution of male and female sheep and goats of different age categories of the special Woreda

Males were removed from the flock at early age (about a year and half), and as a result, the proportion of males declined at later ages. Early removal of males, particularly bucks, was also confirmed by the monitored farmers during continuous surveying period. Higher rates of male offtake were recorded during the study period, the majority being removed from the flock before a year and half. Some key informants suggested that only few males are

required for breeding and others should be disposed off through sale since feed shortage is a problem and insufficient resource base for fattening. Reynolds and Adediran (1994) also reported that it is unnecessary for all farmers to keep a buck in villages with free roaming flocks in Southwest Nigeria. The same authors observed that the majority of male kids are removed from the flock before 12 months of age. A low proportion of males in the flock at the later ages confirm the findings of Reynolds and Adediran (1994) and Getahun (2008). The remaining adult males were castrated and finished. Holiday market targeted finishing was reported in Alaba but not as high as the neighbour Woredas; Kedida Gamela and Badawacho (Getahun, 2008), revealing the micro level differences in resource base, management and finishing systems.

Of the total sheep and goats registered, 78.7% and 21.3% were female and male sheep whereas 75.6% and 24.4% were female and male goats, respectively (Table 9). The present findings are slightly higher and but still confirm the report of CSA (2008), which is 73.38% females and 26.62% male sheep and 69.84% female and 30.16% male goats for the country. Dibissa (2000) also reported 70% of female sheep in the Northern Highlands of Ethiopia, slightly lower than the current results. Lebbie *et al.* (1999) reported 70% females and 15% males in the traditional sheep flocks of Swaziland. The proportion (54.1%) of reproductive age female sheep (1 year and above) obtained in this study is in agreement with findings of Getahun (2008) for Adilo sheep of Kembata Tambaro zone. The proportion was slightly lower than reports for breeding ewes (58.8%) in northern Ethiopia (Lemma, 2002). A study conducted in the central Ethiopia indicated that 52.5% of adult females are above one year (Mukassa et al., (1986), which is in a close agreement with the current findings (54.2%). Females totaled 74.8% of the flock, entire males 22.4%

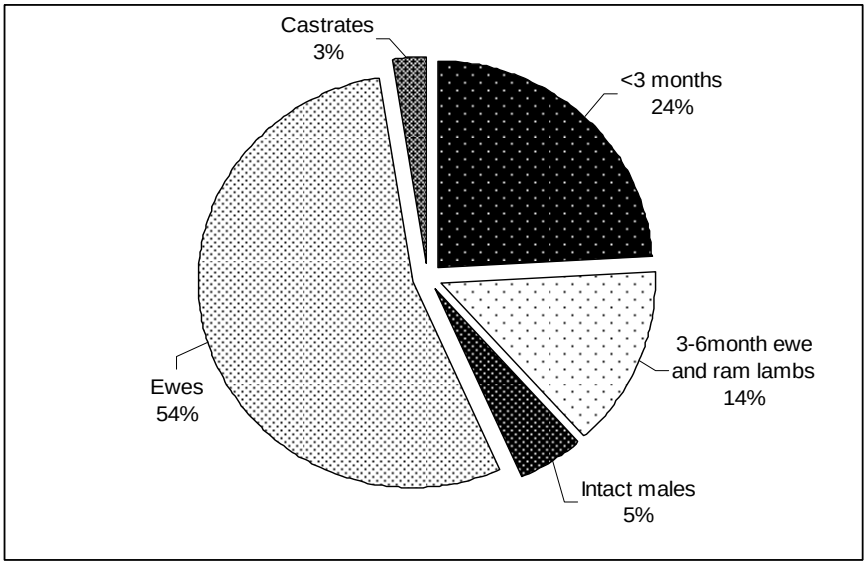
and castrates of 2.8% (Agyemang *et al.,* 1985) were reported in the traditional sheep production of Debre Brehan.

The structure could be further categorized as 54.2% ewes, 24.2% sucking lambs, 14.1% ewe and ram kids (3-12months), 5.0% intact rams and 2.5% castrates and fattening sheep in the flock studied (figures 5 a and b). Likewise, there are 45.2% does, 27.1% suckling kids, 24.2% doe and buck kids (3-12 months), 2.4% intact males and 1.1% castrates and fattening goats (Figure 5). Breeding females and pre-weaning young constitute the largest proportion of the flocks. These results are in a close agreement with the reports of CSA (2008) of the country. The pattern is similar with the previous studies in southern and south western Ethiopia (Tsedeke, 2007; Endashew, 2007; Belete, 2009).

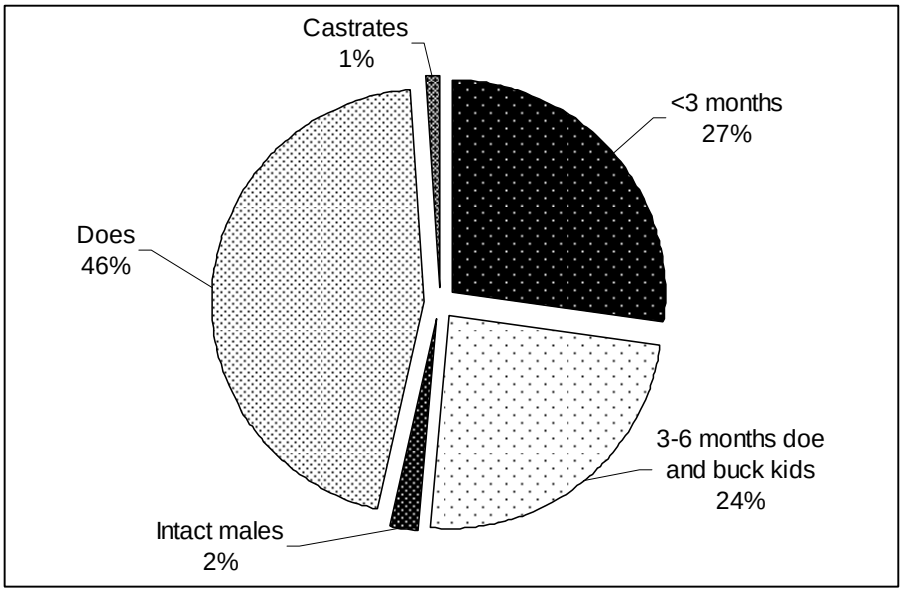
The overall buck to doe and ram to ewe ratios were 0.05 and 0.10, respectively. The proportion of intact male (ram) to ewe ratio for sheep is 0.08 in sheep dominant site, 0.12 in goat dominant site and 0.05 in mixed flock site. Similarly, buck to doe ratio is 0.08, 0.06 and 0.03 in sheep dominant, goat dominant and mixed flock sites, respectively. The buck to doe ratio of the mixed flock area was somehow smaller than the recommended breeding ratio for small ruminants. Shortage of intact males in a mixed flock area was also observed during the monitoring period. However, since the flocks were wandering across the villages, the scarcity is not that much magnified. Farmers take females to the nearby villages when there is shortage of intact males for reproduction.

Intact male sharing for reproduction was also reported in previous studies in Alaba and Dale Woredas (Tsedeke, 2007; Endeshaw, 2007). The overall average male to female ratio for both species in the Woreda was in the range of the recommended breeding male to

female ratio (1:25) for sheep and goat under traditional production system (Wilson and Durkin, 1988).



(a)



(b)

Figure 5: Flock composition of small ruminants in Alaba, sheep (a) and goat (b)

The higher female number in the flocks of the traditional production system was because they are retained for breeding while fewer intact males are kept for breeding and castrates

for finishing. This confirms many other studies (Endeshaw, 2007; Tsedeke, 2007; Getahun, 2008; Belete, 2009) in Ethiopia, irrespective of the differences in a production system and resource base. However, resource availability is the primary element that distinguishes one production system to another (Getahun, 2008), for further finishing and milk production (goats).

4.3.3 Flock dynamics

At the beginning of the study (October, 2008), mean flock size of sheep and goat was 6.1 and 4.5, respectively, (ranges 2-19 sheep and 1-26 goats) (Tables 10 and 11). The 60 households had a total of 366 sheep, of which 288 (78.7%) were females and 270 goats, of which 77% were females. There were 219 adult sheep, of which 21 (9.59%) were males. Likewise, there were 159 adult goats, of which 7 (4.4%) were males. Birth, purchase, shareholding and gifts back[4] were the major routes of entry into the flocks, of which the predominant route was entry through birth. Over 12-month period, 155 lambs and 135 kids were born, with a mean litter size of 1.51 and 1.45, respectively. At the end of the study, mean flock size of 5.52 and 4.90 per household were sheep and goats, respectively, with a total flock size of 334 and 295 for sheep and goats, respectively.

Birth was the most common reason for entry, accounting for 155 lambs (87.1%) and 135 kids (94.4%) out of 178 entries and 143 entries, respectively. Eighteen young female sheep (10.1%) were purchased, 3 (1.7%) animals entered for shareholding and 2 (1.1%) returns from loans. Likewise, 3 adult female goats (2.1%) were purchased, 4 entered from

[4] gifts back is returning the animal taken temporarily, either the animal itself or the replacement.

shareholding (2.8%) and 1 returned from loans (0.7%). Entries as shareholding is not recorded in goat dominant site partly due to the fact that the site is relatively endowed with better feed resources and the owners do not need to transfer their animals. Entry through purchase was not recorded in the goat dominant site primarily due to the presence of large number of young stocks for replacement. In sheep dominant and mixed flock sites, relatively higher shareholding strategy is practiced to reduce risk of losing animals due to feed shortage, diseases and associated emaciation. The current results of entry routes of goats through home born (94.4%) concur with the results reported (93%) by Reynolds and Adediran (1994), but higher than the results (63.3%) reported by Tsedeke (2007) for goats in the same Woreda. The current results approach more to the population mean than the previous study, because the events were obtained by recording. The current results confirm results reported by CSA (2008) strongly, that 90.2% and 90.1% entry of sheep and goats, respectively, in Alaba Woreda was through birth in the year 2007/2008. Share holding, generally, though not an important entry route for the flocks, it is an important way of building initial flock by the poor. The community self-help through shareholding was also reported as an important way of initial flock establishment (Tsedeke, 2007).

The exit routes vary widely among the study sites within the Woreda. Of the total 636 sheep and goats registered in the beginning of the study, 210 sheep and 118 goats exited in the flocks monitored during one year period (Tables 10 and 11). Sale, deaths, slaughter, shareholding and gifts out were the major routes of flock exits. Sell for income generation accounted for 60.5% exits in sheep flocks and 41.5% exits in goat flocks. Death due to diseases, concentrate and forage bloats and other digestive disorders contributed 13.8 and 17.8% in sheep and goat flocks, respectively. The higher death reported were at the goats' dominating site, since it is far from veterinary extension services. More male than female

young stock exited for ceremonial and holiday slaughter (12 young vs 2 adults in sheep and 12 young vs no adults in goats), with young animals outnumbering adults in both species (14 vs 7 in sheep and 12 vs 7 in goats). Predation accounted for 5.71 and 2.54% in sheep and goat flocks, respectively, of which 3.21% is in the mixed flock site. This is perhaps partly related to the topography of the area (gullies, ups and downs and gorges) favor the predators, mainly foxes and hyenas in a mixed flock site (Tables 10 and 11).

Shareholding, gifts out and others (thefts, weak births, mechanical damage, distocia and losses) contributed for 5.2%, 1.4% and 2.4% exits in sheep flock whereas 5.9%, 11.9% and 4.2% in goat flocks. The higher gifts out in goat dominant site contributed for the increased gifts out (11.86%) in goat flocks, since the presence of large flock size and long tradition of society's custom for gifts and exchanges. Exits of sheep and goats through sale is mainly associated with the immediate and seasonal cash needs while exit through predator was partly due to the poor management; releasing the animals without herdsman. Small ruminants were also sold for socioeconomic needs like marriage, covering transport costs to participate in funeral ceremonies, etc. They are considered as risk averters being hedge for other livestock and food grains. The finding of exits through sale of this study, 60.5% in sheep and 41.5% in goat flock, is higher than that of the previous report (29%) in the same Woreda (Tsedeke, 2007). The differences in the sale rate of small ruminants as compared to the previous report might be due to the overall emerging market opportunity and also to some extent the methodology of data collection; recalling versus recording, and thus this study could be more accurate than previous studies. Higher exits through sale (69.4%) was reported (Belete, 2009) from the flocks monitored about six months, which is too short a period to get sufficient data.

Table 10: Structure, entry and exits of village sheep in the study area (values shown are totals across 60 households)

	Male			Female			Total	% of total
	Young	Adult	Total	Young	Adult	Total		
Start								
October 2008 (n)	57	21	78	90	198	288	366	
%	15.6	5.7	21.3	24.6	54.1	78.7		
Entries								
Births	73	-	73	78	-	78	155	87.08
Purchase	-	-		18	-	18	18	10.11
Shareholding	-	-		-	3	3	3	1.69
Gifts back	-	-		-	2	2	2	1.12
Total	73	-	73	96	5	101	178	100
Exits								
Sale	57	18	75	19	33	52	127	60.48
Death	7	-	7	13	9	22	29	13.81
Home slaughter	12	3	15	2	4	8	23	10.95
Shareholding♣	-	-	0	2	9	11	11	5.24
Gifts out	-	-	-	3	-	3	3	1.43
Predator	4	-	4	8	-	8	12	5.71
Others*	2	-	2	3	-	3	5	2.38
Total	48	12	103	52	51	107	210	100
End								
September 2009 (n)	68	8	76	101	157	258	334	
%	20	3	23	30	47	77		

♣Shareholding in this context is that the female doe or ewe (dam) given for car taker from the owner for sharing the offspring's *=Transferred for risk aversion, mechanical damage, theft and losses.

Table 11: Structure, entry and exits of village goats in the study area (values shown are totals across 60 households)

	Male			Female			Total	% of total
	Young	Adult	Total	Young	Adult	Total		
Start								
October 2008 (n)	46	17	63	82	126	207	270	
%	17	6	23	30	47	77		
Entries								
Births	69	-	69	55	-	55	135	94.41
Purchase	-	-	-	-	3	3	3	2.10
Shareholding	-	-	-	-	4	4	4	2.80
Gifts back	-	-	-	-	1	1	1	0.69
Total	69	-	69	55	8	63	143	100
Exits								
Sale	22	7	29	8	12	20	49	41.53
Death	4	-	4	9	8	17	21	17.80
Home slaughter	12	5	17	-	2	2	19	16.10
Shareholding ♣	-	-	-	2	5	7	7	5.93
Gifts out	2	-	2	9	3	12	14	11.86
Predator	1	-	1	2	-	2	3	2.54
Others*	2	-	2	3	-	3	5	4.24
Total	43	12	55	32	31	63	118	100
End								
September 2009 (n)	80	17	97	94	104	197	295	
%	27	6	33	32	35	67		

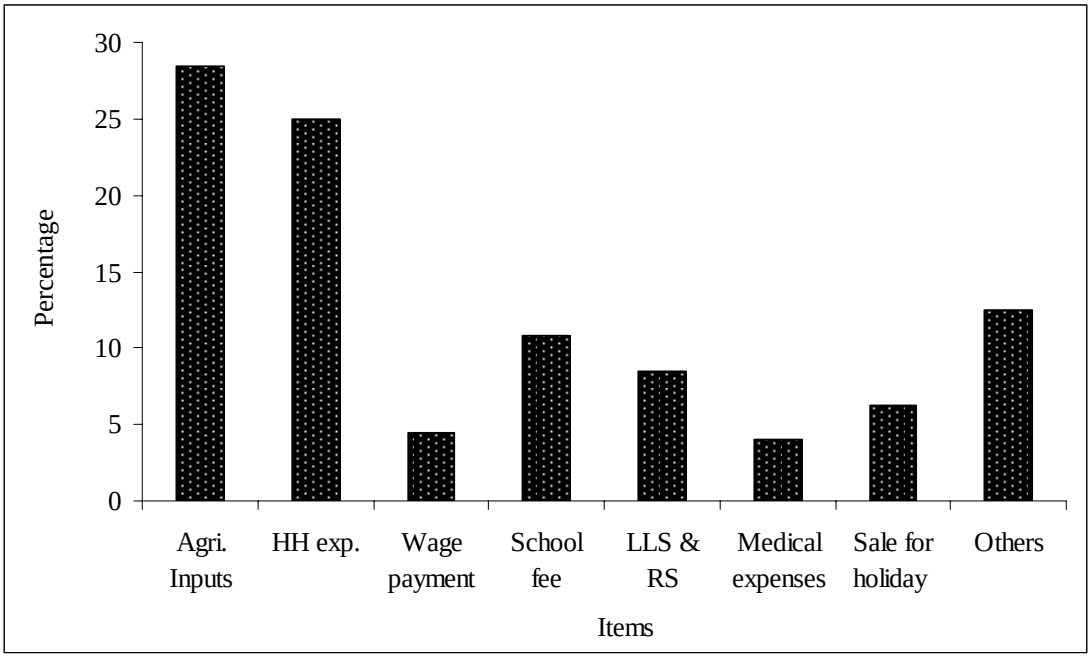
♣Shareholding in this context is that the female doe or ewe (dam) given for car taker from the owner for sharing the offspring's;*=Transferred for risk aversion, mechanical damage, theft and losses.

