Mekelle University

PARTICIPATORY DEFINITION OF BREEDING OBJECTIVES AND TRAIT PREFERENCE OF SHEEP PRODUCERS IN ATSBI DISTRICT, TIGRAY, ETHIOPIA

By:

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Declaration

I, Mr. Tesfay Gebremariam Kahsay, hereby present for consideration by the **Department of Animal, Rangeland and Wildlife Sciences**, College of Dry land Agriculture and Natural Resources at Mekelle University, a thesis entitled **"Participatory Definition of Breeding Objectives and Trait Preference of Sheep Producers in Atsbi District, Tigray, Ethiopia"** for partial fulfillment of the requirement for the degree of Masters in Livestock Production and Pastoral Development." I sincerely declare that this thesis is the product of my own efforts. No other person has published a similar study which I might have copied, and at no stage will this be published without my consent and that of the department of **Animal, Rangeland and Wildlife S ciences**.

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Date of Submission:15/08/2017 E/C

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PARTICIPATORY DEFINITION OF BREEDING OBJECTIVES AND TRAIT PREFERENCE OF SHEEP PRODUCERS IN ATSBI DISTRICT, TIGRAY, ETHIOPIA

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ABSTRACT

The study was conducted in the Atsbi district of Tigray, Ethiopia, with the aim of identifying the breeding goals and trait preferences of sheep producers. Data were collected through structured and open-ended questionnaires, as well as personal observations from 180 households across three peasant associations (Tabias).The results indicated that most respondents came from male-headed households, were married, and nearly half were able to read and write. This suggests a strong potential for adopting improved technologies and enhancing performance in sheep production. Among various farming and non-farming activities, livestock provided the highest cash income, followed by crops (0.23), trading (0.17), and daily labor (0.16). Farmers raised various livestock species, with sheep forming the largest population, followed by chickens and cattle. The average sheep flock consisted of 11.8 heads, primarily made up of breeding ewes. Sheep were mainly raised for income generation, but they also served other purposes such as providing natural fertilizer, savings, meat, milk, and social value.The common criteria for selecting breeding rams included body size, growth rate, coat color, tail type, and active libido. For breeding ewes, the selection criteria included body size, lambing interval, age at first lambing (AFL), mothering ability, and milk yield. Interestingly, some farmers kept more rams than necessary, with 29.4% of flocks having no rams. This limited mating opportunities, as mating typically occurred only during grazing hours in communal pastures.Tigray highland sheep have demonstrated a potential AFL of 16.8 months and an average lambing interval of 8.47 months, with a milk yield of 0.36 kg. The peak lambing season occurs in November, October, and December. During the dry season, various feed resources are utilized, including natural pasture, fallow land, crop residues, hay, agro-industrial byproducts, and established

pasture. Key constraints identified by farmers included drought (index: 0.18), feed shortages (0.17), and inadequate veterinary support (0.14).The study concludes that targeted interventions such as feed conservation techniques and disease control measures can significantly enhance sheep productivity and sustainability. This improvement will contribute to economic resilience for smallholder farmers.

Key words: *breeding objectives; breeding practices; reproductive traits, traits preference.*

DEDICATION

I dedicate this thesis manuscript to my mother W/ro**Tekian Gebre** who passed away and I deeply wish that God might give her peaceful rest for ever and also children's dead through malnutrition and lack of medication treatment due to war in Tigray.

BIOGRAPHICAL SKETCH

The author of this thesis, Mr. TesfayGebremariam, was born on May 16, 1981 G.C.At Genfel kebelle, Kilteawlaelo District, Eastern Zone of Tigray, Ethiopia from his father Keshi Gebremariam Kahsay and his mother W/roTekian Gebre.

He attended his primary education at Grhutsa Elementary School Since 1993 and his secondary education at Wukro Agazi Senior secondary school in 2002.Joined since2005 in Wukro St.Mary's College of Agriculture in Animal science for three years. After too received my Diploma to joined employment in 2008 in Amhara regional state waghimra zone attend in Ziquala woreda as DAs in the PAs for at list two years. Since in 2010 to joined Sekota dry land Agriculture research center in technical assistance until to 4 years. In addition, joined Wollo University, Collegeof Agriculture and Veterinary Medicine in the department of Animal science in 2014 awarded a B.Sc. degree in Agriculture (Animal science) in June 2016.

Soon after graduation, joined again to Sekota dry land Agriculture research center in Junior Researcher (I) in small ruminant case team small ruminant Breeder and then since 2018 shaft to Alamata Agriculture research center (ALARC) in Assistant researcher (I) for one and half years. Then in October 2019, he joined the School of Graduate Studies (SGS) at Mekelle University in the Department of Animal, Rangeland and Wildlife Sciences to pursue his MSc. study with Livestock Production and Pastoral Development with the research title**" Participatory Definition of Breeding Objectives and Trait Preference of Sheep Producers in Atsbi District, Tigray, Ethiopia"**. In the School of Animal, Rangeland and Wild life sciences and extended due to war for about three years.

Wish for better!!

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Thanks to all!!!

ACRONYMS AND ABBERVIATIONS

AFP	Age at first Parturition
BoARD	Bureau of Agriculture and Rural Development
CSA	Central Statistical Authority
DAGRIS	Domestic Animal Genetic Resources Information System
Das	Developmental Agent
ESGPIP	Ethiopian Sheep and Goat Production Improvement Program
FAO	Food and Agriculture Organization of the United Nations
FGD	Focused group discussion
HH	House hold
LI	Lambing interval
N	Number of respondents
SD	Standard Deviation
SPSS	Statically Package for Social Science
SSA	Sub Saharan Africa
TARI	Tigrai Agricultural Research Institute

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CHAPTER 1: INTRODUCTION

1.1. Background and Justification

Ethiopia is believed to have the largest livestock population in Africa, with an estimated 65 million cattle, 42.9 million sheep, and 51 million goats (CSA, 2021). The country is not only abundant in sheep numbers but also possesses significant genetic diversity among its sheep breeds, developed through natural selection (Solomon, 2008). Smallholder sheep production is a crucial source of food security, serving various functions, including cash income, savings, fertilizer, social and cultural roles, and fiber production. Sheep are particularly vital for farmers in the subalpine highlands and among pastoralists/agro-pastoralists where crop production is unreliable. Moreover, sheep resources substantially contribute to foreign currency earnings through live animal and mutton exports (Hiwot et al., 2020).

Sheep production is an important sector of agricultural production in Tigray region of Ethiopia. According to CSA (2020) the populations of sheep in Tigray is estimated to be 2.1 million. Phenotypically, sheep of the region are categorized into four breeds: Highland, Abergelle, Elle and Begait. Highland sheep has found in all agro-ecological zones of Tigray with major concentration in the Eastern and Southern Zones (Abreham and Zelalem, 2010). Atsbi district is noted for its large population of this breed (Getachew et al., 2014) and it is an important supplier of sheep especially to the regional capital town, Mekelle (Berhanu et al., 2007).The overall productivity of sheep can be enhanced through crossbreeding with exotic breeds or by selection from local breeds (Kassahun and Gipson, 2009).While, crossbreeding local breeds with exotic ones may be an option for increase livestock productivity. However, there is a risk for endangerment of the local breeds (Emelie et al., 2015). Indiscriminate crossbreeding without a clear breeding objective presents a potential threat to better adapted indigenous breeds (Tesfaye et al., 2016).

Studies made on Ethiopian indigenous sheep breeds have shown a significant amount of genetic variation within these breeds (Solomon, 2008; Sisay et al., 2023; Zewdu et al., 2018). Despite this, sheep productivity in Ethiopia remains low, characterized by limited productivity, low off-

take rates, and a narrow range of production outputs (Solomon et al., 2010; Jemberu et al., 2022). Enhancing the genetic potential of local sheep breeds could be a critical intervention for reducing poverty and ensuring food self-sufficiency among producers.

To achieve greater productivity in sheep farming, it is essential to develop a sustainable and compatible breeding strategy. Such a strategy should align with the specific goals of targeted farmers and their production systems, as no single approach fits all situations (Groen, 2000; Gemeda et al., 2010). The prevailing production conditions largely determine the purposes of keeping livestock, the suitability of different breeds, and the appropriate breeding methods. Before designing breeding plans, it is necessary to identify the animal traits that farmers wish to improve (Groen, 2000; Solomon et al., 2009).In developing countries, defining breeding objectives through traditional methods, such as profit equations and bio-economic models, is challenging due to a lack of data on production costs and the value of animals that are not linked to marketable profits (Kosgey et al., 2006). In such cases, participatory rural appraisal methods are effective for identifying breeding objective traits and engaging stakeholders (Gemeda et al., 2010). Recently, participatory rural appraisal has been widely used to explore farmers' preferences for animal traits. This method provides a hypothetical representation of trait levels, offering sufficient options for respondents to express their interests (Gemeda et al., 2010; Solomon et al., 2009).

To realize the benefits of a breeding program, it is crucial to define the breeding objectives accurately for the specific breed, community, and environment involved. The strategies outlined must be practical and achievable (Philipsson et al., 2011). The aim should be to help producers make the best use of the resources available to them and to improve their livelihoods in sustainable ways (Nielsen et al., 2014; Rege et al., 2011). Farmers from different production systems may have varying trait preferences (Roessler et al., 2008) and may adopt different strategies based on the agro-environments in which they operate (Gemeda et al., 2010; Ouma et al., 2007). By involving farmers in trait identification and integrating the identified traits into the breeding plan, they can be encouraged to actively participate in implementing the developed technology (Groen, 2000). However, there has been limited study on breeding objectives and the identification of key trait preferences for Tigrai highland sheep in the study area. The focus of

the current study is to define breeding objectives and identify farmers' traits of interest, selection criteria, and preferences related to reproduction and productivity for Tigrai highland sheep producers.

1.2. Statement of the problem

Despite the large number and diverse functions of sheep, the average productivity of indigenous sheep is generally low (Jemberu et al., 2022). This is in agreement with the findings of Gulilat et al. (2018) and Getinet et al. (2014). The reasons for low productivity of indigenous sheep are multilaterally known but largely related to a lack of effective breeding programs. However, most of the indigenous sheep breeds in the various parts of the country are still kept under the traditional breeding system, without having been supported with proven scientific methodologies and state of the art technologies in animal breeding to date (Abiye et al., 2020). Improvement in sheep productivity, given the suitability of the area and the adaptive potentials of the existing sheep, can be a pathway to putting smallholders out of poverty in northern highlands of Tigrai, Ethiopia. However, specific breeding objective traits of sheep breeds reared in the target areas have not yet been identified to design and implement effective breeding programs. This implies that only a proper analysis of sheep breeding experiences and trait preferences were able to sensibly define the breeding objectives and design genetic improvement programs at smallholder level in the study district. Therefore, this study aimed to identify breeding practices and smallholder farmers' trait preferences for indigenous sheep in Atsbi district, Tigray, Ethiopia.

1.3. OBJECTIVES

1.3.1. General objective

- To evaluate the breeding goals and trait preferences of sheep producers in the Atsbi district of Tigray, Ethiopia, using participatory approach.

1.3.2. Specific Objectives

- To identify breeding objective and breeding practices of sheep producers in the study area.
- To identify important traits preference of sheep production in the study area.
- To evaluate productive and reproductive performance of indigenous sheep under farmers management practices in the study area.
- To assess major challenges of sheep producers in the study area.

1.4. HYPOTHESIS OF THE STUDY

- Sheep producers in the study area have defined breeding objectives and follow traditional breeding practices
- Sheep producers prioritize specific traits (growth rate, disease resistance, reproduction) in their selection criteria, influenced by market demand and production systems.
- Major constraints (feed shortages, diseases, lack of improved breeds, and market access) significantly limit sheep production efficiency in the study area.

1.5. RESEARCH QUESTIONS

- What are the breeding objectives and practices of farmers?
- What are the important trait preferences of sheep producers?
- What is the level of productive and reproductive performance in indigenous sheep?
- What are the major challenges faced by sheep producers?

1.6. SIGNIFICANCE OF THE STUDY

This specific study entitled on the “Participatory definition of breeding objectives and trait preference of sheep producers in Atsbi district, Tigrai, Ethiopia", have numerous advantages for different clients. From this data information will benefit too many concerned stakeholders who are involved in development and research activities related with breeding objectives and trait

preference of sheep producers/sheep productivity improvement program. Extensions workers, researchers, students, farm managers, farmers and interested individuals will be significantly benefited from the results of this study. It has significant importance for the economical utilization. In expansion to this, it may serve as a source of data for other thinks about within the future endeavors.

1.7. SCOPE AND LIMITATIONS OF THE STUDY

The study was conducted in the Atsbi district of Tigray, Ethiopia, focusing on sheep producers to identify breeding goals, trait preferences, and production constraints. It covered 180 households, collecting data through structured questionnaires to assess socio-economic characteristics, sheep breeding practices, and selection criteria. Key findings revealed that sheep are primarily kept for income generation, with body size and growth rate being the most important traits for selecting breeding rams and ewes. The study also evaluated reproductive performance; Major constraints included frequent droughts, feed shortages, and limited grazing land. These insights are valuable for designing sheep breeding programs and interventions to enhance productivity in the region.

However, the study had same limitations. Its geographical scope was restricted to Atsbi district, meaning the findings may not fully apply to other areas. Additionally, the study did not include other stakeholders like traders, not did it assess genetic related factors that could influence sheep productivity. Economic aspects, such as profitability, were also not explored in depth. Despite these limitations, the research provides a useful foundation for future studies that could expand the scope, incorporate genetic and economic analyses, and further support sheep production improvements in Ethiopia.

CHAPTER 2: LITERATURE REVIEW

2.1. Sheep Production Systems in Ethiopia

According to the Livestock Master Plan of Ethiopia (LMP, 2015), there is no specialized sheep production system in the country. Two broad types of sheep production systems have been identified (Markos, 2006): the traditional smallholder management system and the private commercial and pastoral production system. The traditional subsistence smallholder management system is the most common system in Ethiopia (Solomon, 2013). These two categories can be further classified into highland sheep-barley, mixed crop-livestock, and pastoral and agro-pastoral production systems (Solomon et al., 2008). Each of these production systems has different production goals and priorities (Belay, 2009). Generally, they are characterized by small flock sizes, communal grazing, uncontrolled mating, lack of recording, low productivity per animal, limited use of improved technology, and reliance on on-farm by-products rather than purchased inputs (Addis et al., 2015; Jemberu et al., 2022).

2.2. Classification of Ethiopian Sheep Breeds

Ethiopia is home to a genetically diverse population of sheep, with approximately three-quarters of them found in the highlands, where mixed crop-livestock and sheep-barley production systems are prevalent (DAGRIS, 2006). Indigenous sheep of Ethiopia are generally classified into 14 based on their ecological distribution, geographic proximity, tail types and tail shape (Solomon, 2008; Nurlign, 2020). They can be further categorized into nine genetically distinct breeds and six breed groups, as detailed by Solomon (2008). Identifying these breeds is essential for developing various sheep breed improvement strategies and enhancing sheep productivity. These breeds inhabit different ecological zones across the country, including sub-alpine, arid lowland, sub-humid lowland, and wet highlands. The sheep types in Ethiopia are classified into four major groups based on their physical characteristics: short fat-tailed, long fat-tailed, thin-tailed and fat-rumped sheep (Solomon, 2008). The genetic diversity and structure of Ethiopian sheep populations can be explained by historical events and selection for ecological adaptation (Zewdu et al., 2017) or due to developmental homeostasis mechanisms generate variation in

body shape corresponding to an optimal size for fitness in different agro ecology(Solomon, 2008).

