BAHIR DAR UNIVERSITY

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

GRADUATE PROGRAM

PERFORMANCES OF HIGHLAND SHEEP UNDER COMMUNITY-BASED BREEDING PROGRAM IN ATSBI WENBERTA DISTRICT, TIGRAY, ETHIOPIA

M.Sc. Thesis

By

Mengestu Regassa

February, 2018

Bahir Dar, Ethiopia

BAHIR DAR UNIVERSITY

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

GRADUATE PROGRAM

PERFORMANCES OF HIGHLAND SHEEP UNDER COMMUNITY-BASED BREEDING PROGRAM IN ATSBI WENBERTA DISTRICT, TIGRAY, ETHIOPIA

M.Sc. Thesis

By

Mengestu Regassa

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science (MSc.) in Animal Breeding and Genetics

February, 2018

Bahir Dar, Ethiopia

THESIS APPROVAL SHEET

As member of the Board of Examiners of the Master of Sciences (M.Sc.) thesis open defense examination, we have read and evaluated this thesis prepared by **Mr. Mengestu Regassa** entitled **"Performances of Highland Sheep Under Community-Based Breeding Program in Atsbi Wenberta District, Tigray , Ethiopia''**. We hereby certify that, the thesis is accepted for fulfilling the requirements for the award of the degree of Master of Sciences (M.Sc.) in **Animal Breeding and Genetics**.

Board of Examiners

_____	_____	_____
Name of External Examiner	Signature	Date
_____	_____	_____
Name of Internal Examiner	Signature	Date
_____	_____	_____
Name of Chairperson	Signature	Date

DECLARATION

This is to certify that this thesis entitled **"Performances of Highland Sheep Under Community-Based Breeding Program in Atsbi Wenberta District, Tigray, Ethiopia"** submitted in partial fulfillment of the requirements for the award of the degree of Master of Science in "**Animal Breeding and Genetics**" to the Graduate Program of College of Agriculture and Environmental Sciences, Bahir Dar University by **Mr. Mengestu Regassa** is an authentic work carried out by him under our guidance. The matter embodied in this project work has not been submitted earlier for award of any degree or diploma to the best of our knowledge and belief.

Name of the Student

Mengestu Regassa

Signature & date _____ February 30, 2018

Name of the Supervisors

1) Kefyalew Alemayehu (PhD) (Major Advisor)

Signature & date_____ February 30, 2018

2) Aynalem Haile (PhD) (Co-Advisor)

Signature & date_____ February 30, 2018

ACKNOWLEDGEMENTS

First, I would like to thank the Almighty God for giving me health, strength and protection throughout my study. I am highly indebted to my advisors Dr. Kefyalew Alemayehu and Dr. Aynalem Haile for their guidance which enabled me to complete this study. Many thanks also go to Dr. Yayenshet Tesfay, Dr. Barbara Rischkowsky and Dr. Zelalem Tesfay for their valuable comments and guidance at all stages of the study. I would like to pass my sincere thanks to International Center for Agricultural Research in the Dry Land Areas (ICARDA) for offering me financial assistance for my study through IFAD project.

I also forward a great deal of thanks to Mekelle Agricultural Research Center (MARC) and Tigray Agricultural Research Institute (TARI) for providing me necessary support including vehicles and other materials. It is my great pleasure to express my heartfelt thanks to Atsbi Wenberta district Bureau of Agriculture for their support and kindness. I greatly appreciate the support and collaboration of smallholder farmers and enumerators of Habes, Golgolnaele and Gebrekidan PAs.

I would like to express my deepest appreciation to Bahir Dar University for allowing me to study there. Special thanks are also forwarded to course instructors in the university.

My gratitude goes to all my family and relatives for their wholehearted love and encouragement during my study period. My sincere appreciation and thanks also goes to my colleagues at MARC for their constant material and moral support during the study period.

DEDICATION

I dedicate this thesis manuscript to my mother W/ro **Tsehay Berhe** and my younger brother **Melaku** for the sacrificing of their life to save mine.