Legesse *et al.* (2008) reported higher number of exits of small ruminants through sale for the purchase of agricultural inputs. Cash sales (1.75%) and home slaughter (0%) were reported as minor causes of exits of kids up to the age of 6 months in North East Zimbabwe, whereas predation was high (17.5%) (Ndlovu and Simela, 1996). Sumbreg *et al.* (1985) reported exits due to death (46.3% in sheep and 31% in goat), sales (9.4% in goat's vs 6.8% in sheep), gifts or loan (14.4% goats vs 14% in sheep), home consumption (19.4% in goat vs 38.7% in sheep) in the village flocks of Nigeria. Of the 47% total outflow, 17% was through offtake and 30% were through mortality in traditional management of Swaziland (Tibbie, 1999). Exits through death by plant poisoning were also reported for Kombolcha and Alaba goats (Workeneh, 2003; Tsedeke, 2007).

Exits for home consumption (slaughtering) were mainly during Moslem holidays, "Id Al Adaha (*Arafa*), Id al Maulid, 'Id Al-fatir (*Ramadan*), and Easter and Ethiopian New Year. Of the total slaughtered animals (11.0% sheep and 16.1% goats), about 19% were slaughtered at half of the fasting period which is locally called '*someni dare'*. Percentage of home slaughtered goats (16.1%) are comparable with reports of Workneh (2000), number of slaughtered goats (15.2%) in eastern Ethiopia and previous report (14.3%) of sheep and goats in Alaba (Tsedeke, 2007), but lower than that of Belete (2009), who reported 28.8%, in Gomma Woreda of Oromia region. Tibbie (1999) also reported that from the total offtake (17%), 60% was by slaughtering for home consumption, emergency and ceremonial reasons, 33% was through commercial sales and 7% was gifted out in the traditional management of Swaziland. On the contrary, only 1% goats exited through home consumption in a village goat herds in southwest Nigeria (Reynolds and Adediran, 1994).

About 25.1% sale and 7.8% slaughters were recorded in traditional sheep production of Debre Brehan (Agyemang *et al.,* 1985), lower than the current results.

Of the overall average exits (51.01%) of both species through sale, income generation to purchase agricultural inputs and food grains contributed the higher proportions, i.e. 28.4% and 25% %, respectively (Fig 6). From the total exits through sale, large proportion of sheep and goats exited from the flocks during the cropping season throughout the study sites, indicating the importance of these animals as generators of immediate and seasonal cash needs.



Agri. inputs=agricultural inputs, HH exp. =household expenditure, LLS= Large livestock and replacement stock, others= risk aversion, social obligations (wedding, funeral ceremonies, mosque payment, etc.)

Figure 6: Utilization of money obtained from sale of sheep and goats

Although large number of small ruminants exited during the cropping season and public holidays, they were sold often throughout the year when need arises, presumably often when price were low, and this supports the results of other reports indicating that *ad hoc*

sales of animals to meet emergencies prevail (Budisatria, 2007; Kosgey *et al.,* 2008). Endeshew (2007) reported that 61% of the farmers sold goats to purchase agricultural inputs, pay school fee and cover household expenditures; 24% to fetch higher prices during public holidays and 5% to reduce risk of total losses during disease outbreaks. However, Kosgey *et al.*(2008) reported somehow different exit routes; 75% of the farmers selling small ruminants in extensive system of Kenya, of which 34% spent their income on school fees, purchase of food (22%), farm investment (18%), medical expenses (10%), off-farm investment (9%), social activities (5%) and re-stocking (4%).

Monthly exits of sheep and goats are set out in Figure 7. Most of the exits recorded during the period between January to May and July to September; February, May and September taking the largest share. During the cropping season, February to May and July to August, most of the exits of the animals were through sale to purchase agricultural inputs (fertilizer and improved seeds). In April, the Easter holiday contributed to an increment in exit rate. The higher exits recorded in sheep flocks in the months between August to November were related mainly due to the Muslim festivals, Ethiopian New year and disease associated complexes. Home slaughtering for Muslim festivals and holidays is more important than other occasions (funerals, dowries) in Alaba context. The current findings confirm reports of Legesse et al. (2008) that high sale rate of small ruminants during peak demands period (agricultural input purchasing period) for Adilo Woreda. Tsedeke (2007) also reported flock sales of 20.3% during planting seasons to purchase farm inputs (seed, fertilizer and farm implements), which was lower than the current results.

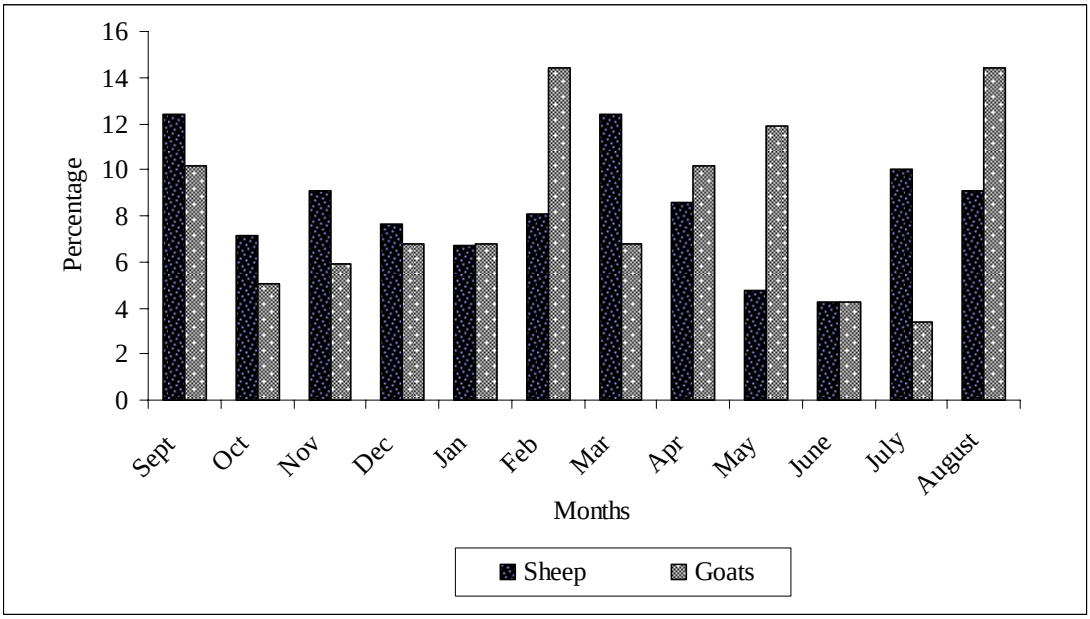


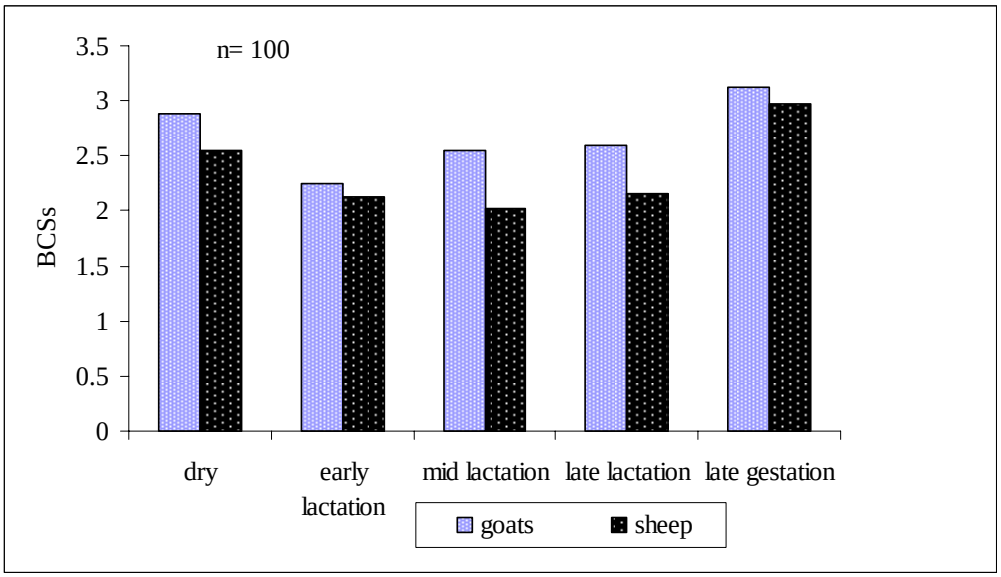
Figure 7: Pattern of sheep and goats exit in the study area

More than 40% of the exits of goats were in months of February, May and August whereas more than 25% of the sheep exits were in September and March. The higher exit of sheep during this period (mainly in September) is due to death associated with high diseases and parasites incidences other than the other forms of exits, as sheep flocks were reported for their susceptibility and less resistant to diseases and drought than goats. During outbreaks and acute cases, deaths were recorded irrespective of the species difference.

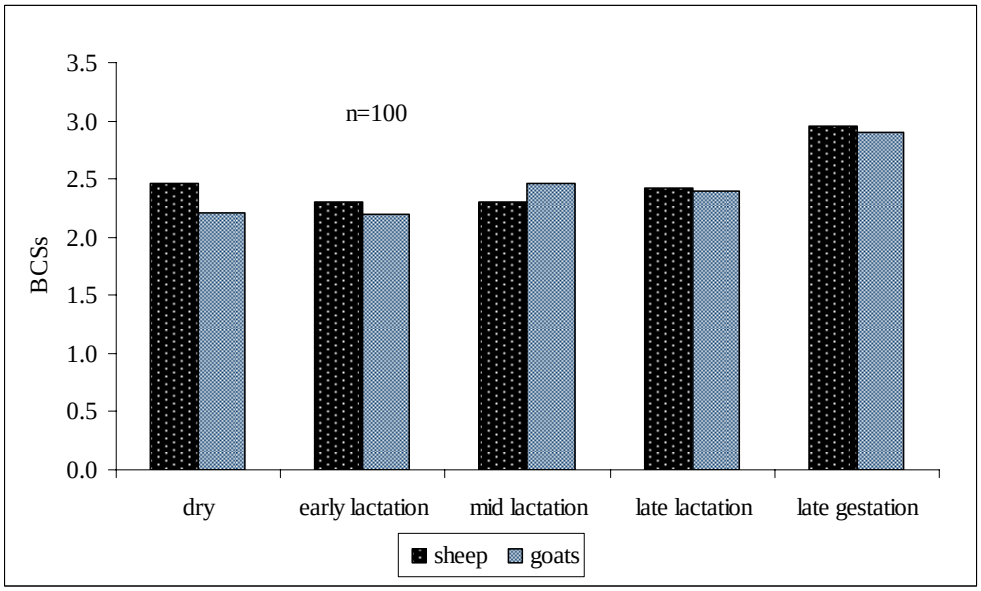
4.4 Body Condition Score (BCSs)

Body condition of animals could vary within and between seasons, depending on feed availability, diseases, physiological status, etc. A total of 200 females of first and higher parties, 100 from each species were assessed for their body condition in two major seasons

(late dry and big rainy). The condition score of the ewes and does is presented in figure 8 (a) and (b).



(a)



(b)

Score 1=very thin, score 2= thin, score 3= moderate, score 4=fat, score 5=very fat
BCS= body condition score

Figure 8: Body condition changes in ewes and does production cycle, dry season (a), wet season (b)

The results indicate that during the end of dry season, goats were tolerant and had relatively better body condition whereas sheep lost their body condition. The mean BCS of 2.88 for does as compared to ewes (2.55) at breeding in dry the season are about optimum. The probable reason for the drop of BCS of dams below 2, particularly in dry season lactation period was that lactation is demanding for more nutrients for mobilization of the body reserves for suckling young while the period is critical feed shortage time.

During the wet season, ewes had better body condition than does, as ewes could get sufficient feed from the available sources (grasses, green weeds, etc) whereas goats are either restrained to restrict their movement and or tethered during this period. Both does and ewes were scored above 2.75 at pregnancy in both the major seasons, which agrees with reports that suggests close supervision of females is necessary to make sure score of close to 3 throughout their pregnancy period. Though there were thin ewes and does scored during the monitoring period, the average score was within the acceptable range (2-3) at breeding time. Ewes and does in a poor condition during lactation period could regain weight later; this could lead to prolonged parturition interval and reduces overall productivity.

Sibanda-Majele *et al.* (2000) reported cyclical changes in does weight around the breeding cycle, with the younger does gaining faster than older one. The same author concluded that typical doe gained substantial amounts of weight during pregnancy and lost some of that weight in early lactation, making a small net gain over the cycle. Burke *et al.*(2002) also reported the seasonal changes in weight and body condition of United State ewes in the breeding cycle. A study conducted on Portugese ewes to determine the effect of body

condition score on blood metabolites and hormonal profiles indicated that there were variations in metabolic status at different BCS (Caldeira *et al.*, 2007); revealing ewes with BCS less than 2 seem more susceptible to metabolic imbalances. Sheep and goats selected for fattening should have medium body condition scores of 2-2.5. If too thin, the fattening period is prolonged and has implications on labour intensiveness and increment in variable costs. BCS is an indispensible tool for producers to make management decisions regarding the health and feeding adjustments to optimize performance (Girma, 2008), and appraise the adequacy of feeding programs, particularly in production systems where the availability of feeds are not constant (Caldeira *et al.*, 2007).

4.5 Reproductive performances

Sex ratio

A total of 290 births were recorded during the flock monitoring period in the three sites of the Woreda, of which, 150 were males and 140 were females. A total of 155 lambs and 135 kids were recorded. From 155 lambs, 74 and 81 were males and females, respectively and from 135kids, 76 and 59 were male and female kids, respectively. Male to female ratio of the new births were 0.91:1 for lambs and 1.29:1 for kids. The difference between observed and expected frequencies of sex ratios in the two species was tested. The non-significant Chi-square ($P>0.01$) in both species and cases indicated the sex categories did not appear differently from the expected ratio of 50:50. Other than normal parturitions, 5.4% stillbirths and 3.3% abortions were recorded in sheep flocks and 2.4% stillbirths and 4.1% abortions were recorded in goat flocks.

Seasonality of parturition /lambing and kidding/

Lambing and kidding were recorded throughout the year. Higher parturitions were observed in April to June in both species as well as October to December, mainly for sheep. The apparent peaks were observed during the small rainy season, April to June; May being the highest (figure 9). Ewes and does that gave birth in April to June must have conceived during the months of November to January, after crop harvest. During this period they probably had enough feeds from grain leftovers in the field, grasses and weeds at farm boundary and tree and shrub browse leaves. Sheep breeding is less likely affected during big rainy season because grasses and green feeds are available. Goats mainly bred from November to February, and most of the kidding occurred from March to June. However, the co-occurrence of higher parturition during critical feed shortage period affected the survival of the young as well as the dams. This implies that the role of proper feeding and managements at lambing and kidding are crucial for the success of reproduction. Nutrition was also reported as a key factor for increased conception and subsequent lambing and kidding recorded. Rosa *et al. (*2002) also suggested that it is feed rather than photoperiod dictating breeding activity in the tropics and subtropics.

Births in the late dry and small rainy seasons could be disadvantageous due to poor quality and limited quantity feed, especially as little supplementary feeding is practiced in the Alaba traditional system. During the rainy season, cultivated areas are protected and goat grazing and browsing is limited sometimes by tethering. Milking of does was seldom practiced during this period, due to feed and water shortage.

Chi-square analysis showed that there was no significant difference ($p>0.01$) in the proportion of lambing whereas had significant effect ($P<0.01$) on proportion of kidding, revealing less general seasonal effect on lambing than kidding. There was significantly higher ($P<0.01$) kidding during the small rainy season (March to June) than the dry season. This is perhaps due to the fact that goats can move freely and select feeds across the villages during the dry season and accordingly high rate of mating and conceptions in the dry season (November to January), and the subsequent parturitions recorded in the following seasons (April to June). Higher mating and conceptions were reported during crop harvesting, and flocks free roaming period, November to February, in traditional farming system of Ethiopia (Mukasa *et al.,* 2002; Tatek *et al.,* 2004, Tsedeke, 2007), which agrees with the current findings. Endeshaw (2007) reported two major breeding seasons, September to October and March to April, reflecting differences in availability of feed resources.