2.3. Sheep Production and Breed Types in Tigrai

Sheep production offers food, cash income, and manure to smallholder farmers (Yenesew et al., 2013). It significantly contributes to farm livelihoods, especially in areas where crop production is unreliable and livestock is the primary means of sustenance (ESGPIP, 2009). Sheep rearing is an important sector of agricultural production in Tigrai, practiced in highland, midland, and lowland areas. This practice has a long history in the region, rooted in a mixed farming system of crops and livestock. The sheep's ability to thrive on low-quality feed, along with its fast growth, short gestation period, and small size, makes it well-suited for family consumption. However, due to poor management practices and uncontrolled breeding systems, the economic returns from sheep production have remained minimal (Berhanu et al., 2007).

Tigrai is home to a large population of sheep with valuable breeds for mutton production (Gebretsadik and Anal, 2014), estimated at about 2.1 million (CSA, 2020). There are four sheep breeds in Tigrai such as Abergelle, Begait, Ille, and Tigrai Highland sheep (Abreham and Zelalem, 2010; Mulata et al., 2024).Each breed has distinct features that make them suitable for their specific production systems. While most sheep breeds are used primarily for meat production, the Begait breed is utilized for both milk and meat (Abreham and Zelalem, 2010; Gebretsadik and Anal, 2014).

2.3. 1. Tigrai Highland Sheep

Highland sheep are found in all agro-ecological zones of Tigrai, with a major concentration in the highlands of the eastern and southern zones of Tigrai (Abreham and Zelalem, 2010). This breed is classified as short fat-tailed sheep (Mulata et al., 2014). It is a dual-purpose breed, primarily raised for meat production, and to a lesser extent, for milk production (Getachew et al., 2014). The breed is characterized by a medium body size, a promising body framework with a wider loin area, a short and wide tail, and red and gray coat colors (Gebretsadik and Anal,

2014).They may also have horns and are known for their docile temperaments. Average adult body weights have been reported as 28 kg for males and 23 kg for females (Mulata et al., 2014).Tigrai Highland sheep are a hardy breed, capable of demonstrating excellent hereditary performance even in the face of feed and rainfall deficiencies. However, they are not particularly prolific when it comes to reproduction; single births are the norm, while twins are rare (Alemayehu and Tikabo, 2010; Getachew et al., 2014).

2.4. Productive and reproductive performance of sheep in Ethiopia

2.4.1. Reproductive performance of sheep in Ethiopia

Good reproductive performance is a pre-requisite for any form of genetic improvement and it determines the efficiency of production (Alexandre et al., 2012; Assan, 2020). Where farm resources are extremely constrained, as is often the case in sub -Sahara Africa, reproduction failure is the first sign of lowered productivity. The poor reproductive performances of Ethiopian sheep can be related to genetic factors, poor management, seasonal fluctuations in feed resources and illnesses (Asmare et al., 2021; Hussein, 2018; Kerga, 2021). The reproductive performance of sheep is the major factor that affects productivity; it depends on various factors including age at first lambing, litter size, lambing interval and the life time productivity of the ewe, the last one being related to longevity (Assan, 2020).

2.4.1.1. Age at first lambing

In small ruminants, age at first lambing (AFL) is an economically important trait because it determines rate of genetic growth and population turnover rate (Assan, 2020; Kierkegaard et al., 2025). Optimal AFL is essential to increase sheep productivity while earlier or late AFL is likely to have a shorter productive life and a lower lifetime production (Hernandez et al., 2011). The optimum age at first lambing in sheep production heavily relies on husbandry system, locally available facilities and policies, and inherent characteristics of the breed (Kierkegaard et al., 2025). The average age at first lambing for Ethiopian indigenous sheep breeds under extensive management condition ranges from 11.3 to 24.8 months (Aklilu, 2012; Amare et al., 2019; Fsahatsion et al, 2013; Mesfin et al., 2014). Longer age at first lambing was reported for Menz

sheep (24.8 months (Lemma et al., 2014). Additionally, Assen and Aklilu (2012) found that15.0 months of AFL across different agro-ecological zones (highland, midland, and lowland) in Tigrai, Ethiopia.

2.4.1.2. Lambing interval

Lambing interval is defined as the period between two successive parturitions and defines the reproductive performance of small ruminant production. Normally, a minimum of three lambs is expected in a span of two years (Ampong et al., 2019). A shorter lambing interval provides a better opportunity to enhance ewes' lifetime productivity by increasing the number of lamb crops per ewe (Abiye et al., 2020; Gazzarin and Benni, 2020). In Ethiopian sheep, the lambing interval generally ranges from 7 to 10 months (Rekik et al., 2015). Lambing interval is considerably influenced by several factors, such as genetics, management practices, agro-ecology, season of lambing, mating management, nutrition, lactation length, ewe parity, birth type in the previous lambing, and ram used for mating purposes (Ampong et al., 2019; Asmare et al., 2021; Vlahek et al., 2022).

2.4.1.3. Liter size

Litter size in sheep (the number of lambs born per ewe), significantly impacts the economic profitability of sheep meat production (Assan, 2020; Farrell et al. 2022; Slavova, 2022). Increasing litter size can lead to higher lamb production and thus greater income. However, it's not a simple linear relationship; the marginal economic benefits of very large litters can diminish due to increased lamb mortality and the ewe's ability to successfully rear multiple lambs (Farrell et al. 2022). The average litter sizes at birth for some Ethiopian indigenous sheep breeds under extensive management condition ranged from 1.01 to 2.4 lambs per ewe (Asmare et al., 2021; Deribe et al., 2021; Solomon et al, .2010). Litter size was largely determined by ovulation rate but is also modified by fertilization rate and embryonic and fetal losses (Abdoli et al., 2016). The main factors influencing ovulation rate in the ewes are breed and level of nutrition while season and age, related factors are also important. Ovulation rates differ between breeds, increases with ewe age up to 6-7years and among seasonal breeders, are greatest in the first half of the breeding season, (Sánchez et al. 2015).

2.4.2. Production performance

Sheep production in Ethiopia plays a crucial role in the mixed crop-livestock system, mainly benefiting smallholder farmers through both cash income and home consumption (Zelalem et al., 2012). It provides an essential source of food, cash, and manure for these farmers, with sheep commonly raised for slaughter during festivals and for sale (Debir and Amelmal, 2024). Consequently, there is a growing demand for small ruminant products, particularly mutton, in both domestic and export markets in Ethiopia (SPS-LMM, 2010; Jemberu et al., 2022). Therefore, improving the productivity of indigenous sheep in Ethiopia is necessary to meet this demand.

2.5. Flock structure and ownership patterns

Sheep flock structure refers to the composition of a flock based on the proportions of different age and sex classes of sheep (Hemacha et al., 2023). It essentially describes the breakdown of the flock into categories like breeding ewes, breeding rams, young lambs, and other sheep. Understanding flock structure is crucial for managing a sheep flock effectively, as it impacts breeding strategies, production goals, and overall flock health. In Ethiopia, the sheep flock structure varies on production system and breeding objectives. Abiye et al (2020) noted that an average flock size of sheep in the northwest highlands of Ethiopia was 10.2. Zewdu et al. (2012) stated that flock size of sheep is 8 to 11 in a mixed (crop-livestock) production system; whereas Helen et al. (2015) noted an average flock size of about 97 and 72 sheep in Pastoral and agro-pastoral production systems, respectively. According to Solomon et al. (2010), the specific factors determining flock size include availability of land and feed, role of livestock as major source of livelihood, and reliability of crop production.

2.6. Breeding Objectives and Breeding Practices of sheep in Ethiopia

Breeding objectives, along with a description of the production system and environment, serve as the foundation for designing customized management and breeding interventions (Solomon et al., 2010). These objectives reflect the farming philosophies of breeders and commercial farmers, as outlined by Tesfaye et al. (2019). They are influenced by various factors and must consider the needs and priorities of animal owners or producers, consumers of animal products, the food

industry, and increasingly, the public. Consequently, Helen et al. (2013) and Solomon et al. (2013) identified milk production as a primary objective in sheep production within pastoral and agro-pastoral systems in Ethiopia. In contrast, the study by Tesfaye et al. (2019) highlighted cash income as the main objective for sheep producers within barley and mixed crop-livestock production systems. Likewise, Kiflay et al. (2019) reported that income generation is considered the foremost purpose of sheep production in the Tigrai region of northern Ethiopia. A significant reason for the failure of many livestock improvement programs in the tropics has been the lack of farmer participation in defining breeding objectives (Wurzinger et al., 2011). Therefore, it is essential to identify the breeding goals that livestock keepers wish to improve, through full participation of farmers in specific communities and production systems.

2.7. Common Phenotypic Trait Preferences

Farmers have specific criteria for selecting breeding sheep, with different factors emphasized for male and female selections. When selecting male sheep, criteria such as tail type, color, and height are prioritized. According to Tesfaye (2008), appearance is one of the most important criteria for selecting rams in both crop-livestock and pastoral production systems, particularly in the Menz and Afar areas. Zewdu et al. (2012) reported that in the Southern Nations, particularly in the Adio Kaka District of the Kaffa Region of Ethiopia, farmers select rams based on body size. For breeding males, sheep that are black, poorly conditioned, or small-sized are generally not preferred. These animals are often slaughtered at a young age, sold, or killed at home. Additionally, farmers operating within different production systems may have varying preferences for traits (Roessler et al., 2008). Their selections can reflect the diverse strategies that correspond to the agro-environments they inhabit (Solomon et al., 2010; Tadele, 2010). Understanding farmers' trait preferences is crucial for identifying which traits are particularly important within their agro-ecosystems. This knowledge can inform the design of sustainable breeding programs.

When it comes to selecting female sheep, farmers also have distinct criteria. Factors such as appearance, coat color, and lamb survival rates are significant considerations for ewes, as reported by Helen et al. (2013) in eastern Ethiopia. Litter size and lamb growth are considered

more important selection criteria in pastoral and agro-pastoral systems compared to mixed crop-livestock systems, as these traits are highly associated with mothering ability (Gemeda et al., 2011). For breeding females, black color, old age, poor condition, and long lambing intervals are reasons for culling ewes (Yenesew et al., 2013; Zewdu et al., 2012).

2.8. Sheep Production Constraints in Ethiopia

Major sheep production systems in Ethiopia are characterized by non-specialized, multi-purpose breeds, extensive production systems, and minimal control over breeding animals (Adane and Girma, 2008; Solomon et al., 2008; Addis, 2015). Extensive production systems typically involve small flock sizes, communal grazing, and uncontrolled mating. There is a lack of record-keeping, low productivity per animal, limited use of improved technology, and reliance on-farm by-products instead of purchased inputs (Addis et al., 2015). In mixed crop-livestock systems, the inbreeding coefficient tends to be high due to uncontrolled mating, and the lack of land exchange for communal herding may increase risks unless appropriate measures are implemented (Zewdu et al., 2012). Flock management within groups, influenced by resource availability, parity, litter size, and seasonal changes in both the quantity and quality of feed, are crucial factors that need to be considered in any sheep improvement plan. Overall, the main challenges of the traditional management system include a lack of market orientation, an underdeveloped marketing infrastructure, and poor financial facilities (Azage et al., 2006; Berhanu et al., 2006). The role of brokers in the marketing of small ruminants is viewed in two contrasting ways: some people view them favorably for facilitating transactions between buyers and sellers, while others criticize them as problematic because they largely determine prices (Endeshaw, 2007; Tsedeke, 2007).

2.8.1. Feed shortage

One of the main factors limiting the production and productivity of small ruminants in many agro-ecological zones of Ethiopia, especially in the highland areas, is shortage and poor quality of feed (Addis, 2015; Tesfay et al., 2016). Ruminants in the smallholder sector rely heavily on natural pasture and fibrous crop residues for their survival, growth, and reproduction. However, the natural pasture land is often overloaded with livestock beyond its optimal carrying capacity,

which results in overgrazing and land degradation, ultimately leading to low agricultural productivity. The availability and quality of natural pasture vary with the seasons (Tesfay et al., 2016), causing nutritional stress for animals that depend on it during the dry season when feed resources are scarce and in short supply. Numerous studies have highlighted the seasonal shortages in both the quality and quantity of feed and the corresponding decline in livestock productivity across different regions of the country (Addis, 2015; Tesfay et al., 2016; Getnet, 2022). The issue of feed shortages is particularly severe in densely populated areas, where diminishing land size is a result of intensive cultivation and soil degradation. However, there is an increasing trend toward more effective utilization of available feed resources and the incorporation of non-conventional feeds for supplementation (Belete, 2009; Yeshitila, 2008).

2.8.2. Health constraints and sheep mortality rate

Dereje et al. (2013) reported that in the Daro Labu district of West Hararghe, 21.7% of farmers in lowland areas and 6.7% of farmers in midland areas traveled more than 10 kilometers to reach government clinics. On average, 46.7% of the respondents had to travel more than 1 kilometer to obtain veterinary services. Diseases and inadequate nutrition, whether in quality or quantity, pose serious constraints to sheep production in Africa (Tadesse, 2012). Additionally, the high prevalence of diseases and parasites presents another significant challenge for sheep production in Ethiopia, resulting in high mortality rates among lambs and diminishing the benefits of their high reproductive performance (Girma et al., 2013; Markos, 2006; Sharif et al., 2005). It has been noted that lambs are at a higher risk of dying if they are not separated from adult animals, which increases the risk of accidents and environmental contamination for neonates. In such stressful environments, animals with good adaptive potential are essential to sustain the livelihoods of local communities (Helen et al., 2013; Solomon et al., 2010; Tadele, 2010; Zewdu et al., 2012).

2.8.2.1. Infectious diseases associated with foot rot

Foot rot is a contagious infection of the feet characterized by inflammation of the skin junction, under-running, ulceration and necrosis of the sensitive laminae and severe lameness. There are no characteristic pathological features associated with foot rot although grossly there is always

interdigital necrosis. A characteristic black, foul smelling material is present due to the bacterial necrosis of the horn. Spread of the infection to joints may result in pyo-arthritis and accumulation of pus in the joint cavity (Aiello and Moses, 2016). Despite the high frequency of occurrence of lameness with the consequent morbidity as well as the vast clinical cases in sheep in Ethiopia, studies showing the epidemiological importance of foot rot seems to be limited (Ferede et al., 2014; Chanyalew and Alemu, 2014; Fesseha, 2021).Dichelobacter nodosus, a gram-negative anaerobe and obligate pathogen, is the primary etiologic agent that must be present for foot rot to develop. Fusobacterium necrophorum, gram-negative anaerobic bacteria, may play a synergistic role in pathogenesis and is a normal resident of manure-contaminated environments that contributes to ovine interdigital dermatitis and foot rot (Aiello and Moses, 2016; McVey et al., 2022).

2.8.2.2. Diseases due to internal parasites Nematodes

Gastrointestinal nematode (GIN) infections are a common constraint in pasture-based herds and can cause a decrease in animal health, productivity and farm profitability (Vande Velde et al., 2018). Small ruminants (sheep and goats) are prone to GIN infections, because the areas they graze (pastures and other grass lands) are contaminated with infective stages (eggs and larvae) of GINs and result in continuous infection and reinfection of these animals (Tariq, 2014).