ABBREVIATIONS / ACRONYMS

BF	Base Flock
CBBP	Community Based Breeding Program
CSA	Central Statistical Authority
DAGRIS	Domestic Animal Genetic Resources Information System
DBoA	District Bureau of Agriculture
ESGPIP	Ethiopian Sheep and Goat Productivity Improvement Program
FAO	Food and Agricultural Organization of the United Nation
FAOSTAT	Food and Agricultural Organization of the United Nation Statistics
HS	Highland Sheep
GLM	General Linear Model
GLS	Grass Land Systems
ICARDA	International Center for Agricultural research in the Dry land Areas
ILRI	International Livestock Research Institute
LIVES	Livestock and Irrigation Value for Ethiopian Smallholder farmers
LMP	Livestock Master Plan
LSM	Least Square Means
MARC	Mekelle Agricultural Research Center
MRD	Mixed Rain-fed moisture Deficient
MRS	Mixed Rain-fed moisture Surplus
NARS	National Agricultural Research Systems
PAs	Peasant Associations
PSR	Progeny of Selected Rams
SAS	Statistical Analysis System
SE	Standard Error
SPSS	Statistical Package for Social Sciences
TARI	Tigray Agricultural Research Institute

Performances of Highland Sheep Under Community- Based Breeding Program in Atsbi Wenberta District, Tigray, Ethiopia.

Mengestu Regassa[1], Kefyalew Alemayehu[2], Aynalem Haile[3]
[1]Mekelle Agricultural Research Center, [2]Bahir Dar University, [3]ICARDA (ILRI)

Abstract

This study was conducted in three PAs namely Habes, Golgolnealea and Gebrekidan of Atsbi Wenberta district of Tigray Region, Ethiopia, aimed at evaluating productive and reproductive performances of Highland sheep under on-going community-based breeding program (CBBP). The study also assessed existing sheep production system, major challenges and opportunities, farmers' perception about the breeding program, its importance and the perceived impacts of the program, opportunities and challenges faced in running the program. Both quantitative and qualitative data were generated from primary and secondary sources. For the survey work a total of 195 household were randomly selected and interviewed using pre-tested, structured questionnaire.

For the performance study, a total of 892 births, 817 weaning, 751 six months, and 564 yearling weight records and for reproductive performance evaluation a total of 464 age at first lambing, 381 lambing interval and 461 liter size records were used for the analysis. Additional data was collected during the study period (monitoring data) from randomly selected flocks in CBBP and non-CBBP households

Growth performances, reflected in both birth and weaning weights, of Highland sheep under CBBP showed an improvement. Birth weight of progeny of selected rams was found significantly heavier than base flocks (2.39± 0.14kg vs. 2.02±0.21 kg; $p<0.01$). Similarly, three month weight had shown highly significant variation between the two groups (8.98 ± 0.24 kg vs. 8.51± 0.38; $p<0.01$). However, this difference became insignificant at six month and yearly weight ($p>0.05$). This variation might indicate body weight improvements were accumulated due to effects of selection of rams in two rounds. In the current study, type of management, parity, sex of lambs, birth type, birth season and year were found significant sources of variation for both birth and three month weights. However, six month and yearling weights were affected by sex of lambs and birth season only ($p<0.05$).

The overall mean reproductive performance in terms age at first lambing, lambing interval and liter size were 494±37.31days, 266.7±11.07days and1.12 ±0.15, respectively. Type of management was not found a significant source of variation (p>0.05). However, type of birth, parity and season of birth had significantly influenced AFL, LI and LS .Findings of the study indicated that the breed can produce three lambings in two years.

Extensive production was the typical feature of the production system in the study PAs. Reported major feed resources were natural pasture (100%), crop residues (80%), crop after-math (38%), hay (15%), and Attela (5.6%). In study PAs, two types of housing were reported. 'Gebela' or"Afgebella" is mostly used during rainy season while "Dembe" is used to confine sheep during dry season. Breeding was reported predominantly uncontrolled mainly in non-CBBP participant households and to some extent in CBBP-participants. Births were distributed throughout the year and peak lambing season occurred in December-January.

Mutton taste of Highland sheep, Abergelle abattoir, high consumers demand, proximity to Mekelle, and gender participation were among the reported sheep production opportunities in the study PAs with index values of 0.30, 0.26, 0.19, 0.16 and 0.09 respectively. On the other hand, feed shortage, health constraints, high sheep mortality, inadequate extension support and poor marketing linkages were identified as major challenges.