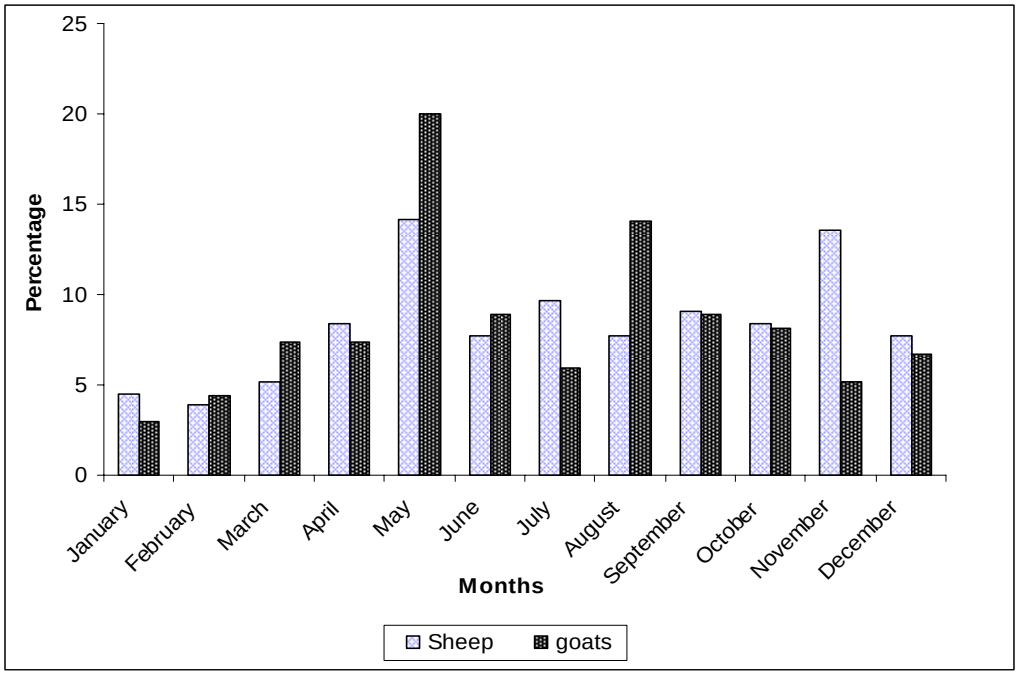


Figure 9: Seasonal distribution of parturition (lambing and kidding) in the study area

More than half (56.7%) and about 37.9% of the kid and lamb crops were dropped within four months small rainy season period, March to June. Less number of parturitions was recorded during December to February due to reduced chance of mating during July to September. The findings of the present study indicated that lambing in the small rainy season were disadvantageous; this is because ewe's weight was affected at the end of dry season. Furthermore, feed shortage persisted until the small rainy season due to most of the lands put under cultivation. As a result, weak and lower birth weight kids and lambs was recorded during the small rainy and the early part of big rainy seasons. Libbie (1999) also reported higher kidding in goat flocks between May and June, though kids were born all the year round. For the kidding to occur between May and June, most conceptions had to occur during the immediate post-rains and early dry periods. Mehlet (2008) also reported the highest kidding in May, which is similar with the current finding. Autumn (Feb-April) was reported as a highest kidding period for Mpumalanga, indigenous goats of South Africa (Webb and Mamabolo, 2004) in which breeding season coincides with optimum feed availability. Ahmadu *et al. (*2002) also reported 30% kidding rate from February to April in Zambian goats, which is in agreement to the current findings.

4.5.1 Prolificacy (Litter size)

The least square means and standard errors of litter size of sheep and goats in the present study was 1.51$\pm$0.04 and 1.47$\pm$0.04, respectively. Of the total births, 53.3% and 46.7% cases of single and twins, respectively, were recorded in goat flock, whereas 48.4% singles, 49.7 % twin and 1.9% triplet births were recorded in the sheep flocks (Table 12).

Table 12: LSM (±SE) total litter size as affected by site, parity and season

effect	Total litter size at birth					
	sheep			goats		
	n	LSM	SE	n	LSM	SE
Overall	155	1.52	0.04	135	1.47	0.04
Site		NS			NS	
Site 1	114	1.47	0.05	31	1.48	0.09
Site 2	20	1.70	0.11	64	1.48	0.06
Site 3	21	1.57	0.11	40	1.40	0.08
Parity		*			***	
1	29	1.31b	0.09	26	1.15c	0.07
2	33	1.55ab	0.09	27	1.26bc	0.09
3	45	1.62a	0.07	26	1.42b	0.10
4	30	1.50ab	0.09	39	1.69a	0.07
≥5	18	1.56ab	0.12	17	1.82a	0.10
Season♣		NS			NS	
Dry season	45	1.42	0.07	18	1.39	0.12
Small rainy season	49	1.51	0.07	49	1.57	0.07
Big rainy season	61	1.59	0.06	68	1.41	0.06

NS- non-significant, * P<0.05), *** (P<0.00001), ♣= Big rainy season (July, August, September, and October); Dry season (November, December, January and February); Small rainy season (March, April , May and June)

Analysis of variances of litter size is presented in Appendix Table 2 and 3. The litter size (1.47) of goats in the current study is relatively lower than sheep (1.52) though not significant (P>0.05). Getahun (2008) reported litter size of 1.42 and 1.24 for Adilo sheep and goats, respectively. However, for both species, litter size of Alaba is slightly higher than Adilo. The higher litter size of Alaba goats than Adilo is perhaps due to relatively larger grazing area and better availability of browse species and less tethering pressure. Reports indicated that litter size of tropical sheep ranges between 1.01-1.60. Endeshaw (2007) reported litter size (2.07) for goats in drier parts of Dale Woreda by monitoring the

flocks for six months, which is very higher than the present study. However, short monitoring period can be questionable, and it is also likely that few elite flocks were sampled for monitoring. Furthermore, micro level differences should be expected. Mukasa Mugrewa *et al.* (2002) reported litter size (1.14) for Horro sheep in western Ethiopia, which is lower than the current findings. Armbruster and Peters (1993) reported litter size of 1.19 for Djallonke sheep and 1.52 for Djallonke goats in southern Cote d'Ivoire under traditional production systems, 1.28 for Zambian goats (Ahmadu et al., 2002) in semi-arid conditions. Tatek *et al*. (2004) also reported litter size of 1.24 for Arsi-Bale goats. Goats of Alaba were grouped within similar population category with Arsi-Bale groups. The overall higher prolificacy, however, in Alaba goats compared to Ars-Bale groups is partly attributed to the better management strategies, feeding ewes and does targeting lamb and kid production for market in Alaba, since the area has some sort of production stratification. However, litter size did not differ significantly ($P>0.05$) across the study sites in both species.

Parity effect was found significant on litter size. Ewes having parity one had significantly lower ($P<0.5$) litter size than parity three. Does having parity four and five and above had significantly ($P<0.05$) higher litter size than parity three and the lower parties. Likewise, does having parity three had significantly ($P<0.05$) higher litter size than parity one. The higher litter size in higher parity is due to the increasing body weight as the ewes or does becoming mature. Higher litter size was recorded in the third parity for ewes whereas in goats the trend is increasing litter though decreasing rate up to fifth parties.

Parity effect was reported to be significant in Red Sokoto goats, the second and fifth parity being significantly higher than other parties (Awemu *et al.*, 1999). Mehlet (2008) reported

the largest litter size in the fifth parity for Arsi-Bale goats. Litter size increases with parity, as a matter of fact that ewes and does physiologically mature with age (Awemu, *et al.*, 1999). However, the same authors reported that after fifth parity, there is a declining trend in litter size in Red Sokoto goats. Wilson (1986) also reported the maximum productivity of ewes by the third parity. Litter size increased with age to about 4 years and remained somewhat similar thereafter (Ibrahim, 1998). Reports suggested the need of balance of replacement rates between young ewes (first parity) and old ones to achieve higher prolificacy. The lambing pattern of Alaba sheep suggests that they are most prolific at about four years of age, when they were at third to fourth parity (Table 8). Relatively better prolificacy of both species in the present study is a good opportunity for the species improvement.

4.5.2 Age at first parturition (AFP)

A total of 120 ewes and 100 does were assessed for their life histories in the study area. The least square means (months) of age at first parturition of sheep and goats were 12.4 and 11.9 months in respective order (Table 13).

Table 13: LSM (±SE) of reproductive parameters of sheep and goats

parameters	Sheep		Goats	
	n	LSM (±SE)	n	LSM (±SE)
Age at 1st parturition (months)	120	12.43 (0.10)	100	11.95(0.13)
Parturition interval (months)	293	9.19(0.08)	237	9.05(0.08)
	n	(%)	n	(%)
Weaning rates (%)	85	79.40	58	58.59
Prolificacy /litter size	155	1.52	135	1.47
Fertility rate (%)	107	54.04	99	81.1

LSM= Least squares mean, SE= standard error, n= number of observations

Age at first parturition found in this study was comparable with the previous reports (12.7 for ewes and 12.1 months for does (Tsedeke, 2007). Age at first parturition of 12.97 for sheep and 12.46 months for goats reported in western Ethiopia (Belete, 2009) is slightly higher than the current findings. Samuel (2005) reported age at first parturition of 17.01 for sheep and 13.18 for goats in Yerer watershed of Ada'a Woreda. Endeshaw (2007) reported age at first kidding of 14.88 for goats in former Dale Woreda, which was slightly higher than the current findings. Tolera (1998) reported 21 months and 19.5 months under agro-pastoral traditionally managed sheep and goats, respectively, in Kochore Woreda of Southern region, which were much higher than the current findings, probably because Alaba goats are managed better than goats of Kochore Woreda. Another reason could be goats of pastoral and agro-pastoral systems are more of late maturing type. The age at first parturition reported by Getahun (2008) for Adilo sheep (14.6) was also higher than the

present study while for goats (12.9) it was slightly higher; however, the observations were very few for AFP of Adilo goats. Age at first parturition of sheep and goats were reported as 20.7±7.1 and 17±6.4, respectively, in pastoral and agro-pastoral system of Southern Ethiopia (Adugna and Aster, 2007). Earlier age at first parturition of goats in the current study might be associated with better management than goats managed in harsh environments of pastoral areas.

The current weaning rates (79.4% for sheep vs 58.6% for goats) are higher than reports of the previous study for sheep (52.7%) whereas slightly lower than the weaning rate reported for goats (62.8%). Fertility rate is 54.04% and 81.1% for sheep and goats, respectively, revealing goats are more fertile than sheep. This is primarily because goats are mainly found in goat dominant site where sufficient amounts of bucks are available and are resistant to drought. The fertility rate obtained in this study is comparable with previous reports for goats (83.8%) but lower than reports (83.6%) for sheep (Tsedeke, 2007). Mehlet (2008) reported fertility rate of 48.3% for Arsi-Bale goats, which is lower than the current findings.

4.5.3 Parturition Interval (PI)

Parturition interval (PI) of ewes and does was given in Table13. The least square means and standard errors of PI in the present study was 9.19±0.08 and 9.05±0.08 months for sheep and goats, respectively. Generally, there were declining trends of PI between successive parturitions as parity advances, unless there were abortions and other reproductive problems. Again in higher parties, there were high number of reported multiple births. The shorter PI gives better opportunity to increase lifetime productivity of

ewes and does by increasing the number of lamb and kid crops. Webb and Mamabolo (2004) and Endashew (2007) reported average kidding intervals of 8.6 months for indigenous goats of Mpumalagna, South Africa and 8.6+0.16 months for goats in Dale Woreda of Southern region, respectively, which is in agreement to the current findings.

The PI obtained in the present study was shorter than reports (Samuel, 2005)), 12.1 and 11.5 months for sheep and goats, respectively, at Yerer watershed and Ada'a Woredas. However, Solomon (2007) reported shorter PI (6.64 months) for Gumuz sheep. The PI for ewes in this study confirms the findings of Wilson (1989) ranging between 7.67-14.57 months for African sheep. PI of 8.07 months for Arsi-Bale goats (Tetek *et al.*, 2004) is slightly shorter than the current findings. The shorter interval obtained in the present study compared to many other studies might partly attributed to better managements; i.e. early weaning practices which leads to early re-conception. The variations within and across region and farming systems might be attributed to the differences in husbandry, lactation length, feeding and level of genetic makeup on possibilities for prompt re-conception after lambing or kidding (Mukassa and Lahlou-kassi, 1995). Shorter parturition interval was reported in the previous report 8.7 months for sheep and 7.5 months for goats in Alaba and Damot Gale Woreda of Wolaita zone (Fikre, 2009).

Mehlet (2008) reported that as parity advances, PI was reduced; which agrees with the current findings obtained through group discussants whereas Awemu *et al.* (1999) reported that kidding interval increased with parity. Apparently shorter kidding intervals are more common in traditional systems where uncontrolled breeding is practiced. In small ruminants, reproductive efficiency is related to the length of parturition interval i.e., doe/ewe with long kidding/lambing interval have lower reproductive efficiency (Ibrahim,

1998). Early weaning and creep feeding was reported as a critical measure in improving conception rates (Alemu, 2008), and thus shortening parturition interval in breeding animals. The parturition interval obtained in this study indicates the possibility of achieving 3 times of births per two year per doe or ewe.

4.5.4 Reproductive problems

Based on the case history assessment, problems associated with ewe and doe reproduction were identified. Major problems reported were abortions (early[5] and late), poor milk let down, poor conception and udder abnormalities. Abortion was one of the major problems in 16% (30.8% early and 69.2% late) of goat flocks and 12.5% (33.3% early and 66.7% late) sheep flocks, respectively, and might partly be suspected for the cases associated with brucellosis and or other infectious diseases. Furthermore, in goat dominant site, drought associated abortions were reported. However, the recorded numbers (3.3% for sheep and 4.1% for goats) of reproductive wastages were lower than those obtained by assessing case histories. Some key informants in goat dominant site suggested that water shortage and associated drought and stress could also have contributed for the increased abortions in goat flocks. A serological survey in arid zones of North-eastern Nigeria indicated that 6% goat and 4.8% sheep were sero-positive for brucellosis (Brisibe *et al.,* 1996).

The total proportion of abortion found in the current study is slightly lower than reports (Getahun, 2008) for Adilo sheep (20%) and goats (17%). The same author found that 12%

[5] Early abortion by this context is an abortion of the fetus whose organs (heads, legs, etc) is not well developed, whereas late abortion has fully developed organs and could survive in rare cases.

of the ewes in Adilo abort at least once in their life time. Poor milk let down of 26% and mastitis problem of 1% was also reported in milking goats of Alaba.

4.6 Growth performances

4.6.1 Birth weight, pre-weaning average daily gain and growth rates of sheep

Birth weight is strongly influenced by breed (genotype), sex of lamb, birth type, age of dam, feeding conditions, season of birth and production system. Least square means and standard errors for birth weight, pre-weaning Average Daily Gain (ADG) and weight at different ages of sheep are presented in Table 14.

Mean birth weight of sheep found in the present study was 2.3kg (ranging from 1.6 to 3.6). Birth weight increased significantly ($P<0.05$) from the first (2.16kg) to second parity (2.27kg). Males were heavier at birth than female lambs (2.37 vs. 2.23kg) and single lambs were heavier (2.43kg) than multiples (2.18kg). The mean birth weight obtained in this study is comparable to the literature reports (Demeke *et al.*, 2004; Tibbo, 2006; Getahun, 2008; Berhanu and Aynalem, 2009). However, it was lower than the birth weight reported by Abegaz *et al.* (2002) and Taye *et al.* (2009). Male lambs had slightly higher and significant ($P<0.05$) birth weight than female. This type of effect has been reported in the literature (Hassen *et al.,* 2004; Gardner *et al.,* 2007; Yilmaz *et al.,* 2007). However, non-significant effects of sex on birth weight were reported by Getahun (2008) for Adilo sheep and Hassen *et al.* (2002) for lambs in the cool highlands of Ethiopia.

Parity effect was found significant (P<0.05) on birth weight (Table 14). There was non-significant difference in birth weight between parity one (2.16kg) and two (2.27kg). However, ewes in parity one had significantly (P<0.05) lower birth weight than those in parity three and beyond. There was a declining trend of birth weight after fourth parity, indicating the maximum productive periods might be before the fifth party in the Alaba situations. This indicates the productive years the dams should stay a flock and or the optimum age for culling. As the younger ewes are still growing, there is a competition between the foetus and the dam for nutrients, which has negative influence on birth weight (Gemeda *et al*., 2002a). Heavier birth weight could be obtained at late parities due to heavier dam weight and larger size (Awgichew, 2000) and physiological imprint in the uterus during the first pregnancy which will facilitate relatively greater foetal growth in the subsequent pregnancies (Gardner *et al*., 2007). Tibbo (2006) also reported the significant increment of birth weight from first to third parity, which was similar to the current findings, and then the increment is at a decreasing rate.