The epidemiology of these parasites depends on the climatic factors (e.g. rainfall, temperature), management systems, hosts and parasite factors. Rainfall (moisture) is most important for survival, development, dissemination and availability of free living stages. GI nematodes can survive harsh conditions by hypobiosis or arrested development of larvae within the host. In the absence of hypobiosis nematodes survive in hosts during the hot and dry season as adults (Taylor et al., 2016; Bowman, 2021). High stocking density increases the contamination of the environment with nematode eggs or larvae and thus makes the infective stages to be more accessible to susceptible animals. Host factors (age, breed, nutrition, physiological status) can also determine the severity and incidences of infections. Factors like the fecundity of the adult worms, the prepatent period and the survival and development rate of the parasite in the environment determines the rate of establishment and size of nematode burden in the host (Taylor et al., 2016).

2.8.2.3. Fasciolosis

Fasciolosis, also known as fascioliasis or liver rot, is caused by two trematodes, *Fasciola hepatica* and *Fasciola gigantica*. It is a disease of sheep, goats, and cattle that occasionally affects humans (Amen et al., 2023). The two species have a common life cycle: In the vertebrate host, immature eggs are discharged in the biliary ducts and excreted with the stool. The eggs become embryonated in water, releasing miracidia, which invade a suitable snail intermediate host. In the snail, the parasites undergo several developmental stages, the last one being released from the snail, encysting as metacercariae on aquatic vegetation or other surfaces. Mammals acquire the infection by eating vegetation containing metacercariae. After ingestion by the final host, the metacercariae excyst in the duodenum and migrate through the intestinal wall, the peritoneal cavity, and the liver parenchyma into the biliary ducts, where they develop into adults (Ayele et al., 2016). Humans can become infected by ingesting metacercariae-containing fresh water or water plants or by ingesting food items washed with such water (Amen et al., 2023; Ayele eta, 2016). The geographical distribution of *F. hepatica* and *F. gigantica* is determined mainly by the distribution patterns of the snails that act as intermediate hosts. *F. hepatica* is found in temperate areas and high-altitude cooler areas in the tropics and subtropics, whereas *F. gigantica* is predominantly found in the tropics and subtropics (Abdisa, 2017).

2.8.2.4. Coenurosis

Coenurosis, caused by the larval stage of *Taenia multiceps*, is often fatal in intermediate hosts, such as small ruminants, and can result in substantial economic losses in livestock farming (*Varcasia et al,. 2022*). Authentic reports of coenurosis began to appear in the literature during the 17th century, although references to nervous disease with the symptoms of coenurosis have been found in texts from the time of Hippocrates (*Godara et al, .2011).* Today, cerebral coenurosis has a worldwide distribution (*Varcasia et al, .2022*).While the disease has been somewhat controlled in many industrialized countries, it continues to cause a burden in many extensive farming systems (*Kibona et al, 2022).*

Coenurus cerebralis*,* the metacestode or larval form of the dog tapeworm *Taenia multiceps* (*Abera et al,* 2016). The adult *T. multiceps* is a parasite of the small intestine of canids such as dogs, foxes, jackals, and coyotes, which act as definitive hosts and are continuous sources of

infection through the discharge of eggs in the feces. The intermediate hosts (mainly ungulates such as sheep and goats, as well as humans) acquire the infection by ingesting food or water contaminated with dog feces containing the eggs of *T. multiceps*. Oncospheres released from the eggs in the intestine of the intermediate host reach the CNS, the muscles, and subcutaneous tissue through blood circulation. As the parasite matures, it develops into a large cyst in the brain (*Godara et al, .2011)*.The mature cyst measures 5–6 cm in diameter and is filled with a large amount of fluid, containing 400–500 protoscolices. In goats, cysts can also grow outside the CNS, and numerous reports exist describing cysts developing in the musculoskeletal system, in the subcutaneous connective tissue of goats, and in the liver and lungs (*Varcasia et al, .2022*). The definitive host becomes infected by ingesting the offal of slaughtered animals with a mature *Coenurus* cyst. It has been reported that African smallholder farmers routinely feed their dogs with offal, including sheep and goat heads, even from infected animals (*Varcasia et al, .2022; Kibona et al, 2022*).

2.8.3. Sheep Marketing Constraints

Market-oriented sheep production is not common in Ethiopia. Selling is mostly done when cash is needed for specific purposes (Berhanu *et al.*, 2007). On the other hand, a sale during the dry season (February-June) is common to avoid risk of animal loss attributed to feed shortage (Belay, 2013). Prices of sheep usually build up toward a peak or down by the buyer and seller types and certain occasion like fasting, holidays and season have also influenced the price variation (Hailemariam *et al.*, 2009; Belete *et al.*, 2010). Flock size and structure of the flock also have crucial factors for market participation; larger flock size is needed to transform livestock production into market orientation (Berhanu *et al.*, 2015). Conversely, proportion of female animals, land size, household wealth, number of dead animals, and distance to livestock market decrease the probability of net selling (Berhanu *et al.*, 2015). Price is central measure of livestock market performance and efficiency, an indicator of producer incentives and a basis of government revenues from livestock market related services (Berhanu *et al.*, 2007). According to Hailemariam *al.* (2009), buyers paid significantly higher premium for sheep with excellent body condition. Mature animals with larger body size also fetch higher prices for their good finishing. Meat quality changes markedly with an animal's age or weight at slaughter (Ameha, 2011).

Hence, producers should know the weight preference of export abattoirs and the major season that fetches a better price per kg of live weight to target their production.

Nearly in all parts of the country, there is no regular market information on prices and supplies, nor formalized grades and standards of sheep and goats and other livestock (Mekuriaw and Harris, 2021). As a result, there is excess supply of animals beyond demands in some seasons. The more mobile trader is better informed on market prices which combined with excess supply places the trader in a better position during price negotiation.

CHAPTER 3: MATERIALS AND METHODS

3.1. Description of the Study area

The representative areas for sheep production potential include DbabAkoryen, Adimesanu, and Felegeweyni in the Atsbi district of the Tigray Region. This district is located in the Eastern Zone, approximately 65 km from Mekelle, the capital city of Tigray, and about 828 km from Addis Ababa, the capital of Ethiopia. The total human population in the district is 87000, out of these 11921 male heads and 11088 female heads with 48% male and 52% female. The district supports a diverse livestock population, including 40084 cattle, 73046 sheep, 24553 goats, 18333 equines, 93469 chickens, and 18146 honey bee colonies available. It is bordered to the north by the SaeseTsaedaemba district, to the south by the Tsrae Wenberta district, to the east by the Afar Regional State, and to the west by the Kiltealaelo district (Alem, A., personal communication, June 12, 2024).

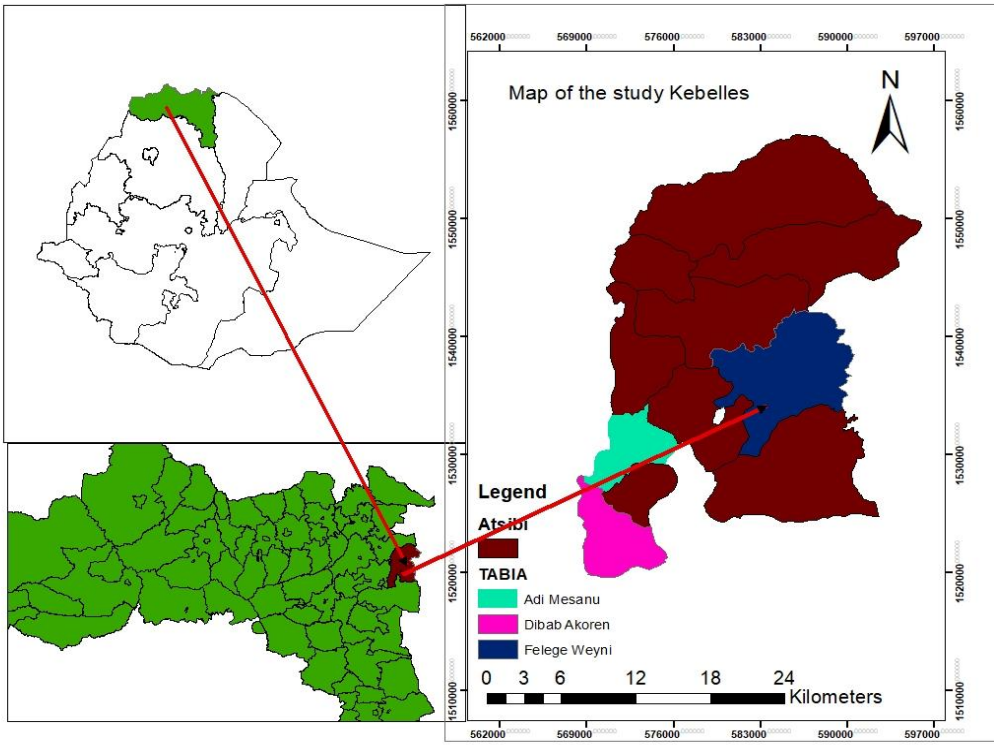

Figure 1: Location map of Atsbi district

3.1.1. Location

The study area was located in Atsbi district, eastern zone of Tigrai northern Ethiopia. The study area was geographically located at 39^0 30’ E to 39^0 45’ E and 13^0 30’ N to 13^0 45’N longitude and latitude. The district has both highland and mid land agro ecologies. It occupies total area coverage of about 1223Km^2.

3.1.2. Climate and land use

According to Mengstu (2018), the average temperature in Atsbi district is 14.5ºC, with an annual average rainfall of about 668 mm. The climate is characterized by one long summer season and one short spring rainy season. The long summer season begins in mid-June and ends in mid-October, serving as the main rainy season for crop production. Meanwhile, the short rainy season, known as 'Belgi,' occurs between March and April. In terms of land use in the study area, the major types include 3300 hectares of forest, 11377.5 hectares of grazing land, and 8457 hectares of cultivated land, according to the respective Woreda Agriculture and Rural Development Office (Abera, M., personal communication, June 18, 2024).

3.1.3. Major agricultural practices

Rain-fed crop production during the summer season is commonly practiced in the study area, where intensive cultivation activities such as sowing and weeding are carried out. The community's livelihood is primarily based on a mixed farming system (BoARD, 2024). The dominant crops in the area include barley, wheat, and beans. Additionally, livestock production plays a significant role in the livelihoods of the local population. Livestock serves as a source of food and cash, as well as being a major provider of draft power, fuel, and fertilizer for crop production. Common livestock in the area includes cattle, sheep, and poultry.

3.2. Methods

3.2.1. Methods of data collection

The data for this study were collected from individual respondents through face-to-face discussions and interviews, as well as focus group discussions. The sources of data included both primary and secondary sources. The field survey gathered information on general household characteristics, including sex, age, family size, education level, marital status, land size, and livestock holdings. Additionally, data were collected on the purposes of sheep keeping. Farmers were asked to identify and rank their trait preferences. The survey also included information about sheep flock size and structure, such as the age and sex distribution of the sheep (including the number of males and females), the marketing age of animals, acquisition and disposal methods, and the reasons for culling sheep from the flock in the selected sheep-rearing areas.

Furthermore, data on reproductive performance (including age at first service or puberty, age at first parturition, lambing interval, and litter size) was collected. The study also investigated farmers' indigenous knowledge regarding breeding practices, watering systems, castration, housing systems, health conditions, and grazing management. Producers' preferences for selection criteria used for breeding rams and ewes, as well as productive and reproductive performances, adaptive traits, and major constraints in sheep production, were assessed using pre-tested and structured questionnaires.

3.2.2. Focused group discussion (FGD)

Focused group discussions (FGDs) were conducted using checklists to gather information on sheep production. The group consisted of a total of 27 members, with 9 participants from each *Tabia*. The proportion of participants included religious leaders, village leaders, elders, kebelle administration officials, model farmers, non-model farmers, youth representatives, women representatives, and development agents (DAs). The FGDs primarily addressed the following topics: trait preferences and breeding objectives of sheep producers in the study area, productive and reproductive performance, the ranking of traits as perceived by producers, the major marketing age for sheep, key entry and exit points in the market, major constraints affecting sheep production, availability of grazing land and feed

resources, and management practices for breeding rams. Information was collected using a prepared checklist.

3.2.3. Sampling technique and sample size determination

The purposive sampling technique was used to select the study area (*Tabia*) based on its production potential, after consulting with the Agriculture and Natural Resource Office of the Woreda. Additionally, three *Tabia*s were chosen from the sample district based on the size of the sheep population. Respondents were randomly selected from the study area to answer a semi-structured questionnaire regarding the definitions of breeding objectives and preferred traits in sheep production. A total of 180 household heads were sampled using this method from the respective lists of farmers in the selected three *Tabia*s, employing proportional-to-size sampling. The site selection and household baseline surveys were conducted from February 30 to early June 2024. Data collected included flock structure, flock size, breeding practices, desirable selection criteria for rams and ewes, mating systems, sheep movement in and out, castration methods, reproductive performance, prolificacy of sheep, and the purpose of sheep keeping. This information was gathered through structured interviews and supplemented with focus group discussions for additional insights.

3.2.4. Methods of data analysis

The data were analyzed using both quantitative and qualitative research methods. The Statistical Package for Social Sciences (SPSS) software was utilized to obtain descriptive statistics, frequencies, and averages. Additionally, SAS was employed to conduct an analysis of variance. The results were then assessed in relation to specific socio-economic conditions within the community. Microsoft Excel was used to rank data regarding the reasons for keeping sheep, the reasons for culling sheep from the flock, and the selection criteria for both male and female sheep. The purposes of sheep keeping, the importance of key traits, and the challenges on sheep production were ranked using the principle of the weighted average method, according to the following formula: Kosgey (2004)

$$\text{Index} = R_n*C_1+R_n\text{-}1*C_2+\ldots+R_1*Cn$$

$$\sum R_n*C_1+R_n\text{-}1*C_2+\ldots+R_1*C_n$$

Where: R_n= Value given for the least ranked level (example if the least rank is 5^{th} rank, then R_n=5, Rn-1=4, and ..., R_1=1), C_n= Counts of the least ranked level (in the above example, the count of the 5^{th} rank = C_n, and counts of the 1^{st} rank = C_1).

CHAPTER 4: RESULT AND DISCUSSION

4.1. Socio-economic characteristics of households

4.1.1. General Socio - economic characteristics in the study area

The socioeconomic characteristics of sheep producers are summarized in Table 1. A majority of the respondents were male, accounting for 80.6% of head households. The ages of the respondents ranged from 20 to 61 years for both sexes. The age groups of 20-40 it depends on animals and family farmland while almost all >40 age groups have their own land and actively involved in farming and animal care. In contrast, individuals over the age of 61 tend to be less involved with farming and animals due to their older age. This finding is consistent with Alubel (2015) study conducted in Ziquala and Lay Armachiho districts of the Amhara Regional State. In terms of educational attainment, the respondents were distributed as follows: 53.9% were illiterate, 32.8% could read and write but were not certified, 11.7% had completed primary school, and 1.7% had completed secondary school. The educational background of half of the respondents indicates that smallholder farmers possess good potential for adopting improved technologies, which can enhance their performance (Kosgey and Okeyo, 2007). It is also essential to focus on upgrading the educational status of the remaining farmers to ensure the success of sheep breeding development interventions. Regarding marital status, the data revealed that 82.8% of respondents were married, 8.9% were single, 4.4% were divorced, and 3.9% were widowed. The higher proportion of married individuals creates an opportunity to introduce and promote effective sheep improvement programs due to their sustainable presence in the area.