Regarding perceived impacts of the CBBP intervention, improvements in mutton consumption or slaughtering frequency (56%), market participation (46%), change in body size of new born (58%) and better breeding practices (79%) were mentioned as improvements due to the intervention. About 64% CBBP participants and 65% non-participants thought they could not sustain the program without external support. Reported major challenges faced in the CBBP were gap in follow up & support, financial limitations, breeding related constraints, wrong perception of farmers and limited representation of female headed households and land less youth. Based on this finding, implementers can take corrective measures against shortcomings and strengthen positive outcomes of the CBBP intervention for benefits of the communities at large.

Key words: Atsbi Wenberta, CBBP, Ethiopia, PAs, Productive performance, Survey, Tigray.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF FIGURES

LIST OF APPENDIX TABLES

Chapter 1. INTRODUCTION

Ethiopia is believed to have the largest livestock population in Africa which is estimated to be 57.83 million cattle, 28.89 million sheep and 29.70 million goats respectively (CSA, 2015). Sheep play important role in contributing to food security, domestic meat consumption and generating cash income as well as providing continuous service to the economic stability of smallholder farmers (Shigedaf Mekuriaw *et al.*, 2013).

Sheep production is an important sector of agricultural production in Tigray region of Ethiopia. According to (CSA, 2015) the population of sheep in the region is estimated to be 1.63 million. Phenotypically sheep of the region were characterized in to four breeds: Highland, Abergelle, Elle and Begait breeds respectively. Highland sheep is found in all agro-ecological zones of Tigray with major concentration in the Eastern and Southern Zones (Zelalem Tesfay and Abreham Haftu, 2010). Atsbi Wenberta district is endowed with huge population of the breed (Getachew Legesse *et al.*, 2014). It is an important supplier of sheep especially to the regional capital town of Mekelle (Birhanu Gebremedhin *et al.*, 2007).

Overall productivity of sheep can be improved through crossbreeding with exotic breeds or selection of local breeds (Kassahun Awgichew and Gipson, 2009). Crossing local breeds with exotic breeds may be an option for increased livestock productivity. However, there is a risk for endangerment of the local breeds (Emelie *et al.*, 2015). Indiscriminate crossbreeding without clear breeding objectives present a potential threat to better adapted indigenous breeds (Tesfaye Getachew *et al.*, 2016).

In Tigray human population is increasing at the same time the demand for mutton is also increasing. Previous cross breeding efforts in the region did not bring desired outputs due to their indiscriminate nature and lack of sustainable dissemination mechanisms (Zelalem Tesfay and Abreham Haftu, 2010). On the other hand, indigenous genotypes have the capacity to cope with the harsh environmental conditions and need relatively less environmental modification to achieve increased productivity (Azage Tegene *et al.*,

2010). Within breed selection of the adapted indigenous genotypes is a viable and promising strategy for efficient on-farm sustainable conservation (Solomon Gizaw *et al., 2008*).Many local breeds have a small population size which puts them at risk of extinction (FAO, 2015).

One of the tools of improving local genotype productivity is Community-Based Breeding Program (CBBP). It is an organized structure that is set up in order to realize the desired genetic improvement of the population (Solomon Abegaz, 2013). It mainly focuses on improvement of economically important production and reproduction traits and is implemented to achieve a certain clearly defined objectives (Gemeda Duguma *et al.*, 2011; Philipsson *et al.*, 2011*;* Tadelle Mirkena, *et al*., 2012; Mueller *et al.*, 2015). Once it has been started it should be evaluated on regular basis (Aynalem Haile *et al.*, 2011).

International Center for Agricultural Research in the Dry Areas (ICARDA), the International Livestock Research Institute (ILRI) in partnership with Ethiopian National Agricultural Systems(NARS) have been implementing community-based sheep breeding programs in few areas of the country, including Atsbi Wenberta district. Accordingly, three potential Peasant Associations, namely: Habes, Golgolneala and Gebrekidan were selected for the implementation of community-based sheep breed improvement program and about 180 households were initially enrolled (60 from each PA). Target farmers were selected based on sharing communal grazing land, neighborhood, flock size owned, and their willingness to participate. The breeding program was based on selection of best breeding rams from sheep flocks of all participating farmers. In first round About 49 growing male lambs (> 6 months old age) and in second round 30 rams were selected through active participation of the community to serve as breeding sires in the breeding program. The selected growing male sheep were purchased through a revolving fund made available by the program, managed by the community and used to serve the community flock. 872 lambs were born from these rams introduced in two rounds.