The effect of type of birth was also significant and single born lambs were heavier than their multiple contemporaries at birth (2.43$\pm$0.04kg and 2.18$\pm$0.03kg, p<0.05). The results concur with the literature reports of some scholars (Abegaz *et al.,* 2002; Gardner *et al.,* 2007; Yilmaz *et al.,* 2007; Getahun, 2008). This could be because of the finite capacity of the maternal uterus space to gestate offspring (Gardner *et al.,* 2007). There was also a significant (P<0.05) difference in birth type of lambs at weaning (10.97±0.26kg vs 9.70±0.24kg).

Season had significant (P<0.05) effect on birth weight. Birth weight in dry season was found significantly (P<0.05) higher than other seasons. Higher birth weight in dry season is

due to the better body condition and body reserves of the dams at the end of the big rainy season. In addition, relatively better available feed in the early dry season further contributed for the foetus development. On the contrary, lambs born in the small rainy and subsequent big rainy seasons had significantly ($P<0.05$) lower birth weights. The observed lower birth weights in small rainy season might partly be attributed to the critical feed shortage at the end of dry season which negatively affected the dams and thereby the foetus development. Reports indicated that incidence of parasite infestation impairs growth of lambs in the big rainy season (Berhanu and Aynalem, 2009). The area, particularly the goat dominant site, is also affected by erratic rainfall; water shortage and drought could also add stress on the dam as well as foetal development. Under field conditions, the effect of one season was reflected on the performance of the animal's in the next season. Yilmaz *et al*. (2007) also reported the effect of seasonal differences in birth weight due to differences in ambient temperature and maternal pre-natal effects during gestation.

Table 14: Least square means and standard errors for weights from birth to 150 days of age (kg) of Alaba sheep

Source of variation	Birth weight		30 day weight		60 day weight		90 day weight		ADG		120 day weight		150 day weight	
	n	LSM(±SE)	n	LSM(±SE)	n	LSM(±SE)	n	LSM(±SE)	n	LSM(±SE)	n	LSM(±SE)	n	LSM(±SE)
Overall		2.30±0.03		4.45±0.11		6.94±0.13		10.35±0.19		89.24±1.98		13.28±0.19		15.70±0.20
Location		NS		NS		NS		NS		NS		NS		NS
Site 1	114	2.28(±0.03)	89	4.46(±0.12)	86	6.90(±0.15)	71	10.38(±0.22)	71	89.61(±2.31)	59	13.30(±0.24)	41	15.75(+0.21)
Site 2	20	2.34(±0.06)	14	4.24(±0.23)	10	6.84(±0.19)	10	9.86(±0.34)	10	83.56(±3.81)	10	13.12(±0.38)	3	15.00(+0.72)
Site 3	21	2.34(±0.08)	10	4.66(±0.44)	9	7.44(±0.59)	9	10.67(±0.67)	9	92.59(±6.65)	7	13.29(±0.39)	2	15.60(+0.60)
Sex		*		NS		NS		NS		NS		NS		NS
Male	74	2.37(±0.04)a	56	4.41±0.14	51	7.07(±0.20)	41	10.56(±0.27)a	43	90.99(±2.88)	36	13.47(±0.29)	23	15.96(±0.30)
Female	81	2.23(±0.03)b	57	4.49±0.16	57	6.81(±0.18)	46	10.15(±0.26)a	42	87.56(±2.73)	40	13.10(±0.26)	23	15.43(±0.25)
Parity		*		NS		NS		NS		NS		NS		NS
1	29	2.16(±0.07)^{b}	18	4.54±0.25	18	6.69(±0.32)	21	9.87 (±0.47)	18	86.45(±4.93)	13	12.92 (±0.61)	9	15.51 (±0.47)
2	33	2.27(±0.06)^{ab}	19	4.30±0.23	17	6.74(±0.21)	14	10.57(±0.54)	10	91.19(±5.50)	10	13.26(±0.43)	4	16.15(±0.54)
3	45	2.33(0.05)^{a}	34	4.32±0.20	29	6.93(±0.30)	27	10.23(±0.36)	24	87.41(±3.88)	24	13.35 (±0.30)	16	15.63(±0.36)
4	30	2.38(0.06)^{a}	25	4.59±0.21	25	6.34(±0.26)	15	10.72±0.33)	21	93.03(±3.21)	21	13.43(±0.33)	12	15.40±0.33)
≥5	18	2.36(±0.07)^{a}	17	4.58±0.35	16	6.80(±0.36)	10	10.27(±0.56)	12	87.59(±6.09)	8	13.25(±0.86)	5	16.60(±0.56)
Birth type		*		NS		NS		*		*		*		NS
Single	75	2.43(±0.04)a	54	4.57(±0.14)	51	7.18(±0.20)	43	10.97(±0.26)a	43	94.78(±2.80)	38	13.74 (±0.29)a	25	15.91(±0.28)
Multiple	80	2.18(±0.03)b	59	4.34(±0.16)	54	6.71(±0.17)	44	9.70(±0.24)b	38	83.44(±2.55)	38	12.82(±0.24)b	21	15.55(±0.26)
Season ♣		*		*		NS		NS		*		*		NS
Dry season	45	2.43(±0.05)a	37	4.84(±0.17)a	37	7.36(±0.26)	30	10.74(±0.34)	32	92.19(±3.69)a	28	14.03(±0.30)a	21	15.95(±0.30)
Small rainy	49	2.26(±0.04)b	47	4.51(±0.16)a	40	6.76(±0.19)	39	10.16(±0.25)	18	88.11(±2.58)b	34	12.65(±0.29)b	20	15.42(±0.27)
Big rainy	61	2.23(±0.04)b	29	3.86(±0.21)b	28	6.64(±0.23)	18	10.08(±0.47)	31	86.48(±4.82)b	14	13.29(±0.48)ab	5	15.72(±0.77)

Means within each subclass with different superscript (^{a,b,c}) letters differ significantly (P<0.05); NS- non significant; *ADG = Average Daily Gain (pre-weaning). ♣ Big rainy season (July, August, September, and October); Dry season (November, December, January and February); Small rainy season (March, April , May and June) .

Average Daily Gain (birth to 90 days)

The least square means of the pre-weaning average daily gain of Alaba sheep was 89.2±1.98g/day (Table 14). All the fixed factors except litter size had non-significant ($P>0.05$) effects on the average daily gain in sheep. Single births gained significantly ($P<0.05$) higher ADG than their multiple counterparts at weaning. Getahun (2008) reported that average daily gain was affected significantly by all the mentioned fixed factors in Adilo and Kofele sheep. According to Awigichew (2000), average pre-weaning daily weight gain and weaning weight are known to be significantly affected by the mothering ability of the dam. The same author reported ADG of 89.3 and 89.2 g/day for Horro and Menz sheep, respectively, which is very similar to the current findings while Taye *et al*. (2009) reported higher ADG (107.1g/day) for Washara sheep. This is particularly important during the growth stages of lambs when there is more dependency on the milk production of the ewe rather than on forage. For the young growth and survival, their dam condition is significantly important across the seasons.

Body weight of sheep at different ages

Factors affecting growth rates of Alaba sheep at different ages (30, 60, 90, 120 and 150 days) are presented in Table 14. The least squares mean weight (kg) at 30, 60, 90, 120 and 150 days were 4.45±0.11kg, 6.94±0.13kg, 10.35±0.19kg, 13.28±0.19kg and 15.70±0.26kg, respectively. The 30 day weight (4.45±0.11kg) obtained in the present study was lower than reports for indigenous sheep under village conditions (Hassen *et al.,* 2002), which is 5.97kg. The results (7.78kg) obtained by the same author and (10.9kg) by Berhanu and

Aynalem (2009) for 60 day weight was higher than the current findings. The weaning weight (90 day) (10.35kg) was comparable with Gumuz sheep (Solomon, 2007), Horro sheep (Abegaz *et al.,* 2002a; Yohannes *et al.,* 1998), and Ethiopian indigenous sheep under village conditions (Hassen *et al.,* 2002). Getahun (2008) reported 11.18kg and 12.23kg weaning weight for Adilo and Kofele sheep, respectively, which was slightly higher than the current findings. Sex effect was found non-significant ($P<0.05$) on weaning weight. The analysis of variance (Appendix Tables 4, 6, 8, 10, 12, 14, and 16) for weights at birth and specific ages indicated that fixed effects were different at different ages.

Birth type had a significant effect ($P<0.05$) on average daily gain and 120 day weight. Single births had significantly higher weight than their multiple counterparts at birth (2.44±0.04kg vs. 2.18±0.03kg), 90 day (10.97±0.26kg vs 9.70±0.24kg) and 120 day (13.74 ±0.29kg vs 12.82±0.24kg). Birth type was found significant because of competition among the multiple births than single for limited amount of milk of the dams. The effect of litter size declined after weaning, being non-significant ($P>0.05$) at 150 day. This is because the young starts to consume forages and depends more on environmental factors than on dams mothering ability. Similar effect of birth type on growth of lambs have been reported (Mourad *et al.,* 2001; Gemeda *et al.,* 2002a; Tibbo, 2006; Yilmaz *et al.,* 2007). These differences can be partially explained as competition for limited milk by multiple births whereas singles are the sole users of milk from their dam (Tibbo, 2006). Berhanu and Aynalem (2009) reported the significant effect of birth type (single vs twins) in lambs under village management conditions in Western Ethiopia. The same authors reported 120 day weight of 15.5 kg, which is higher than the current findings.

Season of birth had also significant (P<0.05) effect on ADG and 120 days. Lambs born in the dry season were heavier at three months; again lambs born in the dry season and big rainy season were heavier at 120 days than those born in the small rainy season (P<0.05). Similarly, Berhanu and Aynalem (2009) that lambs born in the dry season were superior by 6.7% as compared to lambs born in the wet season for weight at 120 days age. The same authors reported that effect of birth season was not clear cut and consistent as age advances. Yilmaz *et al.* (2007) also reported heavier weaning weight at winter than spring season. Niftalem (1990), Abebe (1999) and Tibbo (2006) found out that season of birth significantly affected weight at all ages consistently, which was slightly different from the current results. Contrary to the current findings, reports indicated that lambs born from February to May (lighter rain) performed best in terms of total body weight gains than those born in the dry season (Hassen *et al.*, 2002). The seasonal differences in lamb growth rate to 90 days of age (weaning) may be related to differences in post-natal effects such as the dam's milk production. The significance after weaning was due to the better feed availability in the wet and early dry seasons than the small rainy seasons as the lambs totally depended on feed after weaning. Feed shortage is crucial in late dry and small rainy seasons, and accordingly growth was affected during these periods. Other than the major limiting factor, nutrition, diseases and drought associated stresses also affect the growth rate of sheep and goats in Alaba.

4.6.2 Birth weight, pre-weaning average daily gain and body weight of goats at different ages

Birth weight, average daily gain and growth at specific ages of goats from the three study sites are presented in Table 15. Mean birth weight was 2.34kg (ranging from 1.9 to 3.8kg).

Study locations (site 1, site 2 and site 3) affected birth weight of goats. Site 1 had significantly ($P<0.05$) lower birth weight than site 3. This is perhaps partly due to high human population pressure, shortage of browse species in site 1 (sheep dominant site) and associated poor performances of the animals. The birth weight obtained in the present study is comparable with reports of Mehlet (2008) for Arsi-Bale goats at on-station, Birhane and Erik (2006) for Abergelle goats at on-station and Tatek *et al.* (2004) for Arsi-Bale goats under traditional management conditions. However, they were lighter than reported by Endashew (2007) for goats of Loka Abaya of Dale Woreda, Belete (2009) for Keffa goats of South west Ethiopia, Zeleke (2007) and Abebe (1996) of Somali goats under station and traditional management conditions, respectively. The mean birth weight of 2.12kg reported for Ugandan goats is slightly lower than the current results. Sex had non-significant effect ($P>0.05$) on birth weight.

Does in parity one, two and five had significantly ($P<0.05$) lower birth weight than those in parity three and four. There was non-consistent increment of birth weight as party advanced. The decline of dam's productivity soon after reaching certain level of threshold, as it was observed from the sharp decrement in fifth parity, might partly be due to the management and aging effect at higher parties.

Birth type had significant effect ($P<0.05$) on weight at birth as well as at weaning. Single kids grew faster and reached the weaning age earlier than the multiple born. This is due to the competition of the young's for suckling the limited milk of their dams among the multiple births than single. Again during the monitoring period, farmers suggested that they wean single births kids earlier because they could reach weaning weight earlier than the multiple born.

Season had a significant effect ($P<0.05$) on birth weight. Kids born in the dry season had significantly higher ($P<0.05$) birth weight than those born in the small rainy and big rainy seasons. Likewise, small rainy season had significantly ($P<0.05$) lighter birth weight than big rainy season. The higher birth weight in kids born in the dry season is related to the better body condition of the dams due to good body reserves during the early dry season. Furthermore, goats were in a better body condition irrespective of feed availability when they were free wandering during the dry season, having chance for feed selection. At late gestation, the doe should be provided with sufficient feed, however, wet season at Alaba context is not favourable for goats due to tethering pressure, and accordingly lower birth weights were recorded.

Average Daily Gain (birth to 90 days)

Average daily gain was significantly higher ($P<0.05$) at site 1 and 3 than at site 2; however, the differences were not consistent. Pre-weaning growth (average daily gain) obtained in the present study; 82.3 ± 3.18g/d is higher than reports for Abergelle goats (Birhane and Eirk, 2006) on-station, Arsi-Bale goats under field conditions (Tatek *et al.,* 2004) but is comparable with Somali goats under on-station conditions (Abebe, 1996). Pure Arsi-Bale goats gained 56.2g/d (Girma, 2002), which was lower than the current results, revealing that goats of Alaba could reach market weight earlier than other Arsi-Bale populations.

Table 15: Least square means and standard errors for weights from birth to 150 days of age (kg) of Alaba goats

Source of variation	Birth weight		30 day weight		60 day weight		90 day weight		ADG♣		120 day weight		150 day weight	
	n	LSM(±SE)	n	LSM(±SE)	n	LSM(±SE)	n	LSM(±SE)	n	LSM(±SE)	n	LSM(±SE)	n	LSM(±SE)
Overall	122	2.34±0.03	99	4.39±0.10)	78	6.61±0.14	58	9.85± 0.29	58	82.34±3.18	55	11.82(0.24)	55	13.67(0.24)
Location		**		NS		*		*		*		NS		*
Site 1	31	2.18(±0.05)b	30	4.43(±0.14)	23	6.81± (0.21)ab	14	11.21 ((±0.50)a	14	98.73(±5.46)a	13	11.97 (0.56)	12	13.60(0.57)a
Site 2	64	2.36 (±0.03)a	44	4.29(±0.19)	38	6.27± (0.16)b	29	8.68((±0.60)b	29	69.54(±3.57)b	28	11.39(0.31)	28	13.20(0.29)b
Site 3	40	2.41(±0.09)a	25	4.50(±0.30)	17	7.11±(0.44)a	15	10.83((±0.30)a	15	91.78(±3.85)ab	14	12.54(0.48)	15	14.61(0.47)a
Sex		NS		*		*		*		NS		*		NS
Male	76	2.35(±0.04)	52	4.59(±0.15)a	39	6.95±(0.23)a	33	10.32(±0.33)a	33	86.80(±3.67)	31	12.27(0.34)a	31	13.88(0.35)
Female	59	2.32(±0.04)	47	4.17(±0.13)b	39	6.27±(0.14)b	25	9.22(±0.38)b	25	76.44(±5.44)	24	11.24(0.31)b	24	13.40(0.32)
Parity		***		*		*		NS		NS		*		*
1	26	2.13 (±0.03)c	12	4.37(±0.27)ab	9	7.16±(0.35)a	7	10.33(±0.54)	7	91.11(±8.38)	6	11.80(0.48)ab	5	12.92(0.55)c
2	27	2.26(±0.03)bc	19	4.01(±0.19)b	14	5.86±(0.21)c	12	9.13(±0.70)	12	76.2(±8.47)	11	10.56(0.47)b	11	12.60(0.53)c
3	26	2.44 (±0.07)a	18	4.56(±0.16)ab	15	6.64±(0.27)ab	13	10.19(±0.55)	13	85.87(±6.20)	13	11.91(0.45)ab	14	13.39(0.41)bc
4	39	2.47(±0.07)a	33	4.66(±0.22)a	29	6.92±0.27ab	21	9.72(±0.52)	21	78.94(±5.54)	20	12.22(0.38)ab	20	14.26(0.35)ab
≥5	17	2.29 (±0.09)b	17	4.14(±0.22)ab	11	6.27±0.38bc	5	10.52(±0.67)	5	89.78(±5.10)	5	12.80(1.27)a	5	15.24(0.98)a
Birth type		*		*		*		*		*		NS		NS
Single	72	2.41(±0.05)a	48	4.75(±0.17)a	41	7.05±(0.23)a	32	10.42(±0.37)a	32	87.92(±4.59)a	29	11.93(0.38)	29	13.59(0.39)
Multiple	63	2.25(±0.03)b	51	4.06(±0.09)b	37	6.12±(0.19)b	26	9.15(±0.31)b	25	75.47(±3.99)b	26	11.69(0.29)	26	13.77(0.26)
Season ♦		***		****		****		*		*		NS		****
Dry season	18	2.57(±0.09)a	18	5.21(±0.28)a	17	7.68±(0.39)a	17	10.05((±0.09)b	17	82.81(±4.40)b	17	12.85(0.42)	17	15.09(0.38)a
Small rainy	49	3.39 (±0.05)b	48	4.00(±0.12)c	37	6.12±(0.18)b	35	9.39(±0.09)b	35	77.84(±3.93)b	35	11.33(0.28)	34	12.78(0.23)b
Big rainy	68	2.24 (±0.04)c	33	4.52(±0.14)b	24	6.60±(0.14)b	6	11.97(±0.09)a	6	107.22(±13.45)a	3	11.73(1.25)	4	15.20(0.48)a

Ns=non significant *,P<0.05, **,P<0.01, ***,P<0.001, ****,P<0.0001. ♣ADG = Average Daily Gain (pre-weaning), ♦Big rainy season (July, August, September, and October); Dry season (November, December, January and February); Small rainy season (March, April , May and June) .