Table 1: Gender, age group, educational level, marital status and sheep producers of house-hold heads

Socioeconomic characteristics	N	%
Gender of respondents		
Male	145	80.6
Female	35	19.4
Age group		
20-40 years	36	20
41-60 years	116	64.4
61 and above	28	15.6
Educational level		
Illiterate	97	53.9
Informal	59	32.8
Primary	21	11.7
Secondary	3	1.7
Marital status		
Single	16	8.9
Married	149	82.8
Divorced	8	4.4
Widow	7	3.9
Sheep producers		
Owner	179	99.4
Herdsman	1	0.6

N= Number of respondents

4.1.2. Family size, sheep farming experience and cultivated land holding size

Family size, sheep rearing experience, and cultivated land holding size of respondents are presented in Table 2. The average family size was 5.43±1.61. This value was comparable to the national average family size of 5.2 as reported by the Central Statistical Agency (CSA, 2018).The average cultivated land holding size was 0.29 ±0.10 hectares, and ranged from 0.25 to 0.5 hectares. These results align with earlier reports by Fsahatsion (2013) for the Gamo Gofa Zone. In the highland areas; there was a scarcity of cultivated land. This issue could be attributed to the increasing human population growth rate, which is leading to a decline in landholding per household throughout the study district. The average sheep rearing experience among respondents was 20.9±7.86years. Consequently, respondents in the study area prioritize sheep

rearing, as sheep are suitable for small farmland, require less feed, and have short lambing interval compared to other livestock.

Table 2: Landholding size, sheep farming experience, and family size of respondents

Parameters	Name of villages			Overall mean ±SD	P-value
	Adimesanu	DbabAkoryen	Felegeweni		
Sheep farming experience (year)	21.4	19.7	21.5	20.9±7.8	0.3648
HH family size	5.48	5.43	5.39	5.43±1.6	0.9593
Number of males in the HH	2.70	2.68	2.76	2.72±1.2	0.9464
Number of females in the HH	2.77	2.73	2.78	2.76±1.1	0.9723
Cultivated land holding size (ha)	0.29	0.29	0.29	0.29±0.1	0.9657

HH= household heads; SD= standard deviation

4.1.3. Farming and non-farming activities

In the study area, all respondents practiced a mixed crop-livestock farming system. Table 3 displays the rankings of major farming and non-farming activities based on their contributions to the food sources of the respondents' families. Crops ranked highest, with an index value of 0.39, followed by livestock at 0.34. Trading and daily labor contributed less, with indices of 0.14 and 0.13, respectively.

When looking specifically at cash income generation, livestock had the most significant contribution, with a total index of 0.44. This was followed by crops, which had an index of 0.23, trading at 0.17, and daily labor at 0.16, as shown in Table 4. Although many respondents indicated that they rely on purchased grains, crops still made a substantial contribution to family income. Notably, the contribution of livestock to family income in this study was significantly higher than a previous report (Solomon et al., 2005), which indicated that livestock contributed only 0.29 of the farm cash income in the East Wellega and West Shewa zones. This difference may be attributed to variations in farmland holding capacity and land productivity.

Table 3: Rank of farming and non-farming activities as source food for household

Parameters	1	2	3	4	Weight	Index	Ranking
Crop	134	33	13	0	661	0.39	1
Livestock	41	133	4	2	573	0.34	2
Trading	2	4	49	125	243	0.14	3
daily labor	3	1	39	137	231	0.13	4

Table 4: Farming and non-farming activities as source of cash income for household

Parameters	1st	2nd	3rd	4th	Weight	index	Ranking
crop ranking	3	43	87	47	362	0.23	2
Livestock ranking	163	14	3	0	700	0.44	1
Trading ranking	9	11	33	127	262	0.17	3
daily labor ranking	6	12	29	133	251	0.16	4

HH= household heads

4.2. Livestock holding

The average flock size and livestock composition are detailed in Table 5, which includes various species such as cattle, sheep, goats, equines, chickens, and honeybees. Among these species, sheep have the highest population, followed by chickens and cattle, while goats have the lowest population, as shown in Table 6. This trend aligns with findings from Solomon et al. (2014), which indicated that sheep production is a crucial component of the traditional subsistence mixed crop-livestock system in the Ethiopian highlands. Sheep are the dominant species, primarily used for generating income, providing natural fertilizer, acting as insurance or savings, producing meat and milk, as well as serving various social and cultural purposes. Cattle, which rank as the third most common species, are mainly utilized for draught power, followed by their use for milk and manure (used as fuel and natural fertilizer), income generation, and meat production.

This order of livestock composition corresponds with a previous study conducted in the area by Mengstu (2018). Notably, there were significant differences in the populations of sheep, cattle, goats, and honeybee colonies among the villages. In contrast, the populations of chickens and equines did not show

significant differences across the villages, suggesting that chickens are easier to produce for all farmers and offer significant benefits (as noted in Table 6). Similarly, the number of equines used for transportation remains consistent among the respondents.

Table 5: Livestock holding size in different villages of Atsbi district

Type of livestock	N	Name of villages			Overall mean ±SD	P-value
		Adimesanu	DbabAkoryen	Felegeweni		
Cattle	180	1.08[b]	1.00[b]	2.03[a]	1.37±1.13	<.0001
Goat	180	0.13[b]	0.73[a]	0.00[b]	0.29 ±1.16	0.0009
Sheep	180	12.4[a]	10.3[b]	12.7[a]	11.8±3.54	0.0001
Equines	180	1.03	0.97	0.83	0.94±0.53	0.0997
Chicken	180	4.69	4.08	4.61	4.46 ±1.73	0.1127
Honey bee colony	180	0.07[b]	0.48[a]	0.37[a]	0.31±0.83	0.0148

N= Number of households; SD= Standard deviation

Table 6: Ranked livestock species according to their importance

Species	1st rank	2nd Rank	3rd Rank	4th rank	5th Rank	6th Rank	Index	Rank
Cattle	31	41	34	33	19	0	0.19	3
Goat	1	1	4	2	3	36	0.02	6
Sheep	124	51	5	0	0	0	0.34	1
Equines	5	25	33	76	11	0	0.18	4
Chicken	22	43	72	12	0	31	0.23	2
Apiculture	1	6	13	5	6	2	0.04	5

Index = sum of [6 for rank 1+ 5 for rank 2 +4for rank 3+3for rank4+2for rank5+1for rank6] for particular species of livestock divided by sum of [6 for rank 1+ 5 for rank 2 +4 for rank 3+3 for rank4+2 for rank 5+1 for rank+6] for all species

4.3. Sheep composition and production objectives

4.3.1. Sheep flock structure

The structure of sheep flocks by age and sex across various villages is illustrated in Fig. 2. The average flock size of Tigray highland sheep was found to be 11.8(Table 5 above). This average is higher than the figures reported by Deribe et al. (2021), which was 6.1, and Habtamu et al. (2024), which was 9.1, in Southern and Southwestern Ethiopia. Conversely, this average is lower than the findings of Mengstu (2018) from Eastern Tigray, and Hailai et al. (2018) from Central Tigray. The differences in sheep flock sizes may be attributed to variations in feed availability and the economic roles that sheep play in the community. Solomon et al. (2010) highlighted factors affecting flock size, including land and feed availability, the reliance on livestock as a primary livelihood source, and the reliability of crop production. This aligns with the livestock importance index values presented in Table 6 above, which shows that sheep constitute a major source of livelihood in the study area. In more detail, breeding ewes comprised 47.5% of the flock, female lambs under six months accounted for 14.6%, ewe lambs aged six months to one year made up 13.3%, while male lambs under six months represented 12.7% (Fig. 2). This finding is consistent with the research conducted by Samuel and Belay (2011), which also indicated that breeding ewes constitute a larger proportion of the flock compared to other categories. This distribution suggests that the off-take rate for males, primarily sold for slaughter, is higher than that of females, which are usually retained for breeding and milking purposes, as reported by Jemberu et al. (2022).

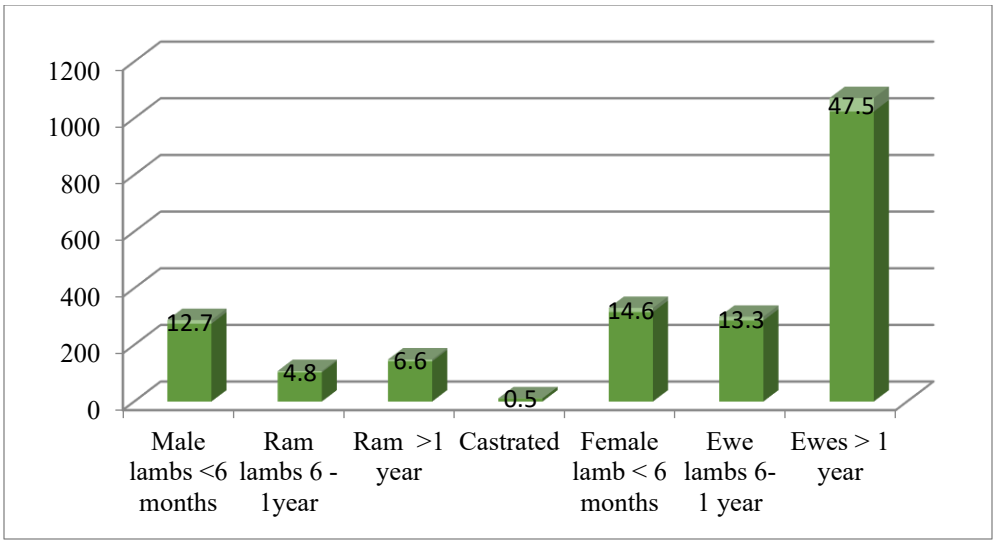

Figure 2: Flock structure over sexes and ages number by percentage

The ownership of sheep flocks in this study reflects the following distribution: 4.45%, 34.44%, 48.89%, and 12.22% for the respective ranges of 1-5, 6-10, 11-15, 16-20 sheep. Additionally, the total number of rams owned by individual sheep producers were described in figure 3, 53 producers has no rams, 78 producers own one ram, 31 producers own two rams, and 18 producers have more than three rams.

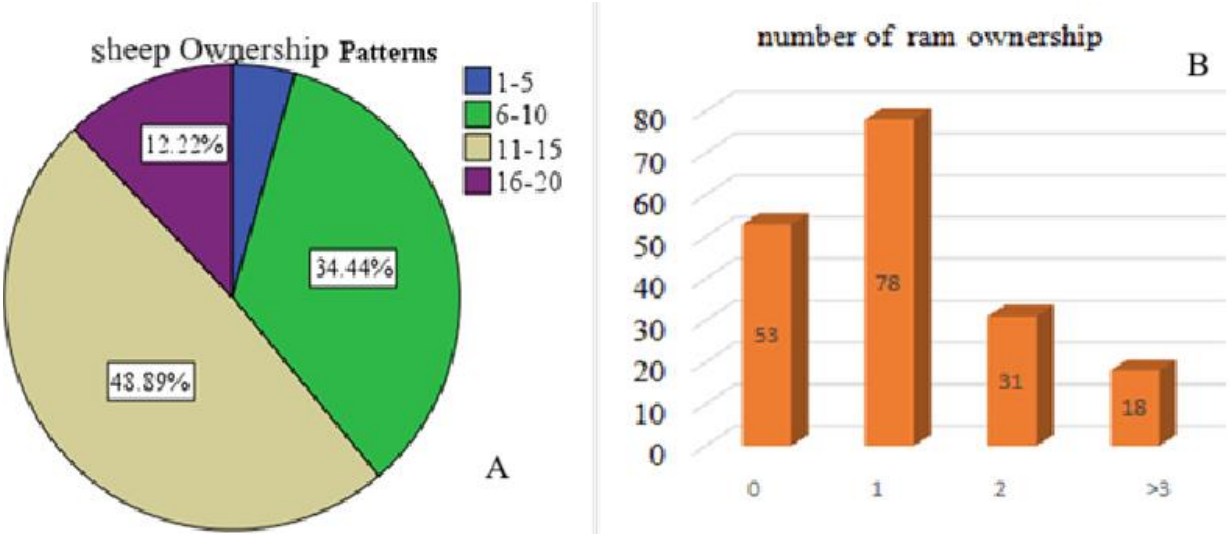

Figure 3: Sheep flock size ownership patterns (A) and breeding ram availability in each flock (B)

4.3.2. Sheep breeding objectives

The reasons for sheep keeping in the study area are summarized in Table 7. The primary motivation for raising sheep was income generation, with an index value of 0.27. Other reasons included the use of natural fertilizer (0.21), savings (0.19), meat production (0.15), milk production (0.10), and social value (0.08). This finding aligns with reports by Dhaba et al. (2013) and Zewdu et al. (2012), who identified income generation as the main objective of sheep farming. They noted that milk consumption from sheep is not common in mixed crop-livestock systems. In contrast, Helen et al. (2013) and Tesfaye et al. (2010) reported that milk production was the primary goal for pastoralists and agro-pastoralists in Eastern and Northeast Ethiopia. While the primary purposes of sheep keeping varied between production systems, the use of indigenous sheep as multipurpose animals was a common practice across all systems. Rearing multipurpose sheep is prevalent in Ethiopia (Tesfaye et al., 2010; Zewdu et al., 2013) and is linked to the need to maximize output from animals that can thrive with low resource inputs (Jimmy et al., 2010). The ability to serve multiple functions is particularly important in low- to medium-input production environments (Zewdu et al., 2013). Given the various purposes farmers and pastoralists have for keeping sheep, careful consideration is necessary when selecting breeding objectives and strategies, as the desired traits are closely tied to the functions of the animals (Kiflay et al., 2022). Understanding the reasons for raising animals is crucial for developing effective operational breeding goals (Jaitner et al., 2001).

Table 7: Rank proportions and index values for sheep production objectives at smallholder level

Purpose	1st	2nd	3rd	4th	5th	6th	Index	Ranking
Sources of cash income	170	5	3	2	0	0	0.27	1
Meat	5	30	18	102	10	15	0.15	4
Manure	90	15	20	15	25	15	0.21	2
Saving	52	44	18	30	6	30	0.19	3
Milk	9	3	14	24	40	90	0.1	5
Social andcultural functions	6	3	11	20	30	110	0.08	6

Index= (6 for rank 1) + (5 for rank 2) + (4 for rank 3) + (3 for rank4) + (2 for rank 5) + (1for rank 6) divided by the sum of all weighed purpose of sheep mentioned by the farmers.

4.3.3. Sheep selection criteria and producer's trait preferences

In the study area, farmers have specific criteria for selecting breeding rams and ewes, as outlined in Table 8. The most commonly used selection criteria for reproductive and productive traits for breeding rams are as follows: body size and conformation (0.29), growth rate (0.27), coat color (0.19), tail type and length (0.13), active libido (0.12), and being horned. For breeding ewes, the top criteria are: body size and conformation (0.30), lambing interval (0.27), age at first lambing (0.18), mothering ability (0.13), and milk yield (0.12). The significance of body size is evident for both rams and ewes, as the values for this criterion are nearly identical. This observation aligns with reports from Kflay et al. (2022) in Tigray, as well as Zewdu et al. (2013) and Fsahatsion (2013), which indicate that body size is a primary factor in ram selection in the southern regions of Ethiopia. Farmers likely prioritize body size because a flock's profitability is directly tied to the growth performance of the lambs. Larger body sizes are in high demand in the market for both breeding and meat purposes, allowing them to command higher prices (Kiflay et al., 2022; Gemeda et al., 2011). Consequently, sheep breeders in this area would benefit significantly from incorporating body size into their genetic improvement programs.