It is important to evaluate performance of the breed under such intervention: If performances are found promising, the practice could be scale out in to other parts of the region. In addition performance information on the breed is scarce and therefore, this study could address such gap. In addition, assessing sheep production system of the study PAs and identifying major challenges and opportunities could serve as in put for future interventions. Last but not least, farmers' perception about perceived impacts of the intervention, its achievements and challenges need to be investigated. The study findings will enable us to understand need of the communities, besides, it can serve as an input to implementers/stakeholders/ to take corrective measures against shortcomings, strengthen positive outcomes and plan similar interventions in other parts of the region for benefit of the communities at large.

Therefore, the objectives of this study were:

- **General objective**:

  ☞ To evaluate performances of Highland Sheep under community-Based Breeding Program in Atsbi Wenberta District, Tigray, Ethiopia.

- **Specific objectives:**

  ☞ To evaluate growth and reproductive performances of Highland sheep under ongoing Community –Based Breeding Program (CBBP).

  ☞ To characterize the sheep production system of the study PAs.

  ☞ Indentify major sheep production opportunities and constraints of the study PAs.

  ☞ Investigate farmers' perception on importance of CBBP intervention and identify major challenges and opportunities of the intervention.

Chapter 2. LITERATURE REVIEW

2.1. Sheep Production Systems in Ethiopia

According to Livestock Master Plan of Ethiopia (LMP, 2011) there is no specialized sheep production system in Ethiopia (table1). Two broad sheep production systems were reported (Markos Tibbo, 2006). These are the traditional smallholder management system and the private commercial and pastoral production system. The traditional subsistence smallholder management system is the most common one in the country (Solomon Abegaz, 2013). These two categories could be further classified as highland sheep-barely, mixed crop-livestock and pastoral and agro-pastoral production systems (Solomon Gizaw *et al.*, 2008). The production systems are characterized by different production goals and priorities (Belay Deribe, 2009). Generally they are characterized by small flock sizes, communally shared grazing, uncontrolled mating, absence of recording, low productivity per animal, relatively limited use of improved technology, and use of on-farm by-products rather than purchased inputs (Addis Getu *et al.*, 2015).

Table 1.The distribution of Ethiopian national livestock herd over production systems

Species	National	GLS	MRD	MRS	specialized
Cattle	53,990,061	14,709,988	14,513,585	24,657,488	109,000
Sheep	29,361,124	14,793,452	5,342,806	9,224,866	-
Goats	28,980,284	20,359,093	4,602,947	4,018,244	-
Equine	7,171,014	-	-	-	-
Camels	4,500,000	4,500,000	-	-	-
Poultry	6,303,938	5,953,937	-	-	350,000
Bee hives	4,993,815	4,993,815	-	-	-

GLS= Grass land system; MRD= Mixed rain-fed moisture deficient; MRS= Mixed rain-fed moisture surplus

Source: Livestock Master Plan (LMP) document, 2011.

2.2. Classification of Ethiopian Sheep Breeds

Ethiopia has a genetically diverse sheep population three-quarters of which is found in the highlands where mixed crop-livestock and sheep-barley production systems dominate (DAGRIS, 2006). The Ethiopian sheep breeds are classified into 14 traditional populations in 9 breeds within 6 major breed groups (table2). There are about 14 traditionally recognized sheep breeds (Solomon Gizaw, 2007). He further indicated that sheep types in Ethiopia are highly affiliated to specific ethnic communities. Several traditional breeds are reared by and named after specific communities.