Body weight of goats at different ages

The least squares mean weight (kg) at 30, 90, ADG, 120 and 150 days were analysed for the fixed factors; location, sex, parity, birth type and season (Table 15). The analysis of variance (Appendix Tables 5, 7, 9, 11, 13, 15, 17) for weights at birth and different ages and ADG indicated that the effects of fixed factors were different at different ages. The overall least square means of body weight (kg) at 30, 60, 90, 120 and 150 day were 4.39±0.10kg, 6.61±0.14kg, 9.85±0.29kg, 11.82±0.24kg and 13.67±0.24kg, respectively. The effect of location was significant ($P<0.05$) at 30, 90, and 150 days; site 1 and 3 having significantly ($P<0.05$) higher growth rates than site 2, though these effects were not consistent. This could most probably be that site 1 and 3 had relatively better feeds (quality and quantity) than site 2. Site 2 is reported for its strict tethering and confinement with seldom practices of supplementation.

Sex had significant effect on weight ($P<0.05$) at 30, 60, 90 and 120 days, males being heavier than their female counterparts. Male lambs had significantly ($P<0.5$) higher weaning weight (10.32kg) than female lambs (9.22kg). The overall weaning weight (9.85±0.29kg) was closely comparable to the reports by Abebe (1996) under station condition and Endashew (2007) under field conditions, but lighter than the reports by Zeleke (2007) under on-station. However, the current weaning weight was heavier than reports of Birhane and Erik (2006) for Abergelle goats under on-station condition and Getahun (2008) for Adilo goats and Tatek *et al* (2004) for Arsi-Bale goats under traditional management conditions. The heavier weaning

weight under on-farm condition of Alaba might partly due to differences in management of kid production to increase market weight and or further finishing through fattening. At later ages, the effect of sex diminished and or disappeared.

The effect of parity affected growth, though it was not consistent, being significant ($P<0.05$) before weaning and after weaning but non-significant ($P>0.05$) at weaning. Kids of parity three and four had relatively better birth weight and growth rate than those from other parties. The effect of parity was highly significant ($P<0.001$) on birth weight, and significant ($P<0.05$) at 30, 60, 120 and 150 days. The significant ($P<0.05$) effect of parity after weaning might be because the new born are totally dependent on feeds; the feed availability both in quality and quantity is important on growth rate. Big rainy and the subsequent dry season were better in growth rate than small rainy season. The non-significant effect of parity on weaning weight was reported by some studies (Mehlet, 2008; Getahun, 2008; Endeshaw, 2007).

The influence of birth type on the growth rate of kids was significant. The effect of birth type affected growth of goats with a similar trend and consistently up to weaning; and thereafter diminished. Single born kids were heavier ($P<0.05$) than their multiple contemporaries at birth (2.41 ± 0.05kg and 2.24 ± 0.03kg, $p<0.05$) and weaning (10.60 ± 0.37 kg vs 9.28 ± 0.31kg).

The effect of season was significant ($P<0.05$) from birth to weaning consistently. Kids born in the dry season were highly significantly ($P<0.0001$) heavier at 30 and 60 days than those born either of the two seasons, while significant at 150 days than small rainy season. Kids born during the big rainy season had significantly ($P<0.05$) heavier weight at 90 day and faster

ADG than those born during the other seasons. Here the effect of season on growth rate of goats was also not consistent. Immediately after weaning (120 day), the difference diminished and reappeared at 150 days. This type of fluctuations is expected in traditional management situations where feed availability fluctuates across seasons. These effects were also reported (Ndlouv and Simela, 1996) that in the majority of the cases, when the dams were in a better condition, so did the young as kid's growth is totally dependent on dam's milk yield before weaning time; their growth was affected by the season due to dams' effect. Goats were in a better body condition throughout the dry to part of the small rainy seasons (Table 15). The higher weaning weight in kids born during the big rainy season is perhaps due to the relative better availability of feeds for the young other than the milk suckled from their dams.

Few literatures assessed on the growth rates of goats. Body weight of 4.3 kg, 6.2 kg, 7.6 kg, and 9.5 kg for 30, 60, 90 and 120 days, respectively, were reported for Mashona East Africa kids (Ndlouv and Simela, 1996), which were slightly lower than the current results. Growth rates (g/d) of 60.2, 59.8, 55.9 and 48.8, reported for the same breed at 30, 60, 90 and 150 days of age, respectively. The effects of season and sex affected the body weights and growth rates of Mashona East Africa kids inconsistently, which is similar to the current findings. Reynods and Adediran(1994) also reported body weight of 2.45kg, 4.0kg, 4.94kg at 30, 60 and 90 days, respectively, in village herds of Southwest Nigeria, which is lighter than the current findings. During the monitoring study period, there were trends of fluctuations in weight gain and loss during different seasons. Relatively better growth was observed during the late big rainy and the dry seasons for Alaba goats.

4.7 Survivability (mortality) rate

Based on the data obtained from flock monitoring, the average pre-weaning mortality of the sheep and goats was calculated (Table 16). The pre-weaning mortality was 13.9% and 10.7% for sheep and goats, respectively.

Table 16: Pre-weaning mortality rates[§] (%) of small ruminants in the study area.

particulars		Pre-weaning mortality (%)			
		sheep		Goats	
		n	%	n	%
Site					
	SDS	11	7.6	2	1.6
	GDS	2	1.4	4	3.3
	MFS	7	4.9	7	5.7
Total		20	13.9	13	10.7
Sex					
	Male	7	4.9	4	3.3
	Female	13	9.04	9	7.4
Overall		20	13.9	13	10.7

[§]Pre-weaning mortality=Mortality before 90 days, SDS= Sheep Dominant Site, GDS= Goat Dominant site, MFS= Mixed Flock Site

Pre-weaning mortality of males was lower than females for both species; (4.9% vs 7.6) for sheep and (3.3 vs 7.4%) goats. The current mortality rate was smaller than those reported by Getahun (2008), 19.5% and 20.4% for Adilo sheep and goats, respectively. Stillbirths and abortions (5.4 vs 3.3 % in sheep, 2.4 vs 4.1 % in goats) were not included in the current pre-weaning mortality, which might be the reason for the lower mortality rate. If those reproductive wastages were included, the pre-natal and pre-weaning mortality increases to

22.6% in sheep and 17.2% in goats. From the total mortality, more than 44% was within four months period, October to January; confirms the reports of mortality rate (42%) for Arsi-Bale goats in the early dry season (Hailu *et al.*, 2006). Belete (2009) reported 20.9% and 22.6% mortality rate for lambs and kids less than three months, respectively, in south west Ethiopia. With the reported relatively low mortality rate, Alaba goat might survive better than other Arsi-Bale breeds or populations. There is a report suggesting pre-weaning mortality rate as high as 47% in East African goats and their crosses, which is too much higher as compared to the current results. Mukasa-Mugerwa *et al.* (1986) also reported higher mortalities; 30% for lambs and 25% for kids in the traditional small ruminant system of central Ethiopia. Results reported by Mukasa-Mugrewa (1995), Awigichew (2000) and Birhan et al. (2006), mortality rate of (15%), 10.6% and (13%) for Menz sheep, respectively, under on-station, on-station and uncontrolled breeding situations in Ethiopian highlands, which agree to certain extent with the present study. Arumbuster *et al*.(1993)reported that mortality rate of 18.1% for sheep and 19.6 % for goats from 0-90 days, which is higher than the current findings. Mortality rates of goats in Mpumalanga, South Africa, reported in the range between 3.8 and 40.1% (Web and Morobolo., 2004). Lamb mortality between birth and 150 days which was estimated between 10-30% in traditionally managed sheep production in the tropics (Gatenby, 1986). Mandal *et al.* (2007) reported the pre-weaning mortality rate of 7.5% for Muzaffarnagari sheep of India.

To reduce young mortality from physical damage, farmers keep the new born covering basket for the first few weeks (2-3 weeks). Diseases associated with respiratory complexes like pneumonia were the most suspected diseases for the higher deaths in Alaba. The higher prevalence of respiratory infections of goats in remotest area (goat dominant site) may be due

to their high stocking rates, coupled with increased dust (during the dry season), dampness in the kraals (rainy season), the chilling effects at nights in the poorly built houses and utmost inaccessibility of veterinary services.

4.8 Milk yield of goats

The milk yield and lactation length of goats in the current study is presented in Table 14. The average milk yield and lactation length were 150.95±56.03ml per day (ranging from 75 to 380ml) and 39.02±2.69 days, respectively. Milk yield of goats at the sheep dominating site was significantly ($P<0.05$) higher than the other sites. This is mainly due to the fact that farmers keep few and selected goats targeted for milk consumption. On the contrary, the number of animals in milk was by far larger in goat dominating site than the other sites.

Table 17: Mean (±SE) of milk yield (ml) and lactation length (days) of goat of Alaba

Flock density group/site	Milk yield (ml/day)		Lactation length (days)	
	n	mean (±SE)	n*	Mean (±SE
Sheep dominant	55	195.16 (32.38) [a]	6	52.50(7.50)
Goat dominant	161	138.26 (59.62) [b]	34	34.85(2.88)
Mixed flock	41	141.46 (32.16) [b]	6	49.17 (7.46)
Overall	257	150.95(56.03)	46	39.02(2.69)

n= number of observations, SE=standard error, n*=number of does in milk, ml=milliliter

Though goat milk consumption is common in the area, priority is given to the kids. When the kids are in a good growth (after about a month) and supplemented with feed, farmers start to take out some amount of milk for consumption, mainly for coffee whitening, children and old people. Some key informants suggested that some times they will pool the goat milk together to make butter. Goat's milk is easily digestible; this is because of the medium chain length fatty acids which are commonly used in the treatment of patients with various mal-absorption disorders (Knights *et al.,* 1997; Aduli *et al.,* 2002)).

Throughout the study sites, participants reported consuming goat milk as a spice for coffee whiting. Some key informants indicated that since goat milk has bad odour (probably due to odour of male goat); they used it by boiling with coffee. They also suggested that though they are not drinking sheep milk, rarely children used to milk and cook the colostrums in the first few (1-3) days. However, sheep milk is not consumed by adult in Alaba unlike reports for Kofele (Legesse *et al.,* 2008). The mean milk yield (150.95 ml) obtained in the present study is lower than the reports of 339.9ml for local Somali does under on-farm condition (Farm Africa, 1996), 290-310ml for goats in Badawacho Woreda (Tsedaye, 2009), and 300ml of indigenous East African goat. The lower milk yield during the dry season and the subsequent small rainy season may have contributed for the overall reduced milk yield in the present study, mainly due to water shortage and tethering stresses. Furthermore, most of the births were twins, and the owners give priority for the young to suckle than milking for home consumption. Adugna and Aster (2007) reported mean milk yield of 0.53$\pm$0.32 litres and lactation length of 2.7$\pm$1.9 months in pastoral areas, which is higher could be due to selection of goats by pastoralists for milk production. As reported in this study, more than 50% of the

goats and 33% of the sheep are watered every three, four and above days, which could affect dry matter intake and milk production. Significant effects of water deprivation on dry matter intake and milk yield was also reported (Mousa and Elkalifa, 1992). Mohammed (2009) reported that 50% and 25% water deprivation can reduce milk production by 20 and 18%, respectively, in goats of Aardi, Saudi Arabia. However, water deprivation up to 48 hours has no significant effect in non-lactating goats.

Dairy goats have become increasingly popular among smallholder mixed crop-livestock farmers of Kenya (Ahuya *et al.,* 2005). Goat milk has a potentially greater role to play in future human nutrition and medicine than milk from cattle, and again the enterprise can be expanded by lower capital investments concurrent with lower overall risks (knights *et al.,* 1997). There are wide variations in milk production potential (75-380ml/day) of the goats in the study area so that further targeted study is needed to exploit the milking potential of goats.

4.9 Offtake

Based on the data collected for one year, offtake was calculated for commercial sales, slaughter and gifted out or transferred permanently for parents or relatives. Table 18 shows the annual gross offtake rate of sheep and goats, respectively, in the study area.

Table 18: Frequency♦ of annual offtake of sheep and goats in the study area

	Site	Total number at the beginning	Sales		Slaughters		Gifted out		#Total offtake	
			n	%	n	%	n	%	n	%
Sheep	SDS*	210	89	24.32	16	4.37	3	0.82	108	29.51
	GDS♦	80	18	4.91	1	0.27	0	-	19	5.19
	MFS♣	76	20	5.46	6	1.64	0	-	26	7.10
	Total	366	127	*34.69*	23	*6.28*	3	*0.82*	153	*41.8*
Goats	SDS*	28	17	6.30	5	1.85	7	2.59	29	10.74
	GDS♦	169	26	9.63	9	3.33	6	2.22	41	15.19
	MFS♣	73	6	2.22	5	1.85	1	0.37	12	4.44
	Total	270	49	18.15	19	7.04	14	5.16	82	*30.37*

♦= percentage is in reference to the original inventory. #Offtake rate is calculated adding the proportion of sales, slaughtered and gifted out animals permanently. *SDS= sheep Dominant Site, GDS♦= Goat Dominant Site, MFS♣= Mixed Flock Site.

Market sales (sale for cash generation) (34.7%) were an important component from the overall annual offtake (41.8%) in sheep flocks. Slaughter and gifts also contributed for the increased offtake although they were relatively lower than sales. Slaughtering for home consumption and gifts out accounted for 6.3% and 0.8%, respectively, of the total offtake in sheep flocks.

The overall offtake rate of goats in this study was 30.4%; the goat dominant area taking the largest share (15.2%) (Table 18). The higher offtake of goats in sheep dominant site is due to scarcity of browse and associated disposal of the animals to reduce risks. Sale (18.2%) contributed a lot for the overall offtake rate of goats observed during the study period. Slaughter and gifts out or loan accounted for 7.0 and 5.2%, respectively, in goat flocks.

Belachew and Jemberu (2003) reported annual offtake rate of 35 and 38% for sheep and goats in pastoral areas of Ethiopia, respectively. Belete (2009) reported sheep offtake of 27.5% and goat offtake of 19.7% for western Ethiopia, which is lower than the current findings. The offtake rate reported by CSA (2008), which was 36.4% for sheep and 28.7% for goats, showed similar pattern with the current findings. Mutton is preferred to goat's meat. However, Goat meat was reported for its medicinal value and its consumption trend is increasing.

The offtake rate in the present study was much lower than the report by Getahun (2008) for Adilo sheep, which was 114% in central south region (Kembata Tembaro zone) while for kofele was 78.4%. However, the current slaughter rate of sheep (6.3%) is more than twice of that of the slaughter rate (2.9%) reported for Adilo sheep. The probable reason for higher offtake in Adilo might be the area is known for its short-term finishing practices to capture the market opportunities through Adilo route to Shashemene, Hawassa and Addis Ababa. However, the current findings is higher than the previous exit reports through sale (31.1%) (Tsedeke, 2007) in Alaba, 18.4% for commercial purposes (Mukasa-Muerwa *et al.,* 1986) and 20% offtake reported by Armbuster and Peters (1993). The relative increment in the offtake rate of small ruminants in these two years time in Alaba might be partly associated with the

lower price of pepper, the major cash crop in the area, during the study period, as an alternative source of cash generation. According to some monitored farmers, they mainly sell cash crops and small ruminants for their household needs. Selling food crops is not common unless it was produced more than family needs. Large number of animal sale occurs during cropping season to purchase fertilizers and improved seed and during crop failure to purchase food grains. Legesse *et al*, (2008) also reported the sale of livestock, particularly small ruminants occurs whenever need arises for cash, primarily during cropping period.