In the study area, sheep with red coat color, medium size, and wider tail types are preferred because they are perceived as more attractive in terms of market price and demand. Research by Gebreselassie (2015) and Tesfaye et al. (2020) has indicated that coat color significantly influences pricing in the Tigray and Afar regions, respectively. Based on their preference red color (Dem Begie) and horned sheep are highly preferred. Additionally, ewes with shorter lambing intervals and earlier ages at first lambing are favored, ranking as the second and third selection criteria. Farmers are likely keen on these traits to increase flock size and enhance overall productivity. Berhanu et al. (2015) confirmed that as the number of births in a sheep flock increases, both the inflow of animals and farmers' market participation also rise. Moreover, shorter lambing intervals contribute to more effective genetic improvements by reducing the average generation interval. Sheep producers prioritize selecting ewes with strong mothering abilities and high milk yields, as these traits are critical for the care and nourishment of lambs, ultimately leading to better growth and survival rates. Solomon et al. (2018) identified mothering

ability as one of the most economically important traits for Menz sheep, evidenced by lamb survival rates, making it a key criterion for selecting female sheep.

In general, farmers' trait preferences vary significantly based on production systems, sheep breeds, and feed availability. For example, Gemeda et al. (2011) found that lambing intervals in the Afar region, body size and twinning in Bonga sheep, and coat color in both Bonga and Horro ewes all had negative coefficients. In the Afar pastoral/agro-pastoral system, a shorter lambing interval is less desirable because lambing is synchronized with the season of feed availability. Body size and twinning concerns are minimal in Bonga sheep, as this breed is well-known for its twinning ability and larger body frame in Ethiopia. Additionally, Helen et al. (2013) reported that income generation is the primary goal for mixed crop-livestock production systems, while milk production is the main objective for pastoral and agro-pastoral sheep production in eastern Ethiopia.

Figure 4: Preferable ram /horned/ (A) and Observations ram /polled/ (B)

Table 8: Ranking of ram and ewes' phenotypic attributes according to producers' interest

Ram selection criterion	1st rank	2nd rank	3rd rank	4th rank	5th Rank	Index	Rank
Body size conformation	74	65	20	13	8	0.29	1
Growth rate	92	18	32	13	25	0.27	2
Coat color	10	47	49	33	41	0.19	3
Tail type/length	3	6	27	60	86	0.13	4
Active libido	0	9	20	70	81	0.12	5
Ewe' selection criterion							
Body size	58	73	25	19	5	0.30	1
Lambing interval	91	10	13	30	36	0.27	2
Age at first lambing	16	23	41	42	23	0.18	3
Mothering ability	5	7	12	67	89	0.13	4
Milk yield	1	3	24	47	105	0.12	5

Index = sum of [5 for rank 1 + 4 for rank 2 + 3 for rank 3+2 for rank4+1for rank 5] for particular trait divided by sum of [5for rank 1 + 4 for rank2 + 3 for rank 3+ 2 for rank 4+1for rank5] for all traits

Figure 5: Black color ewe single birth (left side) and Red and white color ewe single birth (right side)

4.3.4. Mating System and breeding management

The breeding male-to-female ratio varied significantly ($p < 0.05$) among different flocks and villages, shown in Figure 3. The average mating ratio in the villages was 7.21 ewes to 1 ram (Figure 3). It indicates that farmers tend to keep more rams than the actual requirement of breeding. More precisely, 10% of farmers kept 3 rams, 17.2% kept two rams, 43.3% kept one ram, and 29.4% had no rams at all. Mating was not controlled, and lambing occurred throughout the year. All flocks grazed together on communal lands, allowing both selected and unselected rams from the entire village to breed with the flocks in a communal mating system. Additionally, flocks that did not maintain breeding rams had little chance for mating, as this typically happened only during grazing hours, rather than throughout the entire day. This can ultimately lead to poor lambing outcomes for those flocks. Maintaining the optimal male-to-female ratio in sheep is crucial for enhancing lamb performance and achieving genetic improvement.

4.3.5. Sheep flock dynamics

The inflow and outflow of sheep at the household level during the reference period are illustrated in Figures 6 and 7. The ratio of inflow to outflow across the study areas was approximately 1.10, indicating that the rate of inflow was about 10.4% higher than that of outflow. Inflow sources included births (91.8%), purchases (4.91%), and gifts received from family and relatives (3.31%), while outflow components consisted of sales (54.1%), deaths (23.4%), slaughter (17.1%), gifts given to children and relatives (3.33%), predator losses (1.3%), and theft (0.81%), in that order. Additionally, we calculated a ratio of 3.17 between sales and slaughter for household consumption, suggesting that sheep in the Tigray Highlands are primarily kept as a source of cash for households rather than for personal consumption. This finding aligns with the reports from Helen et al. (2013), which noted index values of 0.47 for selling and 0.32 for slaughtering.

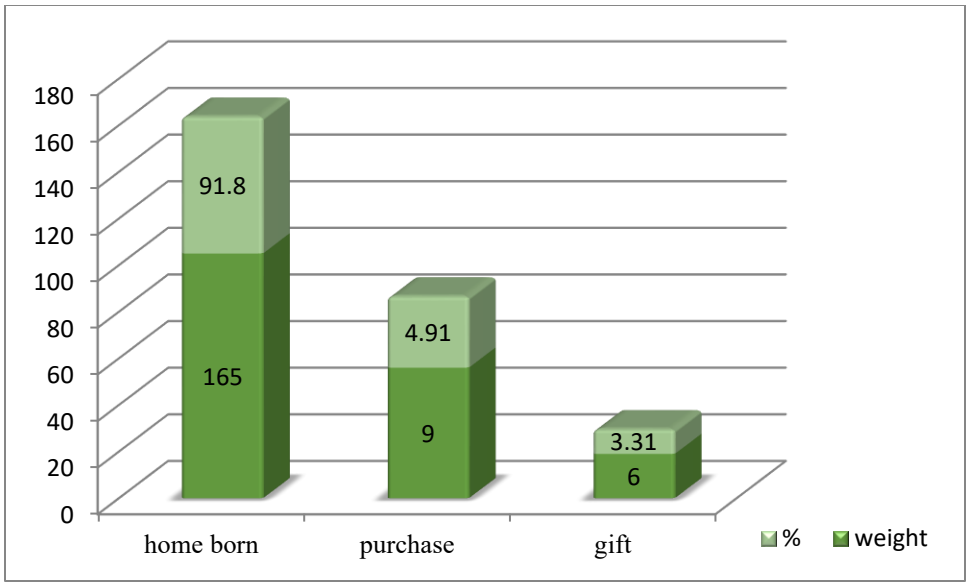

Figure 6: Sheep in flow (flock dynamics)

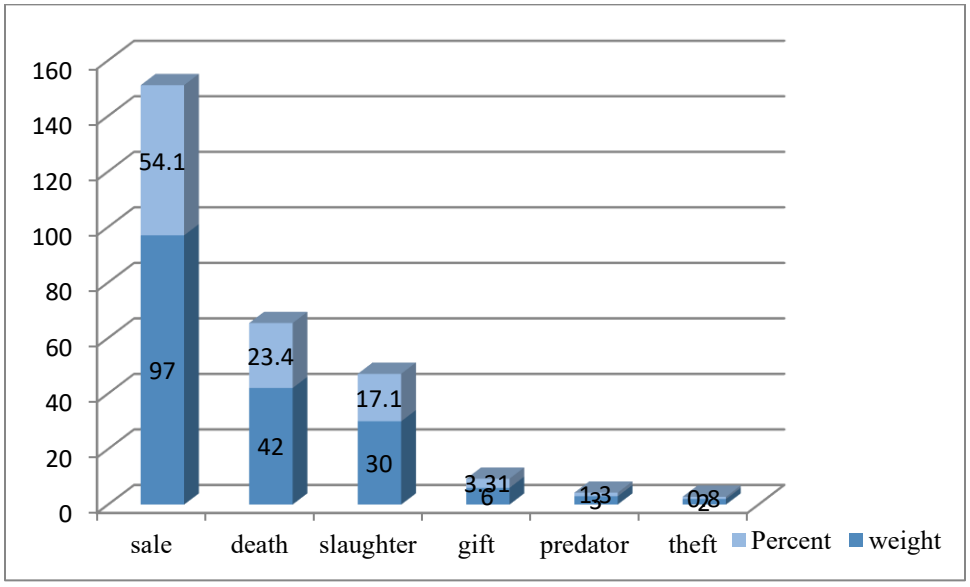

Figure 7: Sheep flock dynamics out flow

4.3.6. Labor division the routine sheep husbandry activities by the household

All family members participated in routine sheep husbandry activities, but the proportion of activities shared by each household member. Detailed profiles of each household member's involvement in these activities are presented in Table 9. Purchasing and selling activities were predominantly carried out by men, particularly by the household head. This is due to the

perception that they possess the necessary knowledge to select the best breeding rams and ewes at favorable prices through negotiation. Although women participated in purchasing and selling, their involvement was comparatively low, although a slightly higher percentage was noted in selling due to cultural factors that limit negotiation opportunities for females. In the study area, over 86.7% of men engaged in purchasing activities, while 78.6% participated in selling. In contrast, only 13.3% of women participated in purchasing, and 21.4% in selling. These figures clearly indicate that men, especially the household head, predominantly make economic decisions within the family. Boys and Hired labor were also more involved in herding, breeding, feeding, and health management activities in the district. On the other hand, cleaning the yard was almost exclusively performed by women and girls, in the Atsbi district.

Table 9: Labor division for the routine sheep husbandry activities by the household members (%)

Tasks	Home labor				Hired labor	Total
	Men	Women	Boy	Girls		
Purchasing	86.7	13.3	-	-	-	100
Selling	78.6	21.4	-	-	-	100
Herding	1.7	0.6	81.4	8.3	8	100
Breeding	6.7	3.9	79	4.4	6	100
Health activities	81.1	18.3	0.6	-	-	100
Feeding activities	0.6	3.9	82.7	7.8	5	100
Cleaning activities	0.6	51.7	-	47.7	-	100

A given activity is possible to be performed by more than one household member and a given household member is responsible for different activity

In the past, many sheep breeding programs were unsuccessful partly because they primarily focused on men, without appreciating the role of women and children in the routine sheep management activities but this is in agreement with the findings of (Kosgey et al., 2006).This is the large contribution on breeding activates boys. Generally, this study demonstrated that women and children are involved in sheep husbandry practices. This study highlights the involvement of women and children in sheep husbandry practices. Therefore, any

developmental interventions related to sheep improvement should include women and children. Additionally, providing training in breeding management and other husbandry practices could significantly enhance the success of these programs (Verbeek et al., 2007).

4.4. Reproductive performance of Tigrai highland sheep

Tigray highland sheep have demonstrated a potential age at first lambing (AFL) of 16.8 months, as shown in Table 10. This is significantly longer than the findings of Mourad et al. (2016), who reported AFLs ranging from 13.7 to 15.8 months for various sheep breeds in Ethiopia. Additionally, Tsedeke (2007) and Fsahatsion et al. (2013) documented AFLs of 12.7 months and 12.4 months, respectively, in the Alaba and Gamo-Goffa Zones of Southern Ethiopia. In contrast, Mesfin et al. (2014) reported an average AFL of 18.10 months in the eastern Amhara region, which exceeds the results of the current study. Respondents indicated that ewe-lambs born during the wet season had a shorter age at first lambing compared to those born in the dry season. This difference may be attributed to limited feed availability, which affects the milk production of the dam and, consequently, the growth performance of the lambs. In the study area, most lambing occurs at the end of the wet season, followed by a prolonged dry season characterized by feed scarcity. These findings align with those of Mengistie et al. (2009), who determined that the age at first lambing is significantly influenced by the season and the type of birth for ewes. They further explained that poor nutrition may hinder the growth of ewe-lambs, potentially prolonging the age at first lambing. The average lambing interval (LI) for sheep in the study area was found to be 8.47 months. This interval shows considerable variation due to factors such as parity, lambing season, and management practices. Younger ewes, particularly those with a parity of one, tend to have longer lambing intervals compared to older ewes. This may be a result of competition for nutrition affecting their growth and production. Reproductive physiology suggests that ewe prolificacy generally increases with age and parity (Mourad et al., 2016).The survey results indicate that lambing intervals are influenced by the lambing season. This observation is consistent with findings from Mengistie (2008) and Mourad et al. (2016), who emphasized that several factors, including previous litter size, parity, lambing season, and management practices, affect lambing intervals. Maintaining an optimal lambing interval is crucial for achieving a surplus of lambs available for sale. According to Girma (2008), under

normal circumstances, ewes should ideally lamb at least three times within two years to benefit sheep producers. Similarly, Belay (2009) concluded that ewes with longer lambing intervals exhibit lower reproductive efficiency. Therefore, the current findings suggest that Tigray highland sheep have strong potential for lambing performance.

Table 10: Reproductive performance of Tigrai highland sheep

Character and reproductive traits	N	Mean	SD
Age at sexual maturity male (months)	180	7.51	1.09
Age at sexual maturity female (months)	180	8.73	1.29
Age at first lambing (months)	180	16.75	1.8
Lambing interval (months)	180	8.25	0.99
Reproductive life span of female (yrs)	180	8.47	0.68
Number of lambs per ewe per life time(number)	180	9.62	1.04

N= Number of respondents; SD=Standard Deviation

Our study found that lambing occurred throughout the entire year, indicating that ewes could come into heat at any time. However, we identified a peak lambing period in October, November, and December, which accounted for 60.1% of all lambing events. This pattern aligns with a previous study of local and Dorper crossbred ewes, which reported the peak lambing season in September, followed by October and December (Ayele et al., 2023). The variation in lambing times may be linked to seasonal fluctuations in feed availability. In Ethiopia, sheep breed year-round; however, conception rates are highest during the short rains and immediately after the harvest (Rekik et al., 2015). This is influenced by environmental and social factors, such as the availability of feed, ambient temperature, and social interactions, including the presence of rams or ewes in estrus within the flock.

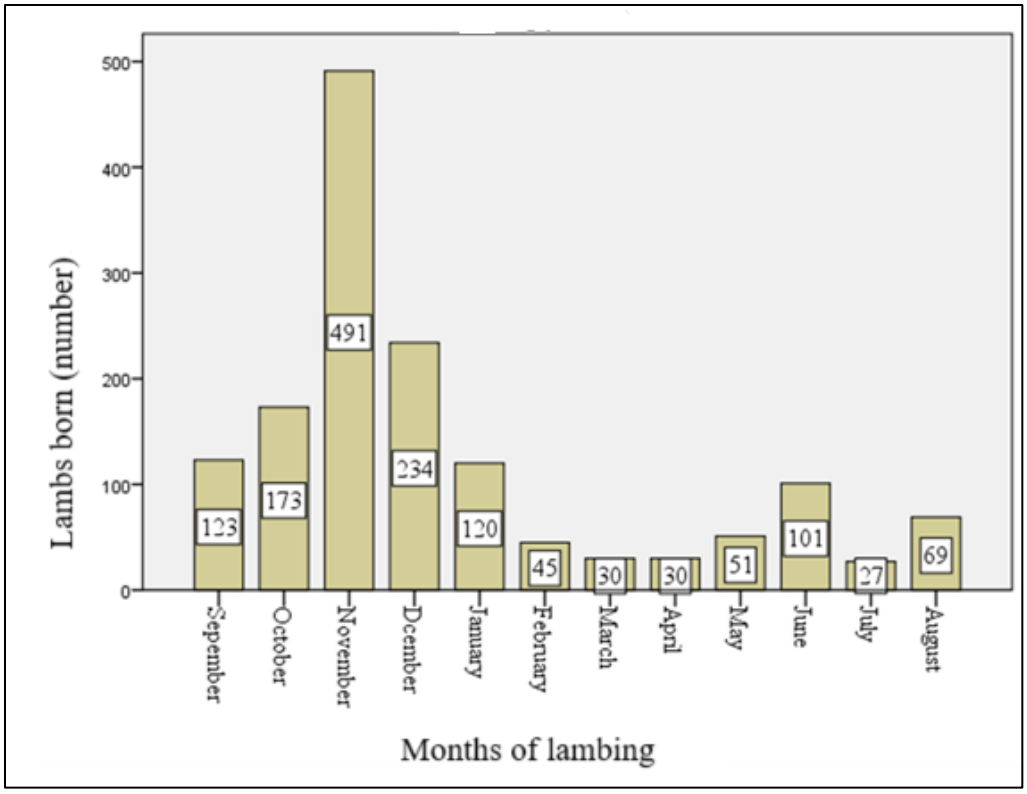

Figure 8: Monthly lambing frequency of Tigray highland sheep in the study area

4.5. Milking production performance of Tigray highland sheep

Milking frequency, milk yield, and lactation length of highland sheep are summarized in Table 11. Some respondents use sheep milk for home consumption, except when the ewe's condition is poor during lambing or if lambing occurs during the dry season. Sheep are typically milked twice a day: in the morning at around 7:00 AM and in the afternoon at about 6:00 PM, with a total average yield of 361 ± 29 ml per day. The specified average lactation length ranges from 1.5 to 2 months, depending on the season, the condition of the ewe, and the availability of feed. Milk production is the primary objective for sheep producers in pastoral and agro-pastoral systems (Helen et al., 2013); however, it is less common in mixed crop-livestock farming systems (Dhaba et al., 2013). Therefore, promoting sheep milk consumption within highland mixed crop-livestock production systems presents a significant opportunity for the efficient utilization of sheep production. Jemberu et al. (2022) emphasized the importance of better utilizing products such as milk to enhance the livelihoods of rural households and contribute positively to the national economy.

Table 11: Milking frequency, yield and lactation length of highland sheep

Parameter	N	Mean	SD
Milking frequency (per day)	33	2.0	0.10
Milk yield per day(ml)	33	361.36	29.38
lactation length(days)	33	60.00	.000

N= Number of respondents; Ml =milliliter; SD = Standard Deviation

4.6. Feed and feeding system

Feed supplementation for sheep is a common practice in the study area, particularly during the dry seasons. The availability of feed changes with the seasons, leading to a critical shortage from February to June. To address this issue, farmers enhance their sheep's diet with grains like maize, by-products, crop residues, leaves, and unconventional feeds such as atella, a byproduct of locally made beverages. Current findings suggest that the prioritization of feed supplementation depends on various reproductive factors, including the sheep's body condition, health status, age, and the potential sale of certain animals. The season also significantly influences these decisions. Consequently, the highest priority is given to newly lambing ewes to support their milk production for lambs and maintain their body condition, along with emaciated sheep, young lambs, and those intended for sale. This supplementation typically occurs from February to early June, unless rain falls at the end of April. During the dry season, various types of feed resources are utilized, including natural pasture (30.2%), Crop after month (13.4%), crop residues (18.5%), hay (23.4%), agro-industrial by-products (9.1%), and established pasture (5.4%). In the wet season, the main feed resources reported include natural pasture (33.9%), established pasture (6.5%), hay (5.3%), crop residues (4.9%), Non conventional (23.6%), and various types of weeds (25.8%). Nutritional stress often increases during the rainy season when most farmland is covered with crops, resulting in a shortage of grazing land. The primary supplementary feeds during this period consist of hay, crop residues, local brewery by-products, wheat bran, and some grains. Pasturelands, which are both communally and privately owned, serve as the primary feed source during both the rainy and dry seasons. In addition to natural grasses, farmers utilize

supplementary green leaf plants such as Tree Lucerne in a cut-and-carry system. In the study area, most grazing land is enclosed to promote the rehabilitation of natural vegetation. Farmers collect grasses from these pasturelands and feed them to tethered animals near their homes. They also cut grass from areas known as "Deret" or "Armo" around cropland, using both green grass and leaves. The use of common salt as a supplement for sheep is widely recognized and practiced by most farmers in the study area, aligning with findings reported by Gumuz sheep keepers in the Metema region, as noted by Solomon (2007). Overall, significantly larger amounts of feed resources are available during the rainy season, while shortages are prevalent during the prolonged dry season.

Table 12: Types of feed sources used in dry season

Feed source in dry season	1st	2nd	3rd	4th	5th	6th	Index	Ranking
Natural pasture	175	1	2	2	0	0	30.2	1
Established pasture	0	0	0	2	8	170	5.4	6
Hay	1	115	56	8	0	0	23.4	2
Crop residues	0	28	92	34	17	9	18.5	3
Crop aftermath	0	3	37	70	30	40	13.4	4
Agro-industrial by product	0	0	5	28	71	76	9.1	5

Index= (6 for rank 1) + (5 for rank 2) + (4 for rank 3) + (3 for rank 4) + (2 for rank 5) + (1for rank 6) divided by the sum of all weighed feed source in dry season mentioned by the farmers

Table 13: Types of feed sources used in wet season

Feed source in wet season	1st	2nd	3rd	4th	5th	6th	Index	Ranking
Natural pasture	169	3	2	5	1	0	33.9	1
Established pasture	0	0	0	2	54	124	6.5	4
Hay	0	0	0	2	12	166	5.3	5
Crop residues	0	0	0	1	15	164	4.9	6
Non conventional	68	42	37	33	0	0	23.6	3
Different types of weeds	78	82	8	12	0	0	25.8	2

Index= (6 for rank 1) + (5 for rank 2) + (4 for rank 3) + (3 for rank 4) + (2 for rank 5) + (1for rank 6) divided by the sum of all weighed feed source in wet season mentioned by the farmers

Figure 9: Sheep grazing on backyard (left side) and Communal grazing land (right side)

The study area reported the use of crop residues as feed sources for sheep. During the dry season, various crop residues, including lentil, wheat, barley, beans, and teff straw, were utilized. The study district had approximately five alternative crop residue feed sources available. The ranking order of these feed supplements, based on their calculated index values for sheep during the dry season, is as follows: barley (0.38), lentil (0.20), wheat (0.17), beans (0.15), and teff straw (0.11).

4.7. Herding and Herd practice

4.7.1. Herding

As noted by Sölkner-Rolleston (2003), understanding the herding practices within a community is essential for fostering sustainable improvements in smallholders' flocks through community-based strategies. In the study area, 96.1% of sheep keepers reported using both roaming and herding methods, while 3.9% primarily relied on tethering their animals during the wet (cropping) season. In the dry season, 88.3% continued to use roaming and herding practices, with 11.7% relying on tethering. It is important to note that sheep keepers in this region primarily raise sheep to prevent crop damage during the cropping season, despite facing challenges such as area closures and increasing theft, which impact sheep production. Typically, sheep graze during the daytime, from 6:30 AM to 7:00 PM, in both the wet and dry seasons. However, some respondents indicated that, during the wet season, animals are often kept at home for extended hours to reduce the risk of bloating and protect them from rain. Grazing hours are lengthened during the dry season as a strategy to cope with feed shortages, a practice that aligns with findings from the Lallo-Mama district in central Ethiopia (Abebe, 1999). The sheep-keeping practices in the study district are summarized in Table 14. Most (96.7%) sheep keepers reported herding their sheep in flocks during the day, while 26.7% kept new lambs separate at night. This separation allows ewes and their lambs to rest at night, minimizing the risk of injury and ensuring close attention. According to respondents, sheep are often herded alongside other livestock. Specifically, 6.2% herd with cattle, 70.5% herd sheep separately, 21.1% herd with calves, and 2.2% herd all livestock species together. Farmers have reported a decline in communal grazing land over time, attributing this to population growth and a shift toward agricultural land use, which has reduced the availability of pastoral lands. In the study area, landholdings are generally quite small, and having private grazing land around homesteads (known as Dert or Armo) is considered crucial, in addition to communal grazing areas.

Table 14: Herding management practice of sheep in the study area

Herding practice	N	%
Within sheep flock		
lambs separated	48	26.7
all classes sheep herded together	132	73.3
Sheep flock is herded		
together with cattle	11	6.2
sheep herded separately	109	70.5
together with calves	56	21.1
all herded together	4	2.2

N= Number of respondents; % = percent

4.7.2. Water sources and watering

According to the respondents, the main sources of water were as follows: rivers (23.3%), water wells (30%), rainwater harvesting (16.1%), a combination of rivers and wells (29.1%), and piped water (1.1%). Most respondents reported watering their livestock once a day in both the wet and dry seasons. During the dry season, 35.6% indicated that the distance to the watering point was less than 1 km, while 64.4% reported traveling a distance of 1-5 km. Conversely, during the wet season, the majority of respondents (97.2%) reported that the distance was less than 1 km, with only 2.8% stating it was 1-5 km. Water shortages were not reported as a problem in the study area. However, this contrasts with previous studies that identified water scarcity as a challenge in the mid-altitude regions of the eastern, northeastern, and southeastern parts of the country (Shenkutie, 2009). Additionally, Mesay et al. (2013) highlighted long distances traveled by sheep in search of water as an issue. Overall, the findings of this study are consistent with reports from Getachew et al. (2014) and Yenesew et al. (2013).

4.7.3. Types of housing

Housing is one of the major sheep husbandry practices, which protects from extreme temperature, rain, wind, predators, and theft. In the study district, different types of housing were identified in (Table 15). The first one and mostly used to confine sheep during the rainy season is known as in Tigrigna ethnic communities that they locally call it "Afgebela" in Tigrigna. It is three side walls constructed from local materials such as stone or wood mud (soil) and partially roofed. Farmers with this sort of housing keep all types of animals or veranda extend of building. The second and most commonly used pen constructed was open ended with/without roof, which usually used to confine sheep during dry season, and it was locally called "Demba". Newborn lambs in the first week of birth were reported separate from their dam and cared at home. The finding is in agreement with report of Mengistie, 2008; Tesfaye, 2008; Shenkute et al., 2010.

Table 15: Types of sheep housing in Atsbi district

Types of sheep housing with roof	N	%
separate house Afgebela	49	27.2
veranda extend of building	13	7.2
both separated Afgebela and veranda extend building	90	50.1
Pen(open ended)	28	15.5
are lambs housed with adult sheep		
Yes	65	36.2
No	115	63.8

N= Number of respondents; %= percent

4.7.4. Major Sheep Diseases

Diseases have a significant negative impact on sheep productivity, leading to issues such as animal mortality, weight loss, stunted growth, poor fertility, and decreased physical strength (CSA, 2012). Jemberu et al. (2022) emphasized that maximum productivity in sheep farming is achieved through effective disease control measures. The major diseases affecting sheep, identified by their index values, are Cenurosis (0.25), Fascioliasis (0.23), internal parasites (0.19), Ovine pneumonia (0.18), and foot rot (0.15). These diseases have been ranked based on

farmers' responses in the study area (see Table 16).The report also highlights the proximity of community health workers to veterinary services. Approximately 56.7% of respondents reported a distance of 1-5 km from veterinary services, while 43.3% indicated a distance of 6-10 km. Following the war in Tigray, farmers reported that the quality of veterinary services was very poor. However, access to these services in the Atsbi district was perceived as fair. Almost all (99.4%) of the veterinary services accessed were provided by both government and private institutions. Although access to veterinary services was adequate prior to the last three years, the post-war conditions in Tigray have resulted in a shortage of vaccines and treatment drugs. These findings are consistent with those of Getachew et al. (2014), who identified diseases and parasites as significant challenges to sheep production in the Atsbi-Wenberta district, particularly after experiencing feed shortages. Markos (2006) noted that the high prevalence of diseases and parasites leads to increased mortality rates, negatively affecting the reproductive performance of sheep. Other researchers have similarly pointed out that diseases and parasites are major obstacles to sheep production in Ethiopia (Helen et al., 2013; Zewudu et al., 2012).

Table 16: Common disease and parasites that affect sheep production as ranked order

Disease name		1st rank	2nd rank	3rd rank	4th rank	5th rank	Index	Rank
Local Name	Scientific Name							
Zarti	*Coenurus*	70	47	33	17	12	0.25	1
Tselam kebdi	*Fasciolosis*	34	50	48	34	15	0.23	2
Efeal	*Internal parasites*	11	49	66	32	20	0.19	3
Samba mchi	*Ovinpleuro pneumonia*	45	26	26	37	47	0.18	4
Mujelle	*Footrot*	16	12	16	67	69	0.14	5

Index= (5 for rank 1) + (4 for rank 2) + (3 for rank 3) + (2 for rank 4) + (1 for rank 5) divided by the sum of all weighed mentioned by the respondent

4.7.5. Fattening practice and culling mechanism

In the study area, 35.6% of farmers practiced weight gain methods by fattening their livestock. The proportions of fattening among different categories of animals were 54.4% for older male sheep, 5.9% for older female sheep, and 39.7% for culled young stock. Survey results indicated that female sheep of the same age were less frequently chosen for fattening compared to males. Typically, females are only fattened when they reach an older age or are culled, as productive females are often retained for breeding to replenish the flock. The selection of animals for fattening depended on the producer's interests and market demand. In this area, poorer farmers tended to sell young males at an earlier age due to a lack of alternatives, leading to negative selection. In contrast, wealthier farmers would wait for better prices and breeding opportunities. This observation aligns with the findings of Solomon et al. (1999), which reported similar trends in the Masai group ranches, where approximately 13% of castrated males were retained by wealthier households compared to 8% by poorer ones.

Farmers provided various supplements for fattening sheep, including roughage such as hay, crop residues, salt, grain, wheat bran, home leftovers, and non-conventional local brewery by-products like atella. They also administered Albendazole to fattening animals to treat internal parasites. According to the respondents, sheep fattening was primarily practiced in winter (54.4%), followed by autumn (26.5%) and spring (19.1%). This seasonal preference was attributed to better forage availability, warmer temperatures, and targeting specific markets. Sheep producers managed their flock sizes according to their specific sheep-rearing objectives. The main reasons for culling included reducing flock size, generating income, and providing meat for home consumption. Common reasons for culling were old age (10.6%), undesirable physical appearance (27.8%), disease (28.9%), reproductive problems (21.3%), and physical defects (11.4%). The most prevalent culling practice involved selling animals for immediate cash. However, the highest value associated with culling was linked to negative selection, where smallholder sheep producers chose to sell their best-performing sheep for quick cash income.

4.8. Sheep Marketing

Farmers primarily sell their sheep to traders and consumers, with other farmers being less common buyers. Many farmers in the study area sell their animals due to financial difficulties, especially during crop failures (78.3%) or drought conditions (20%). A small percentage of farmers (1.7%) sell due to culling. Farmers prefer to sell their sheep during holidays and festivals. The majority of sheep are sold at local markets, where local traders play a significant role in the marketing process. According to respondents, sheep prices are closely linked to local holidays and festival seasons. Higher prices are typically obtained during holidays such as New Year, Christmas, and Easter.