Mukasa-Mugerwa *et al.* (1986) reported 13.1% and 0.8% offtake through sale and slaughter for home consumption of goats in central highland of Ethiopia, which is lower than the current report. The relatively higher rate of home consumption (7.0%) in Alaba is partly attributed to long tradition of the society to slaughter small ruminants for guests and when females give birth, other than the major period of slaughtering small ruminants (the Muslim and other public holidays) in which higher number of animals are slaughtered. The higher offtake rate of in the current report might not only be due to local but also the emerging demand of national and regional markets for meat of small ruminants, particularly sheep through Alaba Kulito and Adilo market routes.

4.10 Economic performances

Other than biological performances, the efficiency of sheep and goats enterprises was assessed for their economic benefits. The data used for economic performance evaluation were derived from the longitudinal survey study in the Woreda over a period of one year. All the variable costs (feed, medicines, replacement costs, water costs, etc) and fixed costs (family labour) were recorded.

For the intended calculation, the average flock size per household per year is summarized in Table 19. Within the Woreda, sale rate of sheep is higher than goats, indicating the higher dynamics in the sheep sub-system. This may be related to the proximity of the sheep sub-system for market routes emerging currently, Adilo market. Again sheep meat is preferred to goat meat in the area; hence butcheries and restaurants prefer to purchase more sheep than goats.

Table 19: Flock dynamics per household in the study area during one year period

Descriptors♣	Species studied		Total
	Sheep	Goats	
Stock at the beginning (a)	6.1	4.5	10.6
Inflow			
Birth (b)	2.58	2.23	4.81
Purchases(c)	0.30	0.05	0.35
Shareholding (d)	0.05	0.07	0.12
Received as gifts (e)	0.03	0.02	0.05
Outflow			
Sales (f)	2.17	0.82	2.99
Deaths (g)	0.48	0.35	0.83
Slaughter(h)	0.38	0.32	0.70
Predator (i)	0.20	0.05	0.25
Shareholding (j)	0.18	0.12	0.30
Given as gifts(k)	0.05	0.23	0.28
Others* (L)	0.08	0.08	0.16
Stock at the end (M)=(a+b+c+d)-(e+f+g+h+i+J+k+L)	5.52	4.90	10.42
Change in stock (M-a)	-0.58	0.40	-0.18
Average flock size (a+L/2)	5.81	4.7	10.51

♣ Averaged for the number of monitored households

Water costs, which was determinant for human and livestock productivity in Alaba, particularly during the dry season, was taken into consideration and accordingly the costs related to small ruminant watering were valued.

Under an extensive management system, the demand for labor for herding and grazing can vary substantially during the cropping season. During this period, animals are not allowed to roam freely in fear of damaging other peoples' crops. The strong local bylaw also restricts this free movement. They are instead herded around the cultivated fields and fragmented communal and individual grazing areas for about 7-9 h per day under strict supervision by the herdsmen (boys). This practice puts severe pressure on the available household labor, which normally becomes critical during the cultivation period. It was observed that during the cropping season, in households with critical labor shortages, animals have less access for grazing. A probable implication of this practice is reduced feed intake by the animals, since they may not have enough time to graze or browse adequately. Thus, household labor was valued.

Results indicated that on average, a household earned a total net profit of ETB 140.51. The profit per animal was ETB13.38 (Table 20). The estimated capital per average small ruminant owning household in the study area was ETB 1852.5. From the calculation it can be drawn that the return on capital for the study area is 7.6%. Variable costs like feed, medicinal costs, and labour cost contributed for the overall increased enterprise costs in the system. Unlike the higher feed costs of about 70% reported from many studies in the country, feed associated costs were very small (6.5%) in the current study.

On the contrary, labour cost contributed a lot for the increased total enterprise costs, accounting for 52.5% of the total enterprise costs, particularly for goat dominant site. The inclusion of water and labor cost as an opportunity cost may have inflated the total cost with

negative effects on feasibility. This is reflected in goat dominant site where water and labor costs were the highest (Table 20), with profit per animal of ETB -1.07.

Table 20: Average small ruminant enterprise budget in the study area

Item*	Total value (ETB⅄)			Overall
	Small ruminants			
	SDS	GDS	MFS	
Revenue (A)				
Value of sold animals (*)	191.82	144.33	118.86	455.01
Value of slaughtered animals	25.17	6.0	29.34	60.51
Value of sold skin	2.21	1	1.74	4.95
Value of animals given as gifts	38	5	10	53
Sub total A	257.2	156.33	159.94	573.47
Operating cost (B)				
Feed costs	23.33	1.25	3.56	28.14
Veterinary costs	14.53	6.66	1.90	23.09
Water costs	-	26.30	6.37	32.67
Replacement costs[§]	28.57	2.42	16.26	47.25
Sub total B				106.35
(C) Value of family labour	43	112.21	72.5	227.71
(D) Interest on capital (4%)	31.1	27.4	15.6	74.1
Total costs of enterprise (B+C+D)	140.53	176.24	116.19	432.96
Net enterprise profit (A)-(B+C+D)	116.67	-19.91	43.75	140.51
Profit per animal	11.11	-1.90	4.20	13.38
Percentage of return on capital	6.30%	-1.07%	2.36%	7.59%

[§] =the average value of purchased animals was considered as replacement costs, SDS=sheep dominant site, GDS= Goat Dominant Site, MFS= Mixed Flock Site. ⅄ETB (Ethiopian Birr) is Ethiopia's currency; 1ETB=US$0.08(2009 exchange rate), * includes milk value of goats.

If labour is assumed to be available in rural areas as it was indicated by the larger average family size, the total net profit earned can be increased as high as ETB 375.35 and profit per animal could increase up to ETB 36.16 and percentage return on capital increases to 20.3%. Getahun (2008) found that labor cost accounted for 37.8% of the total costs of the enterprises in Adilo. Panin *et al.* (1997) also found that labor cost contributed 54.5% of the total enterprise costs in Botswana, which is in a close agreement to the present results. Family labor was also reported as a most single important fixed input under the smallholder sheep and goat farming system (Panin *et al.,* 1997). Variable costs attributed to 95% of the total costs in Kenya (Kosgey *et al.,* 2003).

Percentage of return on capital reported for Adilo and Kofele small ruminants was 28.8% and 17.1%, respectively, which is higher than the current study (Getahun, 2008). The lower percentage of return on capital in Alaba might partly be due to less market oriented production. Panin *et al.* (1997) reported 34% of return on capital for small ruminants of Botswana, concluding that small ruminant enterprise is economically viable and contributes a substantial amount to the total household income. Workeneh *et al.* (2004) suggested that the net benefit of the goat could be underestimated until the socio-cultural roles have been included in the productivity indices.

The total net profit (ETB140.51) obtained from small ruminants enterprise in the current study is higher than results reported (Getahun, 2008) for small ruminants in Adilo (ETB136.2), but lower than Kofele (ETB148.3). Panin *et al.* (1997) reported the profitability and economic viability of small ruminants in Botswana, forwarding US$ 11.27 dollar per animal per annum

for small ruminant owning households. It provided a return of 34% on capital invested in the enterprise and contributed 15% to the household income, which was substantial, exceeding the contribution from crop production by more than 100%.

The average net total agricultural income for the studied households in Alaba during the study period amounted ETB2366.82 (Table 21). Crops are major income sources for the household during the study period. Teff, hot pepper and chat are the major contributors for the increased net cash income from crops production. Livestock contributes ETB1068.50, which is about 45.14% of the total net agricultural cash income. This result is in the range reported of livestock contribution (37-87%) for the total farm income for farmers in the country.

Net cash income from small ruminants was ETB 559.06 or 24.2% of the net total agricultural cash income (Table 21) and 52.3% of the net total cash comes from livestock. Small ruminants contribute as high as one third of the cash income coming from the crops. Small ruminants are reported to contribute 48% of the cash income generated at farm level (Degefu, 2003), which agrees with the current results. The total net agricultural cash income contribution of small ruminants is as high as that of cattle. Cattle were sold very rarely but small ruminant sale was frequent and throughout the year to generate immediate cash income. Moreover, the cash obtained is used for purchasing critical inputs for crop production making sheep and goats an important link in crop-livestock system.

Table 21: Net total cash income per household from livestock as compared to other farm activities

Item[§]	Value[§] (ETB)
A) Value of sales	
Crops	2219.19
Small ruminants	573.47
Cattle	554.96
Other livestock*	44.83
(B) Value of purchased inputs**	
Crops	921.17
Small ruminants	14.41
Cattle	48.75
Other livestock	41.60
(C) Net cash income (A-B)	
Crops	1298.02
Small ruminants	559.06
Cattle	506.21
Other livestock	3.23
Net total livestock cash income	1068.50
Net total agricultural cash income	2366.82

[§]averaged for the number of households, [*]this includes horses, donkeys and chicken. **this includes expenses for inputs (fertilizer, seed, herbicide, etc) and feed, vet medicine, mineral salt, etc.

The total net cash income (ETB1068.50) from livestock, which was 45.1% of the total net agricultural cash income obtained in the current study, was lower than the total net cash income for Adilo (82%) (Getahun, 2008). Field studies in different parts of Ethiopia showed that livestock account for 37-87% of total farm cash income of farmers, indicating the

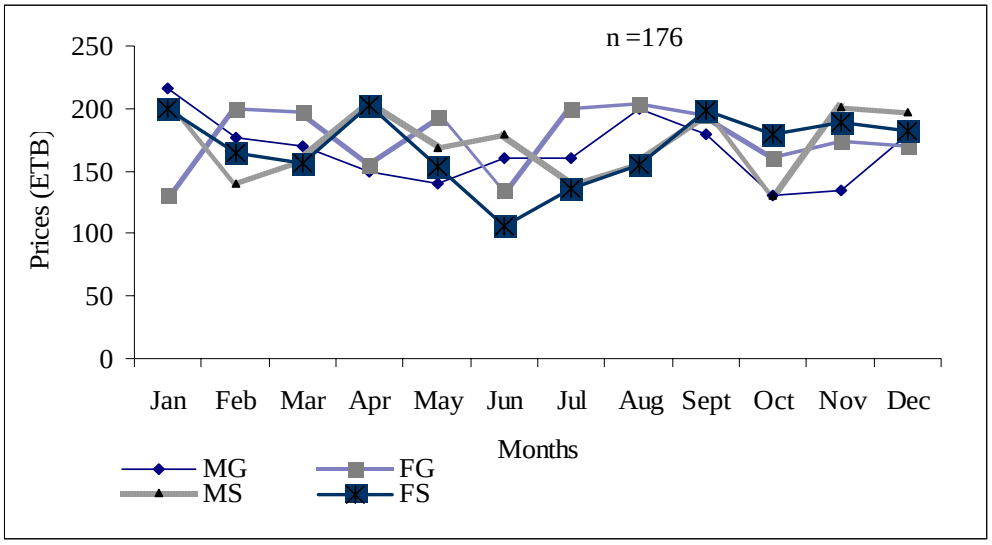
importance of livestock in rural livelihood, especially as one moves from mixed farming in the highlands to agro pastoral systems on the highland-lowland margins (Ayele *et al.,* 2004). Incomes from livestock are the major source of farm household income, accounting for 49% of the total in Botswana (Panin *et al.,* 1997), which is comparable with the current findings. The study conducted in Botswana to estimate the relative efficiency of cattle and goats, indicated that the capital invested in the animals was only slightly higher for a cattle-rearing enterprise (30%) than for a goat-rearing enterprise (28%). This implies that both enterprises are almost equally efficient. The same author reported that family labor plays a crucial role in the management of the animals, and played a significant role as fixed costs of the two enterprises.

Cash income generated through sale of small ruminants in this study as a proportion of total cash income from other livestock was 53.7%, indicating their significant role in the livelihood of the farmers rearing them. The return on capital of 10% from Olkalkar sheep and 8% from Olkalkar and Mbirkani goats of Kenya was reported (Peacock, 1987), agrees with the present result. Peacock (1987) in her conclusion suggested that maximum sustainable return of 30% for sheep and 26% for goats could be obtained if certain simple innovations were adopted. Goat husbandry contributed 12% to the total agricultural margin in successful households in Pakistan. The profitability of goat rearing under 'cut and carry' system can be successful under smallholder production system, especially where farmers can grow improved fodders, often to mark boundaries and as live hedges (Ahuya *et al.,* 2005). Small ruminants can complement the system by diversification of economic portfolios as a means of risk management (Devendra, 1999). In addition to economic importance, small ruminants are

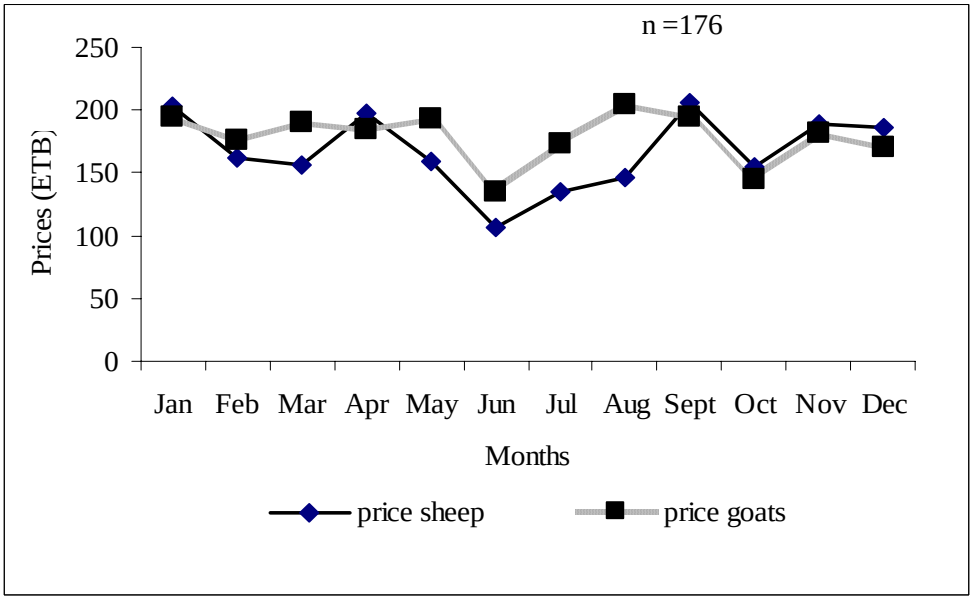
being considered as an insurance (security) benefit for the household with security through liquidation at any one time when the need arises and income over time (Bosman *et al.,* 1997) and aid in savings of the households income over time by balancing the current cash needs against unexpected cash needs of the future (Workneh, 2003).

Price pattern

Monthly distribution of the sale price of small ruminants is presented in Figure 10, a and b. The highest sale prices for both species were recorded around holidays, April to May, August to September (Easter, Ethiopian New Year and Id-Al-Fetir) and grain harvesting period and Ethiopian Christmas (December to January). The higher price during crop harvesting period is the farmers increased purchasing power whereas in public holidays is the higher price of fattened sheep and goats targeting holiday market. Fattened sheep are preferable and fetch higher sale prices than fattened goats. Price fluctuates throughout the year, the lowest being in June and October for both species. Males fetch higher price over females, particularly during holiday markets. Most farmers' sale fattened animals on holiday markets as an external traders purchase these animals by providing incentives and premium price. Some key informants suggested that most animals sold during periods of public holidays are much fattened so that the price of others, particularly young fluctuates. The prices of the animals were usually higher during holiday markets. The sale and purchase price of the two species declined when farmers came across with shortage of money and whenever they sell their animals on ad hoc or unplanned during cropping period, due to higher supply.



(a)



(b)

MG=male goat, MS= male sheep, FG= female goat, FS= female sheep

Figure 10: Monthly average sale price of sheep and goats, by sex (a) and species (b)

Fattened sheep are commonly marketed and their average price is usually higher than goats at holiday markets (202.5ETB vs 195 ETB in January and 205.63 vs 194 ETB in September).