4.8.1. Sales of sheep by sex and age group

Table 17 outlines the preferences for selling sheep based on different age groups and sexes. Most respondents expressed a preference for selling sheep that are less than 6 months old, those between 6 months and 1 year, adult sheep older than 1 year, castrated rams, as well as old or sterile ewes and old rams, for both males and females. The respondents ranked the age groups available for sale in the following order: first, castrated and old sterile ewes; second, old rams; third, sheep aged 6 months to 1 year; and finally, adult sheep older than 1 year. Breeding rams and ewes were ranked last in terms of preference. Focus group discussions (FGDs) revealed similar trends regarding the sale of these age groups. Additionally, findings from Yenesew et al. (2013) in the Burie district of northwestern Ethiopia confirmed that male sheep aged 6 months to 1 year and adults older than 1 year were frequently sold. The market preference for sheep aged between 6 months and 1 year indicates that both male and female sheep with good genetic potential are commonly sold, leading to their regular removal from the population. Alubel (2015) also highlighted this trend. Such practices significantly affect future genetic improvement and may reduce genetic diversity within flocks, ultimately resulting in a higher coefficient of inbreeding as the population of both sexes' decreases.

Table 17: Preference of households for sale of sheep by sex and age groups

Sex	Age group	%	Over all (N180) Rank
Male sheep	< 6-monthslambs	11.2	5
	6-months to 1-year ram lambs	13.3	4
	breeding ram	4.5	8
	>1-year old ram	15.4	3
	>1-year castrated ram	19	1
Female sheep	<6-month lambs	9	6
	6-months to 1-year ewe lambs	6.6	7
	>1-breeding ewe	2.2	9
	>1-year sterility	18.8	2

N= Number of respondents

4.8.2. Marketing participants and mode of price setting

The market participation and methods of price setting are summarized in Table 18. The survey results indicated that respondents primarily sold their sheep to small traders (50%), followed by traders and hotels (27.8%), farmers (11.1%), a combination of farmers and traders (8.3%), and civil servants (2.8%). This shows that civil servants, farmers, and traders occupy the least significant roles in the marketing process, whereas small traders are identified as the most important participants in the market. This finding is consistent with research by Tsedeke (2007) in southern Ethiopia and Yenesew (2010) in the Burie woreda of the Amhara region, which reported low participation rates among general consumers (12.2%) and hotels (16.7%) in sheep purchases. Additionally, the method of price setting for selling or purchasing sheep revealed that 100% of respondents determined prices based on "eye-ball" estimation (visual appraisal) rather than using live weight measurements. Therefore, introducing a modern marketing system that bases pricing on live weight could enhance productivity and reduce the reliance on qualitative appearance traits.

Table 18: Marketing of sheep participants and price setting on buying

Particular	N	%
Farmers	20	11.1
Traders	90	50
civil servants	5	2.8
farmers and traders	15	8.3
traders and hotels	50	27.8
Mode of price setting		
Eye ball estimation	180	100

This report differs from Tsedeke (2007), who studied livestock marketing in southern Ethiopia. He noted that most producers tend to market their animals based on visual estimation, with only a small fraction (2.0%) selling based on live weight. In his findings, animals were typically sold individually, with prices established after extensive one-on-one negotiations between buyers and sellers. Sometimes, brokers were involved in these transactions. Producers commonly inspected the animals visually and engaged in discussions to negotiate prices until both parties reached an agreement.

4.9. Major sheep production challenges

The major constraints affecting sheep production in the study area are summarized in Table 19. The primary challenges, ranked by significance, include drought, feed shortages, lack of grazing land, insufficient veterinary services and extension support, diseases, inadequate market information, predators, and a shortage of breeding ram. These constraints have respective index values of 0.18, 0.17, 0.16, 0.14, 0.13, 0.10, 0.07, and 0.05, respectively, indicating that they are the most limiting factors for sheep production in the region. These findings align with previous reports by Helen et al. (2015), which identified feed shortages, disease prevalence, and predators as major constraints in a mixed crop-livestock system. Additionally, Mulata (2013) noted that drought, feed shortages, and diseases are significant constraints in the same study area. Moreover, Solomon et al. (2014) stated that sheep production in Ethiopia is constrained by inadequate feeds, animal diseases, inferior genotype, market systems, and infrastructure

challenges. Drought is identified as the primary cause of sheep mortality and poor performance among highland sheep. Respondents reported that three years of conflict in the region, followed by severe drought, resulted in significant sheep losses. Mortality rates can reach up to 30%, particularly during periods of drought and feed shortages, as supported by secondary data. Similar studies on other sheep breeds in Ethiopia have indicated mortality rates exceeding 20% in the Horro and Menz breeds (Markos, 2006; Tsedeke, 2007). Additionally, a lack of farmland for raising sheep has been ranked as a major constraint in the study area. The inadequate veterinary and extension support also reflects the findings of Aynalem and Belay (2009), who discussed similar challenges facing Ethiopian sheep breeds.

Feed shortages are reported as a significant issue inhibiting sheep productivity in the study area. This problem has worsened due to unreliable and inconsistent rainfall, leading to a gradual decline in available pastureland. This aligns with the findings of Zelalem et al. (2012), which noted that much of the available pasture in Tigray is either deteriorating or severely overgrazed. Respondents noted that feed shortages occur even during the rainy seasons, as most lands are occupied by crops, further limiting grazing areas for sheep. Poor nutrition results in slow growth rates among growing animals and negatively impacts both production and reproductive performance (Azage et al., 2010). It also leads to delayed onset of puberty, longer intervals between births, low conception rates, and overall poor reproductive outcomes (Mourad et al., 2016). The lack of adequate feed resources is especially pronounced in mixed crop-livestock systems, where most cultivated areas and higher human populations are concentrated (Mesay et al., 2013; Yenesew et al., 2013).The District Bureau of Agriculture was identified five years ago as a key source of information and knowledge transfer for farmers, providing comprehensive extension support to well-trained farmers aimed at increasing their production income. However, currently, the aftermath of war and declining service approaches pose significant challenges to sheep production in the Tigray Region's districts. Major bottlenecks in extension support for sheep production include a lack of training and capacity development, infrequent contact and support, and inadequate facilitation of market information.

One of the main challenges in sheep breeding is the shortage of breeding rams. Selling off the best rams can lead to negative selection within the flock. Survey respondents noted that they do not maintain a

sufficient number of rams. Over the past three years, the availability of live animals for sale has declined due to economic constraints, prompting farmers to sell their best rams at higher market prices. These findings are consistent with a report by Getachew et al. (2014), which identified uncontrolled mating and a shortage of breeding rams as significant concerns in the Atsbi-Wenberta district. Additionally, the sale of fast-growing, well-formed rams and ewes has become common in the areas involved in the study.

The major marketing challenges in the study area include a lack of marketing information and poor market orientation. Most respondents mentioned that they typically sell their animals at small local markets that operate only once a week. There is a significant lack of information regarding market prices, with farmers mainly relying on neighbors for updates. Respondents expressed that there is no public source of market information in the district, leading to inefficiencies and outdated data. In this scenario, the price of an animal reflects not only the bargaining skills of the buyer and seller but also the buyer's preferences regarding the animal's characteristics and the seller's willingness to sell. This situation can sometimes result in transaction failures (Ayele et al., 2003). This finding is consistent with research conducted by Yenesew et al. (2013) in Burie woreda, West Gojjam. Additionally, the lack of a market-oriented approach in the livestock sector has been shown to significantly affect the quantity and quality of marketable livestock for both domestic and export markets (Belete et al., 2010).

Table 19: Major sheep production constraints as rated by the respondents

Constraints	1st	2nd	3rd	4th	5th	6th	7th	8th	index	Rank
Drought	42	55	45	14	9	5	3	7	0.18	1
Feed shortage	44	44	48	12	6	7	5	14	0.17	2
Shortage of grazing land	34	45	50	16	11	7	3	16	0.16	3
in adequate veterinary service and extension support	31	21	15	28	40	19	13	14	0.14	4
Disease	22	18	11	42	32	31	15	9	0.13	5
Lack of market information	3	2	8	46	36	46	18	21	0.1	6
Predators	1	0	0	16	18	23	47	75	0.07	7
Shortage of breeding ram	0	1	0	10	13	14	32	110	0.05	8

Index= sum of (8for ranked1 +7for ranked 2 +6for ranked3+5 for ranked 4+4for ranked 5+ 3 for rank 6+2 for rank7+1 for rank 8) give for each constraint divided by sum of (8forranked 1+7for ranked 2+6for ranked3+5for ranked 4+4for ranked5+3for rank6+2for rank7+1for rank8) for all of the constraints for sheep production

CHAPTTER 5: SUMMARY AND CONCLUSIONS

5.1. Conclusion

The current study provides valuable insights into the socio-economic characteristics, job classifications, and integration of Tigray highland sheep producers. Assessing sheep contributions to the livelihoods of these producers. The study also analyzes the feeding systems used during the wet and dry seasons, the methods for flock herding, and the criteria for selecting and prioritizing practices that ensure flock sustainability. Additionally, it highlights both existing and emerging challenges related to sheep improvement in the area. This foundational information can serve as a basis for designing comprehensive programs aimed at enhancing sheep productivity in the region. The analysis emphasizes various criteria for selecting sheep traits, focusing on factors such as body size, number of lambs, early growth, and visual appraisal. There are significant opportunities to improve sheep productivity through several means, such as selecting better breeding stock, providing a balanced diet, and ensuring access to proper health services to help sheep reach their genetic potential. Furthermore, utilizing updated market information and implementing effective marketing systems such as pricing based on live weight rather than visual appearance could enhance productivity and profitability. However, sheep production and marketing face numerous challenges. The most significant difficulties include frequent droughts, feed shortages, limited grazing land, insufficient veterinary services and extension support, diseases, inadequate market information, predators, and a shortage of breeding rams. The current economic conditions may lead to considerable changes in sheep production within the study area, prompting many farmers to reassess the profitability of their operations and adopt substantial modifications. Fortunately, an objective assessment of current sheep production methods indicates that numerous improvements can be made in both genetic and environmental management. These changes have the potential to significantly enhance the cost-effectiveness of sheep production and increase profitability.

The study provides a detailed analysis of sheep production in the Atsbi district of Tigray, Ethiopia. It highlights the socio-economic characteristics of households, livestock management practices, and the constraint faced by sheep producers. The findings indicate that sheep play a vital role in the livelihoods of

smallholder farmers by serving as a primary source of income and providing natural fertilizer. Most respondents were male headed households and sheep rearing was primarily integrated with crop production within a mixed farming system. The average flock size consisted of 11.8 sheep, with breeding ewes the largest proportion of the herd. When selecting breeding stock, farmers prioritized traits such as body size, growth rate, and coat color, reflecting market demands and their production goals. The study identifies significant constraint in sheep production, including drought, feed shortage and inadequate veterinary services. These issues have been worsened by recent conflicts and environmental stressors, resulting in declines in livestock populations and productivity. Selling of high-quality breeding rams at early age impede efforts for genetic improvement. Additionally, there is a notable gender disparity in labor division within sheep husbandry; men primarily handle economic decisions, while women and children are more involved in day-to-day management tasks. Despite these challenges, the study highlights the potential for improving sheep production through targeted interventions. The reproductive performance of Tigray highland sheep, such as the age at first lambing and lambing intervals, shows potential for enhancement through better nutrition and management practices. Furthermore, involving women and children in sheep husbandry offers an opportunity to expand training and capacity building programs. By addressing the identified constraints and leveraging the existing strengths of the production system, significant improvements in productivity and sustainability of Tigrai highland sheep farming in the study area is possible.

5.2. Recommendations

- Farmers' preferences for sheep traits vary significantly based on production systems, sheep breeds, and feed availability. Consequently, the selection criteria for productive and reproductive traits of sheep should be considered in any efforts to enhance sheep productivity in the study area.

- In this area, sheep are the predominant and economically significant livestock species. Moreover, farmers maintain similar population sizes of sheep. Therefore, implementing a community-based breeding program could enhance productivity and mitigate the negative selection of existing rams.

- There is a pressing need for future detailed studies on feed shortages, diseases, marketing, and economic traits. Feed shortages are worsening due to erratic and unreliable rainfall, and pasturelands are diminishing over time. Additionally, a specific disease known locally as "Zarti," or Cenurosis, poses a significant threat in the studied areas. While some studies have been conducted to address these challenges, there is still ample opportunity for further investigation.
- To enhance sheep production in the Atsbi district, the following recommendations are proposed:

- Improve feed availability and quality promotes the cultivation of drought resistant forage crops and encourages enhancing quality of crop residues to alleviate feed shortages. Provide training on feed conservation techniques, such as haymaking and silage production.
- Strengthen veterinary and extension services: Increase the availability of vaccines, and treatment drugs, and other veterinary supplies to combat prevalent diseases. Conduct regular training sessions for farmers on disease prevention, breeding management, and best husbandry practices.
- Enhance Breeding Programs: Implement community-based breeding programs to improve genetic traits and prevent early selling of high-quality breeding rams through revolving fund. Secure optimal ram-to-ewe ratios year-round to enhance flock productivity.

CHAPTER 6: REFERENCE

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APPENDIXS

Appendix I. Points govern the focus group discussion session

Appendix Table 1. Composition, name, social rank and addresses of focus group discussion

No.	Name	Sex	Age	Social rank and responsibility*	Address	Cell phone
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
*1. Community leader, 2. Kebelle admin 3. Religious leader, 4. Model farmer, 5.Non-Model 6. Women representative, 7. Youth representative, 8. Elder Farmer, 9.Das						

1. History of the breed
2. Communal land utilization and management
3. Trend in grazing land
4. What are the major livestock species (cattle, sheep, Goat, poultry, honeybee, and Donkey, Mule, Horse) produced in the order of their importance in the area?
5. Major loss of livestock specifically sheep in the last 5 years.(Reason)
6. Occurrence and frequency of disease, drought.
7. Copping mechanism during this problem
8. Indigenous knowledge in management of the breed
    - 8.1 Breed identification
    - 8.2 Special qualities of the breed
    - 8.3 Good and desirable character of sheep compared with other livestock

9. Which **traits** or attributes do you consider in selecting breeding ram and ewe? **Rank the traits in order of importance for selection.**

For ram (with their respective rank) top 5max.	rank	For ewe (with their respective rank) top 5max.	rank

10. Major sheep production constraints in your areas
11. The most common sheep disease in the PAs and any measures taken
12. Sheep population trend in the last 10 years? 1. Increased 2. Decreased 3. Stable

If the answer is Decreased Reason_____

13. Do you get extension services in sheep production husbandry?

Appendix II. Checklist for collection of secondary data

1. Total human population in the district_____
   1.1 Male headed
   1.2 Female headed
2. Average land holding per household (in ha)
3. Climatic data (distribution and amount)
   4.1 Annual average temperature_____ Maximum_____Minimum___
   4.2 Annual average rain fall_____ Maximum_____Minimum___
4. Production system /Farming system used in the district

Appendix III. The questionnaire for survey study

Semi-structured Questionnaire

Research Title: Participatory Definition of Breeding Objectives and Trait Preference of Sheep Producers in Atsbi District, Tigray, Ethiopia.

Objective of the questionnaire: This questionnaire is aimed to collect data on Breeding Objective, Breeding practice and trait preference of sheep producers in the study areas. The responses given are confidential to the researcher and will be exclusively used for this research purpose.