4.11 OPPORTUNITIES AND CONSTRAINTS

Alaba Woreda has relatively better land resources and high sheep and goat populations with diverse potential. These indigenous resources, are demonstrating remarkable response for market oriented lamb and kid production. This kind of product stratification, raising lambs and kids in some part (mostly mid and highland ecological zones) and intensive fattening in the other part (mid altitudinal agro-ecological zones), where feeds with high energy and protein concentration such as sweet potato, enset corm, boiled haricot bean are dominating, is a systematic way of maximizing production from the animals. The area also has potential for improved fodder production to alleviate feed problems and supplement animals during critical physiological stage at least to minimize weight loss. The local fattening management practices of the area and nearby zones (Kembata, Hadiya and Wolaita) are also becoming popular through holiday market targeted intensive fattening and marketing at Adilo, a potential local market for fattened animals. Apart from the domestic market, there is an emerging export demand for medium weight young male animals, and this gives a good opportunity to improve the product targeting export abattoirs.

Sheep and goats in the area are relatively better in their prolificacy, so that the lamb and kid crops produced per doe/ewe per year could be increased if modest interventions are adopted to minimize the losses through diseases and predators.

Major constraints impeding the performances of sheep and goats of smallholder farmers identified were diseases and predators, water shortage (in some parts) and associated drought, feed shortage in general and browse shortages in particular, poor extension and veterinary coverage. These environmental influences do not allow the potential of the animals to be fully expressed. Disease and predators contributed for stunted growth and loss of animals, respectively. The cross-cutting issue across the study sites was that animals die primarily due to poor managements which otherwise could have been tackled by simple interventions.

Furthermore, very few veterinary clinics and veterinary services coverage, accounted for the increased losses of animals. Farmers far from Kulito Animal Health Clinic reported that they were either not visited or seldom visited by the Animal Health Technicians. The poorest ratio of veterinarian and Animal Health Technicians (1 DVm and 6 Animal Health Technicians and 2 meat quality inspectors) to high number of Kebeles (79) and vast livestock population in the area put the livestock disease prevention and control efforts at low level.

Grazing land size is diminishing due to cropping encroachment and land re-distribution, putting nutritional stress on livestock in general and small ruminants in particular. Tethering pressure and insufficient nutrition are often responsible for the appearance of prolonged anoestrous and silent oestrous periods, a reduction in fertility, prolonged parturition interval and reduction in prolificacy.

Water provision is generally poor in the Woreda, mainly in goat dominating site. As a result, flocks are trekking over long distances losing energy which otherwise would have been used

for growth, reproduction or milk production. Watering frequency affect the daily feed intake of animals and lead to reduced productivity. Female animals, particularly milking goats were in a stressed condition and reported abortions and milk reduction was associated with water shortage and drought. Trekking over long distances has additional consequences on labor; labor intensiveness and burden on men and women. Fetching dirty water for human and livestock consumption leads for water borne diseases and has a big implication on human and livestock productivity.

Lengthy finishing process of animals, probably more than a year and half or two, had implications on the resource use, labor and space competition. This is because unless market targeted finishing is practiced, fat deposition is costly, which farmers might not be aware of the situations. Farmers do not want to dispose their animals through short term finishing because they consider them as a savings and capital building for socioeconomic and socio-cultural benefits. This points out to the need for strong extension service and institutional commitment for improving input supply system, marketing system, credits and overall extension system.

5. SUMMARY AND CONCLUSIONS

Small ruminants are a componential part of the crop-livestock mixed farming systems play a significant role in the livelihood of smallholders. They do have socio-economic and cultural values other than their physical products; meat, milk, skin, manure, etc. They are considered as a risk averters for a family through sale for quick and seasonal needs. Sheep and goats are carried out integrated with crop production contributing a lot for the household income and stability of the system.

The objective of this study was to evaluate the biological and socioeconomic contribution of small ruminants for the households; and identify production barriers and suggest intervention options in Alaba Special Woreda, Southern Ethiopia. The Woreda was classified into small ruminant density groups, and the respective kebeles and households were selected using multi-stage sampling techniques. The study was undertaken through flock monitoring, longitudinal survey and group discussion. Information was collected on growth, reproductive and economic parameters through one year long, October 2008 to September 2009, flock and household monitoring on 60 households.

The results showed that the area has relatively large mean landholdings (1.5ha). Hot pepper, teff and chat are the major cash crops while small ruminants are kept mainly for income generation. Considerable proportion (44%) of mortality was recorded within 4 months period, October to January, mainly associated with diseases, parasites and predators. Sheep and goats

are watered at long intervals (often at interval of three or more days) during the dry season, which had significant impact on their productivity. Most kebeles in goat dominant site are suffering from severe water shortage, particularly during the late dry season; fattening animals lose weight and milk yield reduced in milking does. Herd's men or women trek over long distances searching for water, labor demand and cost increases, putting pressure on other agricultural activities. Sheep and goats are tethered or herded during the cropping season. '*Afelama*', a local bylaw and binding rule, punishes a person who lets his animals and damages crops during cropping season.

Young (lambs and kids of both sexes) and mature females constitute the major proportion of the flock while others exit from the flock at early age primarily through sale, particularly in the sheep sub-system. Sale, death and home slaughter are the major routes of exits in both species, of which sale is the predominant (60.5% in sheep and 41.5% in goats). The farmer's removals of males before attaining puberty through sell; might affect the genetic improvement of the flock and its future productivity, particularly if these animals are of fast growing. Birth is the predominant entry route for both species (87.1% for sheep and 94.4% for goats). Lambing and kidding were recorded throughout the year. Higher parturitions were recorded during March to June, the apparent peak being in May. However, the co-occurrence of higher parturitions during the time of critical feed and water shortage affected the overall performances of the dams as well as the kids or lambs. The mean litter size at birth was 1.52 for sheep (the rate of single, twin and triplet being 48.4, 49.7 and 1.9%, respectively) and 1.47 for goats (the rate of single and twin being 53.3 and 46.7%, respectively). Age at first parturition and parturition interval of sheep were 12.43 and 9.19 months, respectively, while

the corresponding values for goats were 11.95 and 9.05, respectively. Ewes and does expressed higher reproductive capacity through higher prolificacy, early AFP and shorter PI compared to most of the indigenous small ruminants. This capacity could be offset by increased abortions and mortalities.

The mean birth weight, weaning weight and average daily gain of sheep obtained were 2.3 kg, 10.35 kg and 89.2 g/day while the corresponding values for goats were 2.34 kg, 9.85 kg and 82.3 g/day, respectively. These weights and growth rates at specific ages pointed out that sheep and goats of the area express better productive capacity. These situations indicate the opportunity for further improvement of the reproductive and growth performances of the animals through appropriate strategies of disease prevention and control, water development, feeding and husbandry practices. Most of the goat owners consume goat milk. Wide variations in milk yield of does points out the need of further targeted study.

The off take rate of sheep and goat (41.8 vs 30.4%) in this study is relatively higher, indicating the emerging market demands and opportunities. Most of the offtake was through sale to generate income. Enterprise budgeting of the sheep and goats revealed that they contribute more than large livestock (23.6 vs 21.4%) for the household income and stability of the system. The higher income obtained from high value cash crops might emasculate the economic significance of small ruminants.

Fattening system of the area could be improved by designing cost-effective short term finishing strategy. Further study is needed to evaluate the fattening system and its efficiency in

the area. Furthermore, an overall extension support is needed by improving institutional arrangements, infrastructure, and policy environment to improve the sub-sector.

It is concluded that performance level of the sheep and goats of Alaba as measured by reproduction and growth parameters is reasonably good and if constraints are tackled higher performance could be expected. The contribution of small ruminants to the farming enterprise is also satisfactory and could be further improved if modest interventions are undertaken to reduce the barriers.

High within variability observed through growth & reproductive performances, indicates the need of devising an appropriate breeding strategy, selection. Moreover, to improve the productivity of the populations, genetic parameter estimation of some of the important traits of the breeds is also a great importance for the improvement of the animals.

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APPENDICES

Appendix I: Flock monitoring format

1. General Background
ENUMERATORS'S NAME _____
Recorder/data collector name
FARMER'S NAME (HH Head) _____Farmer name
AGE: _____YRS SEX: 1=M 2=F ETHINICITY _____RELIGION _____
MARITAL STATUS 1=MARRIED: 1.1=Polygamous 1.2=Monogamous 2=SINGLE

KEBELE NAME _____VILLAGE/*GOTE* NAME _____
DATE OF COMMENCE OF RECORDING (DD/MM/2008/2009) _____

2. Livestock holding

Ser No	*Type of animal*	*quantity (No)*	*Holdings*			*Source of animals*			
			own	*Share/Ribi*		*Family/parents*	*Born at home*	*purchased*	*gifts*
Cattle									
1	Cow								
2	bull								
3	Heifer								
4	Male bull??								
5	Male calf (1-1.5 yr)								
6	Female calf (1-1.5 yr)								
7	Draught oxen								
8	Fattening ox								
Sheep									
1	Below 3 months								
2	3-6 month males								
3	3-6 month females								
4	6-12 females								
5	Intact males (6month and above								
6	Females								
7	Castrates								
8	Fattened								
Goats									
1	Below 3month								

2	3-6 month males								
3	3-6 month females								
4	6-12 females								
5	Intact males (6month and above								
6	Females								
7	Castrates								
8	Fattened								
Equines									
1	Male horse								
2	Female horse								
3	Male donkey								
4	Female donkey								
5	Mule								
Chicken									
1	All age groups								

Initial and final weight recording format

I.D	Initial weight	No of broken/erupted teeth	Final weight	No of broken teeth	Remark

3. House type and housing for people and animals

1. Where is sheep and goat housing; 1, dwelling house 2, adjoining house, 3, sheep and goats house 4, field 5, others, mention

2. House number and type

No	*Houses (Code 1)*	*Major use (Code 2)*	*Roof type (Code 3)*
1			

Code 1 1, dwelling house 2, Store 3, Burn 4, Mosque 5, others, mention

Code 2 1, dwelling house 2, Store 3, Burn 4, Worshipping and guest house 5, Kitchen 6, toilet 7, others, mention *Code3* 1=grass (hay) 2= tin 3=brick

4. Body condition scoring and traditional grading system recording format

Scales for body condition scoring

No	Classes of animal	Score*	lumbar region	rib	sternum	remark

* 1= very thin, 2= thin, 3= moderate, 4= fat, 5= very fat

Traditional body scoring method

No	Classes of animal	Score	Scoring criteria			remark

How they manage at different scores----------

5. Major crops grown, patterns of utilizations and uses of crop residues

S N	*CROP TYPES*	*MEHER*			*BELG*			*IRRIGATED*			*MARKETING PRICES (BR/QT)*		*USE OF RESIDUE (CODES)*
		Variety (code)	Area (timad)	Yield (Qt/ha)	Variety (code)	Area (timad)	Yield (Qt/ha)	Variety (code)	Area (timad)	Yield (Qt/ha)	When High	When Low	
I	*Cereals*												
1													
II	*Pulses*												
1													
2													
III	*Oil crops*												
1													
IV	*Root and tuber*												
1													
V	*Others*												
	Chat												
	Hot pepper												

Code for use of crop residues 1=Feed 2=Compost 3=Fuel 3=Construction/thatch 4=Fence 5=Sold

6=Bed material (including barns) 7=Others, specify _____

Code for Variety 1=Local cultivars 2=Improved 3=Both

What are major crops grown, area covered and yield of each crop during 2000/2001?

Crop	Variety	Area (ha)	Yield (Qt/ha)
Maize			
H. bean			
Tef			
Hot pepper			
Wheat			
F. bean			

Field pea			
Others, specify			

6. Feeds of sheep and goats and their seasonal distribution

Major feeds	*Age and sex of animals given*	*Season of availability*											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept

7. Supplementary feeds and their seasonal availability

Supplementary feeds	*sources (own field/ purchased)*	*Age of animals given*	*Season of availability*											
			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept

8. Water sources of sheep and goats and its seasonal distribution

Water sources	Summer season (July-October)	Distance from dwelling house (Km)	Dry season (Dec-February)	Distance from dwelling house (Km)	Short rainy season (March-June)	Distance from Dwelling house (Km)	Remark

Frequency of Watering

ency of watering	*Distance from dwelling house* (Km)	*sheep*			*goats*		
		Dry season	Wet season	Small rainy season	Dry season	Wet season	Small rainy season
Once per day							
Every two day							
Every three day							
Every four day							

* 1 hour travel = 5 Km

9. Exit and Entry relationships/flock dynamism

9.1 Exit ways and reason of exit

I.D	death (No)	Sell (No)	Slaughtered (No)	Theft/ (No)	Predator (No)	Gifts (No)	Share holding/ Ribi (No)	Date of exit	Reason of exit	Remark

9.2 Entry ways and their reason

I.D	Birth	Share holding(*	Gifts back	purchased	Date of entry	Reason of entry	Remark

Note:- * could be 'Ribi' or care taker ownership

10.Flock Identification

Flock detail	Identification (colour, unique home name, body marks, age, sex, etc…)	I.D	Remark

11. Mortality of sheep and goats data/information

I.D	Sex	Birth date/erupted teeth	I.D	Death date	Death reason	Remark

12. Major diseases and other associated reasons of sheep and goats

Local name	Major reasons	No of animals affected by this disease	No of animals died by this diseases	Remark

13. Traditional treatments and their importance

Types of	For which disease	For which animal (age,		Efficacy	

traditional treatments		sex, etc)	Source of medicaments	Very effective	Intermediate	Not effective	Remark

- Do you use any indigenous/traditional treatment to your infected sheep and goats?

1. Yes_____ 2.No_____, If yes, what type of treatment?

Disease/parasite	*Type of treatment*	*Effectiveness/ efficacy* *1. Complete cure 2. Reduced damage 3. Doubtful*
CCPP		
Trypanosomiasis		
Endoparasitism		
Respiratory diseases		
Ectoparasitism		
Mineral deficiency		
Enteritis		

4. Do you have access to veterinary service? 1. Yes_____ 2. No_____
5. If yes, how far is the nearest veterinary centre?_____Km.
6. Can you afford paying for veterinary service? 1. Yes_____ 2. No_____
7. If no, how much is the lowest veterinary service charge for a single animal?

14.2 Major household expenditures

14.2 Major household Income

No	HH member	Income sources	Amount per year (Br)	Total	Remark

14.2 Major household expenditures

No	HH member	Reason Expenditure	Amount per year (Br)	Total	Remark

14.3 Cash expenditure on major items (non-durable goods) in the last 12 months

S N	*PURCHASED PRODUCTS*	*FREQUENCY*	*AVERAGE EXPENDITURE*	*S N*	*PURCHASED PRODUCTS*	*FREQUENCY PURCHASED*	*AVERAGE EXPENDITURE*

			PER PURCHASE				*PER PURCHASE*
	Staples			3	Cooking oil/ghee		
1	Teff			4	Coffee/tea		
2	Maize grain			5	Drinks		
3	Maize flour			6	Tobacco/cigarette		
4	Sorghum			7	Chat		
5	Wheat flour				Non-food items		
6	Enset			1	School fee, textbooks, etc		
7	Barley			2	Medical expenses		
8	Potatoes			3	Transportation		
	Nan-staple fresh foods			4	Clothing/shoes		
1	Beans			5	Soap/other detergents		
2	Ground nuts				Contributions		
3	Vegetables/fruits			1	Remittances to relatives		
4	Chicken			2	Churches/mosques		
5	Meats			3	Mutual supporting groups		
6	Eggs			4	Cooperatives/committees		
7	Fresh milk			5	Land tax		
8	Cheese				Fuel		
9	Butter			6	Electricity		
	Non-fresh food items			7	Fuel wood		
1	Sugar			8	Charcoal		
2	Salt			9	Kerosene		

Code for purchased frequency 1=Daily 2=Weekly 3=Monthly 4=Yearly 5=Others, specify

15. Animal health and feed inputs

15.1Feed inputs

Ser No	Types of feeds input	Amount (kg)	Amount purchased		Type of animals given		Remark
			Min (birr)	Max (birr)	Age	Sex	

15.2 Medical inputs

	Types of medical inputs	Amount (kg)	Amount purchased		Type of animals given		Remark
			Min (birr)	Max (birr)	Age	Sex	
1							

⇔ Inputs include medical purchase, feed purchase, salt purchase, etc…

16. Labour division and responsibility of family members for sheep and goats

Activities	Male head	Female head	Male	Female	Daily labourer	Remark
Tether / take to filed for grazing						
harvesting feed						
watering						
Cleaning burn and house						
Caring kids and lambs						
Caring fattening animals						
Taking sick animals to clinics						
Milking						
Milk churning						
Selling animals/ marketing						
Decision making on the income from sell						
Owner of sheep and goats						

17. Milk recording format

Name of farmer	Lactating females I.D	*Lactation length (days/ month)*	*parity*	Days of recording															
				Mor	*Eve*	*Mor*	*Eve*	*Mor*	*Eve*	*Mor*	*Eve*	*Mor*	*Eve*	*Mor*	*Eve*	*Mo*	*Eve*	*Mor*	*Eve*