Part1. General information and socio-economic aspects of the households

Questionnaire number: _____ Name of the respondent _____

Date: _____Kebelle /Village_____

Zone: _____ Woreda_____

Name of enumerator_____

1.1 Respondent and Owner details

Respondent [1. Owner; 2. Shepherd;	
Age (years)	
Sex of the household head(code)	
Instruction (level)	
Type of schooling (code)	
Farming experience (years)	
Experience in sheep farming (years)	
Marital status (code)	
Religion group(code)	
Educational status (codes)1=illiterate; 2= Informal; 3=Primary; 4= Secondary; 5= Vocational;	
Age group codes 1= [<20] 2= [21<-30] 3= [31 <-40] 4= [41<-50] 5= [51 <-60] 6=[>61]	
Sex HH 1. Male 2. Female	
Marital status codes 1= Single 2=Married 3= Divorced 4= Widow	
Religion codes 1= orthodox 2=Muslim 3=Seventh Day Adventist 4=Protestant	

1.2 Household family size (number): Male _____ Female_____ Total _____

1.3 What is your major farming activity? [….] 1. Livestock production 2. Crop production

3. Both Crop and livestock mixed production system

1.4 Cultivated land holding size_____ Hr

Non-farm activities […] 1. Hand craft 2. Trading 3. Daily labor 4. Others (specify)

Rank your farming and non-farm activities according to the respective criteria

Rank	Major HH food source	Major HH Cash income
1st		
2nd		
3rd		
4th		
5th		
6th		
Activities codes 1=livestock 2= crop 3=Both 4=Handcraft 5= Trading 6= Daily		

Part 2. Production and management systems

2.1. General

Please indicate the number of animals for the different species that are currently owned by your household.

Livestock		Total number owned by the household	Most important (Rank)
Cattle	Indigenous		
	Exotic/cross		
Goat	Indigenous		
Sheep	Indigenous		
Donkey	Indigenous		
Horse	Indigenous		
Camel	Indigenous		
Chicken	Indigenous		
	Exotic/cross		
Bees (bee hives)	Modern hive		
	Traditional		

2.1.1. Please indicates the type of sheep you keep on your farm, their breed types, number kept on the farm and number owned by your household.

Sheep type	Breed name	Number on farm	Number owned

Codes: For any question dealing with sheep type and breed names, please use the following codes.

Sheep type codes	
1 = Ram lambs <6 month	5=no of rams > 1year
2= Ewe lambs < 6 month	6= no of ewes > 1year
3= no of ram lambs > 6-1 year	5= Castrated Ram
4= no of ewe lambs >6-1year	

2.1.2. When did you start keeping sheep? Year [____]

2.1.3. With how many sheep did you start your sheep farming with? [___] (Number)

2.1.4. Where did you get your first sheep from?[___] (Code)

1= Inherited (from mother or father?)	6= Obtained from a development project as loan
2= Purchased from neighboring farm/ market	7= As a gift from relatives/friends
3 = Purchased from a distance farm/market	8= As a loan from relative/friend/ neighbor payment
4 = Purchased from a friend	9 = Purchased from a neighbor
5 = Obtained from a development project as gift	10 = Other (specify) _____

2.1.5. For the year 2023, did you purchase/acquire any sheep? [___] (Code) 1 = Yes 2 = No

If yes for question 2.1.5.Why? 1. Born from my flock 2.Bought from market 3.As gift from relatives/friends or as loan from NGOS and development project

2.1.6. For the year 2023, did you sale/reduce any sheep? [___] (Code) 1 = Yes 2 = No

If yes for question 2.1.6.why? 1. through Sale 2. Death 3. Slaughter 4. Theft 5. Predator6.gift

2.1.7 How do you usually identify your sheep? (Code) [__] [__] [__] [__] [__]

0 = No identification	2 = Ear tag	4 = Parentage
1 = Name	3 = Color	5 = Others (specify)

2.1.8. Which is the main (first) purpose that you keep sheep for? [___] [Code]

2.1.9. Which is the second most important purpose that you keep sheep for? [___] (Code)

1 = Sale (cash income)	2 = meat for home Consumption	3 = Manure
4= Milk	5=Wealth status	6=saving
7=gift	8. Others (specify)_____	

2.1.10. The type of mechanism you use to wean lambs [___] (code) 1. Natural 2. Assisted

2.1.11. Average weaning age of lambs is [___] months.

2.1.12. Members of household responsibilities for sheep production activities [_√__] (tick the appropriate answer)

Activities	Family			
	male		Females	
	≤15years	>15years	≤15years	>15years
Purchasing				
Selling				
Herding				
Breeding				
Health management				
Feeding				
Barn cleaning				

2.2. Feeding and grazing management

2.2.1. Feed source (√□tick the appropriate answer) and rank them

Type of feed source	Wet season	Rank	Dry season	Rank
Natural pasture				
Established pasture				
Hay				
Crop residues				
Fallow land				
Agro-industrial by-products				
Others/specify ____				

2.2.2. The major crop residues used for sheep feed (listat list five according tothe priority)

2.2.3. Grazing land ownership [_____] Code. 1. Private; 2. Communal; 3. Both

2.2.4. Grazing method during dry season [__] Code 1.Roaming, 2. Tethered,3. Herding,4. Paddock, 5. Zero, 6.Both roaming and Herding

2.2.5. Grazing method during wet season [__] Code 1.roaming, 2. Tethered, 3. Herding, 4. Paddock, 5. Zero, 6. Both roaming and Herding

2.2.6. Length of grazing time during **dry** season [___] Code 1. Morning, 2. Afternoon, 3. Whole day

2.2.7. Length of grazing time during **wet** season:[___] Code 1. Morning, 2. Afternoon, 3. Whole day

2.2.8. Trend in communal grazing areas? [__] 1. Decreasing 2. Increasing 3. Stable

What do you think the reason? _____

2.2.9. How is sheep flock herded during the daytime? [____] Code. 1. Male and female are separated, 2. Lambs are separated; 3. Male and female sheep are herded together; 4. All classes' sheep herded together

2.2.10. Sheep flock is herded [_____] Code 1. Together with cattle, 2. Sheep herded separately, 3. Together with goat 4. Together with calves 5. Together with equines 7. All herded together

2.2.11. Is there seasonal fluctuation in feed supply? [_____] Code 1= Yes, 2= No

. If the answer is **Yes**, at which month(s) of the year do you experience most feed shortage._____

_____

2.2.12. Do you supplement your sheep? [___] Code 1= Yes 2= No If your answer is **yes** for question 2.2.12 what is your supplementation _____

2.2.13. Do you practice sheep fattening [____] 1= Yes 2=No

If your answer is **yes** for question no. 2.2.13, which categories of animals do you fatten? (You can tick more than **2**) [_____]

1. Older males 3. Castrates 5.Young female 7. Culled Young female

2. Older female 4. Young males 6. Culled young males 8. 1 and2, 9. 6and7

2.2.14. Can you tell us the type of feed resources you use to fatten sheep?

2.2.14. At which periods of the year do you commonly fatten sheep?_____
Season Fattening_____duration (in months) Reason _____

2.2.15. What are the common water sources of sheep in your area? 1. River 2.pond3.rain water 4. Water harvest 5.deep well 6.pipe 7. Any other sources

2.2.16. Distance to water point during dry season. 1. <1Km 2. 1-5 Km 3. 6-10Km 4.>10 Km

2.2.17. Distance to water point wet season. 1. <1Km 2. 1-5 Km 3. 6-10Km 4.>10 Km

2.3 Housing

2.3.1. Housing/enclosure for adult sheep (√□ □tick one or more boxes)

With roof	In family house	
	Separate house(Afgebela)	
	Veranda (extend of building)	
	separated Afgebela and veranda extend building	
Without roof	Pen/Yard (enclosed village) is culled as Demba	
Others (specify)		

2.3.2 Are lambs housed with adult sheep? [__] 1= Yes 2=No

If no, reason_____

2.3.3Are sheep housed together with other animals? [_____] 1= Yes 2= No.

If yes, 2.3. 3 what are the advantages and disadvantages you noticed? _____

2.4. Health

2.4.1. List types of diseases which occur frequently and affect the productivity of sheep in the area and rank them based on importance

Type of disease	Scientific name	Rank

2.4.2. Do you have access to veterinary services [___] 1. Yes 2. No

If yes, 2.4.2, which types of veterinary service you, accessed. [____] 1.Government veterinarian 2. Private veterinarian 3. NGOs 4. Shop or market

2.4.3. Community association health workers Distance to nearest veterinary services [____]

1-5km 6-10km >10km other (specify)___

2.5. Breeding practices

2.5.1. Do you have local ram? 1= Yes 2= No

If the answer 2.5.1 is yes, how many? 1. None(0)2.One(1) 3. Two (2) 4. More than three(>3)

2.5.2. If more than one, why do you need to keep more than one ram? _____

2.5.3. For how many years on the average is the same breeding ram serving in your flock? [].

1. = 2 2=33 =44=55= 6 years

2.5.4. Is there any special management for breeding ram? [_] 1= Yes 2= No

If yes, specify type of management_____

2.5.5. Purpose of keeping ram[]1=Mating 2= Socio-cultural 3=for fattening 4= others (specify)

2.5.6. Source of breeding ram []

1=Inherited (from mother or father)	6= Born in the flock
2= Purchased from neighboring farm/ market	7= As a gift from relatives/friends
3 = Purchased from a distant farm/market	8= As a loan from relative/friend/ neighbor
4 = Purchased from a friend	9 = Purchased from a neighbor
5 = Obtained from a development project as gif	10= Other (specify) _____

2.5.7. Do you face shortage of breeding rams? ----------

1=Yes 2=No

2.5.8. If you do not have breeding ram, how do you mate your Ewe? []

1= Neighboring ram 2= Unknown 3= Others (Specify) _____

2.5.9. Do you face shortage of breeding rams? [] 1=Yes 2=No

2.5.10. Do you practice selection for breeding ram [_] 1. Yes, 2. No

If the answer 2.5.11 is yes Age of selection breeding male _____ months

2.5.11 Do you practice selection for breeding ewe [_] 1. Yes, 2. No

If the answer 2.5.12is yes Age of selection breeding Female_____ months

2.5.12. Which attributes or traits do you consider in selecting breeding ram and ewe? **Rank the traits in order of importance for selection.**

For ram (with their respective rank) top 5max.	rank	For ewe (with their respective rank) top 5max.	rank

Associated attributes/Traits code	
1 = Size appearance/conformation	1 = Body size/appearance
2 = Coat color (please record the names)	2 = Coat color (please record the names)
3 = Horns	3 = Lamb survival
4 =Lamb weight	4 = Lamb growth
5 = Growth	5 = Age at first sexual maturity
6 = Active libido	6= Lambing interval
7 = Tail type/length	7 = Twining ability
8= Parent history	8= Milk yield
9 = Parent history	9= Tail type/length

10= Others (specify) _____	10= Other (specify) _____

2.5.13 List the top 3 preferred color

1. _____
2. _____
3. _____

2.5.14 List the unwanted colors

1. _____
2. _____
3. _____

2.5.14 Type of mating used [_] 1. Controlled; 2. Uncontrolled/Random 2.5.15. If uncontrolled, what is the reason? [__] 1. sheep grazed together, 2. Lack of awareness, 3. Insufficient number of ram, 4. Others/specify _____

2.5.15could you be able to identify the sire of a lamb? []1= Yes2= No

If yes, specify the criteria used to identify _____

2.5.16. What is the reason for poor reproductive performance of sheep? 1. Poor management 2.seasonalflections 3. Genetic and environmental 4. Other

2.5.17. What would you usually do with the 'best' ram born in your flock? 1. Sell them soon before they mature(less than one year) 2. Keep them for breeding for about three years 3. Keep them for breeding for more than three years 4. Keep them for fattening for some time 5. Others

2.5.18. Do you allow your ram to serve ewes other than yours?

Reason

1. Yes _____ _____
2. No _____

2.5.19. Do you allow your ewe to be served by anyone else ram.

Reason

1. Yes _____
2. No _____

2.5.20. Did you observe inbreeding problem in your sheep flock? 1. Yes 2. No If yes, how sever is the problem? 1. Very Critical 2. Critical 3. Bearable 4. Easily manageable

2.5.21. Do you think inbreeding is a problem among sheep flock in this area.1. Yes 2. No 3. Not sure

2.5.22. Occurrences of birth type per ewes in your sheep flock.

1) Single 2) twin 3) triple 4) not constant

2.5.24.Lambing pattern, occurrence of most births (√□tick one or more boxes then rank top three)

January		July		Top 3 months most births occur
February		August		
March		September		
April		October		
May		November		
June		December		

2.6 culling mechanism

2.6.1 Do you culling your sheep? [__] 1. Yes, 2. No

If yes, reasons for culling [___] 1. Old age 2. Undesirable physical appearance 3. Disease 4. Reproductive problem5.physical defects

2.7. Marketing

2.7.1 Reasons for selling [___] 1. Cash needed 2. Disposal/culling

2.7.2 Which class of sheep do you sell first in case of cash needed?

Class	Rank
male lambs less than 6 months	
Female lambs less than 6 months	
Ram lambs between 6 months and one year	
ewe lambs between 6 months and one year	
Breeding ewes	
Breeding rams	
Castrated	
Old ewes/Sterility	
Old rams	

2.7.3 Rank major market problems in sheep. 1. Price determine by visual (lack of weighting) no 2. Public market information 3. The market is once a week 4. Price determined brokers

2.7.4 Who buy your sheep? 1. Farmers 2.Traders3.hotels 4. Civil servants

2.7.5 How you sell or purchase your sheep? 1. Live weight 2.Eye ball Estimation 3. Both

2.7.6 Average market age in month male_____ female_____

2.7.7 Average culling age in years due to old age male_____female_____

2.7.8 Is your sheep number increasing in the last 5 years? [_]

1. Increased 2. Decreased 3. Stable

2.7.9 What is the trend compared with other livestock?

Increased 2.Decreased3. Same

1. Compared with cattle
2. Compared with goat
3. Compared with equine

Reason_____

_____

_____

2.8 Production Characteristics

2.8.1. Average age at sexual maturity

1. Male ____ Months
2. Female ____ Months

2. Age at first lambing

Average ____ Months
Maximum ____ Months
Mini ___ Months

3. Lambing interval

Average ____ Months
Maximum ___Months
Mini ____ Months

2.8.2 Do you fix age at first mating for the males? [_] 1.Yes, 2. No

2.8.3 Average reproductive lifetime of ewe (in years) _____

2.8.4 Average number of lambing per ewe lifetime _____

2.9 Milking

2.9.1 Is the sheep milked? [__] 1.Yes, 2. No

If yes Milk production per day per ewe Average_____Littre's

Maximum_____Littre's

Minimum_____Littre's

2.9.2 Lactation length Average_____Months

Maximum_____Months

Minimum_____Months

2.10. Major Sheep production constraints(pair wise ranking)

No	Major sheep production constraints	1	2	3	4	5	6	7	8	Points	Rank
1	Feed shortage										
2	Disease										
3	. Drought										
4	Lack of Market information										
5	inadequate veterinary and extension support										
6	Predator										
7	Absence of Labor										
8	Shortage of grazing land										

2.10.1. Major sheep production constraints mentioned top three according their impact

1. _____

2. _____

3._____

Thank You for your time!!