*Mor= morning milk yield, Eve= evening milk yield

Utilization of Goats milk

1. Uses of goats milk _____

_____

2. If the family is making use of it, explain the way of preparation and utilization and for whom it is offered_____

_____

_____

_____

8. 1 New birth recording format

Farmer name	I. D	Birth date	Sex	Colour	Weight	Date weight taken	Dam No	Birth type (Single, twin, triplet etc.)	Parity	Weaning weight	Remark

18.2 Mating and parturition seasons

Spp.		Mating and parturition seasons											
		Oct	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*
Sheep	*Service time/conception time*												
	Parturition time												
Goats	*Service time/conception. time*												
	Parturition time												

19.1 Purchase recording format

Farmer name	Animal I.D	Sex	Birth date/erupted teeth	Color	Purchased date	Price	Reason of purchasing	Remark

19.2 Sell recording format

Farmer name	Animal I.D	Sex	Birth date/erupted teeth	Colour	Date of selling	Price	Reason of selling	Remark

20. Sheep and goats skin use

Farmer name	Slaughtered animals I.D and type	Slaughtering time /season	Reason of slaughtering	Source of slaughtered animal	Use of skin	price	Remark

21. Family size, Work condition, Education and land use of the selected participants (in the last 12 months, Oct 2008 –Sept 2009)

1. How many wives does HH head have? 1= one 2,two 3= three 4= four 5= four and above

2. Fill the following: (All the families of polygamous households will be recorded)

Ser no	Name of family members	Marriage type (1= married, 2= unmarried, 3= , 4= divorced)	Age (yrs)	Sex (1= M, 2= F)	Education level (1= illiterate 2= read and write 3= Higher	*Work condition/ livelihood*	
						summer (dry	*winter (wet*

					education, 4= others	season)	*season)*
1							

Livelihood/Job of participants 1, Agriculture 2= female household head 3= student 4, shephered 5,welder 6,No job
7, Government worker 8, kitchen worker 9, paid pension 10, trader 11= others, mention

3. Land size (Ha); (Please mention record from land certificate) _____(Ha)

4. Land allocation for different activities; (Mention in Timad, 4 Timad= 1 Ha)

1. Crop_____Timad 3. Fallow land_____Timad
2. Grazing_____Timad 4. Others (Perennial crops, valley bottom areas) Timad

22. Opportunities and constraints of sheep and goats production

1. What was the trends of Livestock production and productivity in the last 5-10 years?
1. Decreasing 2. Increasing 3. No change
2. If any changes, what are the reasons for these changes? Please mention the reasons for each problem_____
_____
3. If any change, what were the influences of these changes on sheep and goats?
_____
4. Mat are the major purposes of rearing sheep and goats? How can you compare role of sheep and goats with other animals?_____
5. If you are rearing mixed sheep and goats, why you doing so; _____
_____
6. Suggest how to improve productivity of livestock including sheep and goats alleviating the problems?_____
_____

Appendix II: Life histories questionnaires for breeding females

1. Name of the owner_____
2. Tag No. of the ewe/doe_____
3. How old is this ewe/doe?_____
4. Was she born in your flock or did you get from somewhere else?_____
5. How many lambs/kids did this ewe or doe deliver up to now? (the complete number, alive as well as dead ones_____
6. At what age did she give birth for the first time? (age in months)_____
7. What was the interval(in months) between
   i. 1^{st} parturition and 2^{nd} parturition_____
   ii. 2^{nd} parturition and 3^{rd} parturition
   iii. 3^{rd} parturition and 4^{th} parturition _____
   iv. 4^{th} parturition and 5^{th} parturition _____
   v. 5^{th} parturition and 6^{th} parturition _____
   vi. 6^{th} parturition and 7^{th} parturition _____
   vii. 7^{th} parturition and 8^{th} parturition _____

8. Does the animal have any problems like udder abnormalities, mastitis, poor milk let down of else? _____

_____

9. Does this animal have any abortions?
   a. If yes, how many and before which lamb/kid did they occur?_____
   b. Where those early or late abortions?_____
10. Did this animal ever show difficulties to conceive? a. yes b. no
   i. If yes, what do you think was the reason?_____
11. Is the ewe (doe) now pregnant and since how many months or lactating?_____

_____

Appendix III: Income-expenditure and labour particulars

1. Provide the following info regarding income and expense of last season's crops

parameters	Type of the crop			
	Crop 1	Crop 2	Crop 3	Crop 4
Area planted				
Total yield (in quintals)				
Quantity sold (in quintals)				
Average price per quintal)				
Input costs Improved seeds Fertilizers Pesticides/herbicides Farm implements Labor cost (external) others	----------	----------	----------	----------
The money utilized for	----------	----------	----------	----------

2. Please provide the number of hours invested by family members for different activities in the last seasons cropping

Activities	Hours spent for various activities of different crops	Remark

	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5	
Land preparation Children <15 Adults (15-60) Adults >60						
Planting • Children <15 • Adults (15-60) • Adults >60						
Harvesting • Children <15 • Adults (15-60) • Adults >60						
Weeding • Children <15 • Adults (15-60) • Adults >60						
Sales and purchases • Children <15 • Adults (15-60) ▪ Adults >60						
Others, specify • Children <15 • Adults (15-60) • Adults >60						

3. Provide the following info regarding last season's income and expense from livestock

parameters	Type of the crop					Remark
	Cattle	equines	Sheep	Goats	Chicken	
Number of animals sold						
No. of animals slaughtered						
Income obtained from the sale of live animals (in Birr)						

Income from butter sale						
Input costs feed veterinary drugs/ services Salt/ bole Hired labor Construction barn/shelter others	---------- ---------- - ---------- --------	---------- ---------- - ---------- ---------- -	---------- ---------- - ---------- ----------	---------- ---------- --- ---------- ----------	---------- ---------- - ---------- ---------- -	---------- ---------- - ---------- ----------
The money utilized for	---------- -	---------- -----	---------- ---	---------- ----	---------- -------	---------- --

4. Please provide average No. of hours invested by family members for different activities in the last seasons livestock husbandry

Activities	Hours spent for various activities of different crops					Remark
	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5	
Land preparation • Children <15 • Adults (15-60) • Adults >60						
Planting						

• Children <15 • Adults (15-60) • Adults >60						
Harvesting • Children <15 • Adults (15-60) • Adults >60						
Weeding • Children <15 • Adults (15-60) • Adults >60						
Sales and purchases • Children <15 • Adults (15-60) • Adults >60						
Others, specify • Children <15 • Adults (15-60) • Adults >60						

Thank you for your cooperation!

APPENDICES

Appendix Table 1: Monthly distribution of SR parturition

Month	sheep	Goats	Total	% (percent)
January	7	4	11	3.8
February	6	6	12	4.1
March	8	10	18	6.2
April	13	10	23	7.9
May	22	27	49	16.9
June	12	12	24	8.3
July	15	8	23	7.9
August	12	19	31	10.7
September	14	12	26	9
October	13	11	24	8.3
November	21	7	28	9.7
December	12	9	21	7.2

Appendix Table 2: ANOVA of litter size of sheep

Source	DF	Mean Square	F Value	Pr > F
site	2	0.16252178	0.67	0.5142
season	2	0.20559574	0.85	0.4315
parity	4	0.44696373	1.84	0.1247
Error	154	0.24323275		
R^2=0.09				
CV=32.53				

Appendix Table 3: ANOVA of litter size of goat

Source	DF	Mean Square	F Value	Pr > F
site	2	0.08637830	0.44	0.6447
season	2	0.05297296	0.27	0.7637
parity	4	1.78575052	9.11	<.0001
error	134	0.19607549		
R^2=0.27				
CV=30.19				

Appendix Table 4: ANOVA of birth weight of sheep

Source	DF	Mean Square	F Value	Pr > F
site	2	0.25797354	3.90	0.0224
Birth season	2	0.34659731	5.24	0.0063
sex	1	0.26665354	4.03	0.0465
parity	4	0.30716653	4.65	0.0015
Litter size	1	0.30716653	4.65	0.0015
Error	121	0.06611892		
R^2=0.36				
CV=11.19				

Appendix Table 5: ANOVA of birth weight of goat

Source	DF	Mean Square	F Value	Pr > F
site	2	0.53677864	8.76	0.0003
Birth season	2	0.46986468	7.66	0.0007
sex	1	0.00000088	0.00	0.9970
parity	4	0.88339161	14.41	<.0001
Litter size	1	0.88339161	14.41	<.0001
Error	121	0.06130992		
R^2=0.48				
CV=10.60				

Appendix Table 6: ANOVA of 30 days weight of sheep

Source	DF	Mean Square	F Value	Pr > F
Site	2	0.97336638	0.81	0.4488
Birth season	2	8.13153774	6.75	0.0018
sex	1	0.44773055	0.37	0.5436
parity	4	0.67022498	0.56	0.6951
Birth type	1	0.67022498	0.56	0.6951
error	112	1.2053413		
R^2= 0.14				
CV=24.67				

Appendix Table 7: ANOVA of 30 days weight of goat

Source	DF	Mean Square	F Value	Pr > F
Site	2	0.33805754	0.52	0.596
Birth season	2	7.68578972	11.83	<.0001
sex	1	0.12415971	0.19	0.6631
parity	4	3.22029799	4.96	0.001
Birth type	1	12.92263153	19.88	<.000
Error	98	0.6498775		
R^2=0.42				
CV=18.36				

Appendix Table 8: ANOVA of 60 weight of sheep

Source	DF	Mean Square	F Value	Pr > F
site	2	2.36237663	1.35	0.2649
season	2	3.53746170	2.02	0.1387
sex	1	1.05051766	0.60	0.4408
parity	4	1.67116615	0.95	0.4370
Litter size	1	1.67116615	0.95	0.4370
error	104	1.7531576		
R^2=0.14				
CV=19.08				

Appendix Table 9: ANOVA of 60 days weight of goat

Source	DF	Mean Square	F Value	Pr > F
site	2	0.74828540	0.83	0.4398
season	2	9.46581869	10.52	0.0001
sex	1	0.24967908	0.28	0.6001
parity	4	3.97432543	4.42	0.0031
Litter size	1	12.22736186	13.59	0.0005
error	77	0.8998046		
R^2= 0.50				
CV=14.35				

Appendix Table 10: ANOVA of 90 days weight of sheep

Source	DF	Mean Square	F Value	Pr > F
site	2	2.86327229	1.00	0.3726
season	2	2.21785560	0.77	0.4645
sex	1	2.98212801	1.04	0.3106
parity	4	3.21737911	1.12	0.3515
Litter size	1	36.80835764	12.85	0.0006
error	89	2.8640170		
R^2=0.21				
CV=16.35				

Appendix Table 11: ANOVA of 90 days weight of goat

Source	DF	Mean Square	F Value	Pr > F
site	2	18.23072895	5.26	0.0087
season	2	11.95931308	3.45	0.0401
sex	1	0.31974843	0.09	0.7628
parity	4	3.73724535	1.08	0.3785
Litter size	1	9.89661874	2.85	0.0978
Error	57	3.4691456		
R^2=0.42				
CV=18.92				

Appendix Table 12: ANOVA of Average daily gain of sheep

Source	DF	Mean Square	F Value	Pr > F
site	2	2514.028580	5.95	0.0050
season	2	1446.322126	3.43	0.0409
sex	1	1.486008	0.00	0.9529
parity	4	297.663501	0.71	0.5925
Litter size	1	297.663501	0.71	0.5925
Error	57	422.21512		
R^2=0.48				
CV=24.96				

Appendix Table 13: ANOVA of average daily gain of goats

Source	DF	Mean Square	F Value	Pr > F
site	2	249.295498	0.74	0.4800
season	2	125.665980	0.37	0.689
sex	1	286.678323	0.85	0.3588
parity	4	270.792192	0.80	0.5259
Litter size	1	2854.536481	8.48	0.0047
Error	89	336.54047		
R^2=0.15				
CV=20.56				

Appendix Table 14: ANOVA of 120 days weight of sheep

Source	DF	Mean Square	F Value	Pr > F
site	2	0.47900516	0.19	0.8274
season	2	13.19326095	5.23	0.0078
sex	1	0.61058592	0.24	0.6242
parity	4	1.21440068	0.48	0.7490
Litter size	1	1.21440068	0.48	0.7490
Error	75	2.5203959		
R^2=0.24				
CV=11.96				

Appendix Table 15: ANOVA of 120 days weight of goats

Source	DF	Mean Square	F Value	Pr > F
site	2	1.22824602	0.46	0.6345
season	2	10.07908949	3.77	0.0308
sex	1	0.56144733	0.21	0.6489
parity	4	4.46819571	1.67	0.1735
Litter size	1	4.46819571	1.67	0.1735
Error	54	2.6721816		
R^2=0.33				
CV=13.83				

Appendix Table 16: ANOVA of 150 day weight of sheep

Source	DF	Mean Square	F Value	Pr > F
site	2	0.11767983	0.07	0.9359
season	2	2.58579953	1.46	0.2462
sex	1	2.32807038	1.31	0.2595
parity	4	1.53544060	0.87	0.4936
Litter size	1	1.53544060	0.87	0.4936
Error	45	1.77178593		

R^2=0.21
CV=8.48

Appendix Table 17: ANOVA of 150 day weight of goat

Source	DF	Mean Square	F Value	Pr > F
site	2	0.76228344	0.54	0.5864
season	2	28.11144070	19.93	<.0001
sex	1	3.93087072	2.79	0.1022
parity	4	7.71270868	5.47	0.0012
Litter size	1	0.08834712	0.06	0.8036
Error	54	1.4107344		

R^2=0.64
CV=8.68

Appendix Table 18: Major diseases and physiological disorder and their traditional treatment methods

Major disease	Local name	Species affected	Season of occurrence	Typical symptom	Traditional treatment methods
Fasciolosis	'Lugo'	S,G,C	All season, mainly wet season	Diarrhea, emaciation, and depression	No traditional treatment reported
Respiratory diseases	'Sombeta'	S,G	Rainy to early dry season	Increased respiratory rate, coughing, and abnormal breathing sound on auscultation	No traditional treatment reported
Pasteurellosis	'Gororisa'	C,S,G, P	Rainy season	Swelling of throat region, neck and brisket drooling of saliva, tongue protrude and dark red	'Hechela*' and 'Enboy' crushed mixed with timbeho and salt, and about a cup dose is drenched orally. Cutting protrude tongue
Blackleg	Tefiqa/Abagorba	C,S	All season, mainly wet season	Pronounced lameness, swelling of the upper part of the affected leg, skin discoloration	The back skin cut and let the frothy air move out
Anthrax	'Ari Tedeneta'/	All	Dry season	Widespread signs of oedema, protrusion of rectum, exudation of blood from natural orifices of cadaver and sudden death and zoonotic	If known at early stage, "Hechela' tuber will be dug, crushed and drenched orally. Burning around neck and shoulder with hot iron metal or sickle
Sheep pox	'Bega'	S	Dry and small rainy season	High fever, eruption of papule and vesicles, development of pus, scab formation	Not reported
CCPP	'Ari mosu'	G	All season	Depression, blood discharge from nostrils, low appetite, coughing	Not reported
Bloat	'kuftena'	C,S,G	All season conc. or forage bloat	Left stomach extended, breathing blocked	Fuel in noise, food oil orally, 'timbaho ,hot pepper and salt grounded and drenched orally

Source: Tsedeke (2007), Alaba BoARD and participant farmers

S=sheep, G= goat, C= cattle, P=poultry; * 'Hechela or *Farsi Belala* is a rhizobious type of tuber dug from the ground, uses for about 10 diseases(for example 'Gormote', 'Kurmi', Kesanohani', lung disease, Anthrax and pasteurellosis, etc..)

BIOGRAPHICAL SKETCH

The author of the present thesis was born in 1979 in Kemabata Tembaro Zone of SNNPR, Ethiopia. He attended his elementary and junior secondary schools in Mugunja and Hadero between 1985 and 1991. He attended Senior Secondary Schools in Areka and Durame between 1992 and 1995.

He joined Debub University, Awassa College of Agriculture in 1996 where he studied Animal Production and Rangeland Management. He graduated in July 2000 with the Bachelor of Sciences in Agriculture (Animal Production and Rangeland Management). He was employed in Kechabira Office of Agriculture and Rural Development between 2000 and 2002. Then he joined the Dilla Agricultural Technical Vocational Education and Training College (ATVET) between 2002 and 2004. He was then employed by the Areka Agricultural Research Center, SARI, between 2004 and 2007. He worked as a livestock researcher in the Department of Animal Science Research.

He was admitted to the School of Graduate Studies of University of Hawassa in 2007 for his graduate studies in the specialization of Animal Production.