Table 2. Ethiopian sheep breed classification

Breed group	Breed	Population	Tail type/shape	Fiber type
Short-fat tailed	Simien Short-fattailed	Simien Sekota, Farta, Tikur,Wollo, Menz	Fatty and short Fatty and short	Fleece Fleece
Washera	Washera	Washera	Fatty and short	Hair
Thin-tailed	Gumz	Gumz	Thin and long	Hair
Long-fat-Tailed	Horro, Arsi	Horro,Arsi-Bale, Adilo	Fatty and long	Hair
Bonga	Bonga	Bonga	Fatty and long	Hair
Fat rump Sheep	Afar, Blackhead Somalia	Afar,Blackhead Somalia	Fat rump/fat tail hair, Fat rump/tiny tail	Hair

Source: *Solomon Gizaw et al., 2007*

According to Solomon Gizaw (2008), morphological and molecular characterization of Ethiopian sheep breeds by targeting those populations traditionally recognized by ethnic and/or geographic nomenclatures nine genetically distinct breeds were identified (figure 1).

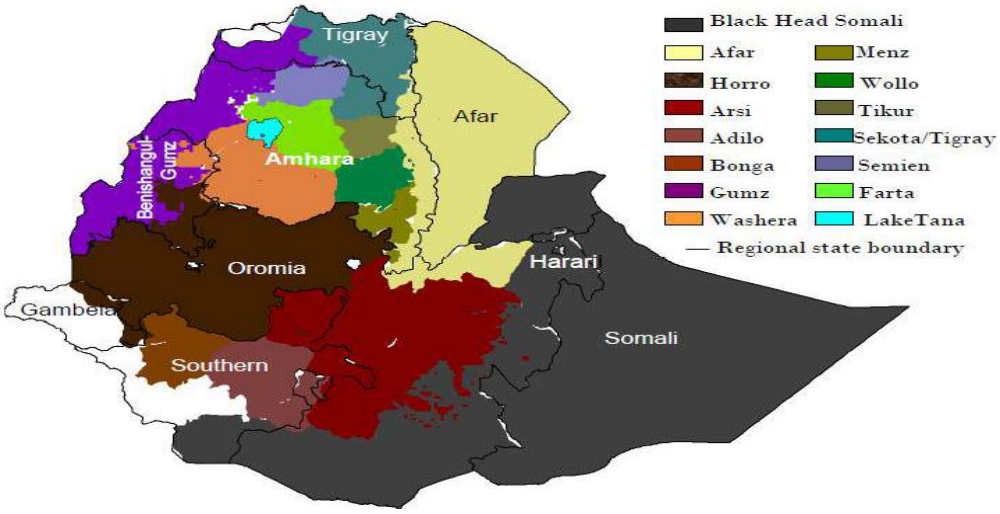

Figure 1. Ethiopian sheep breeds and their distribution

2.3. Sheep Production and Indigenous Breeds in Tigray

Sheep production provides food, cash income and manure to the smallholder farmers (Yenesew Abebe *et al*., 2013). It contributes significantly to farm livelihoods, particularly where crop production is unreliable and where livestock is the mainstay of livelihoods (ESGPIP, 2009). Sheep production is an important sector of Agricultural production in Tigray. It is practiced in highlands, midlands and low land areas. It is a long period history of the crop livestock mixed farming system. This could have been due to the nature of sheep to thrive in low quality feed complemented with the fast growing and short gestation period added with the small size of the animals to be suitable for family consumption. However, due to poor management and uncontrolled breeding system the economic return fetched from the sector had remained minimal (Birhanu Gibremedhin *et al.*, 2007).

Tigray is endowed with huge number of sheep, with potential breeds for mutton production. Estimated population is about 1.63 million (CSA, 2015). To identify breeds in the region efforts have been made by Tigray Agricultural Research institute (TARI) to phenotypically characterize the breeds in the region.

The breeds are Abergelle (Distributed in Districts such as Tanqua- Abergelle, Tselemti, Kola tmeben and Alamata, lowlands of Ofla and Sokota), Begait (distributed entirely in Western and North Western Tigray including districts such as Tahtay–Adyabo, Tsegede and Kafta Humera), Ille (distributed in Raya-Azebo district and Afar region) and highland sheep (distributed in all mid and highlands of Tigray). All have distinct features which make them fit to their specific production system. Almost all sheep breeds are utilized for meat production except the Begait which is both milk and meat type. (Zelalem Tesfay and Abreham Haftu, 2010).

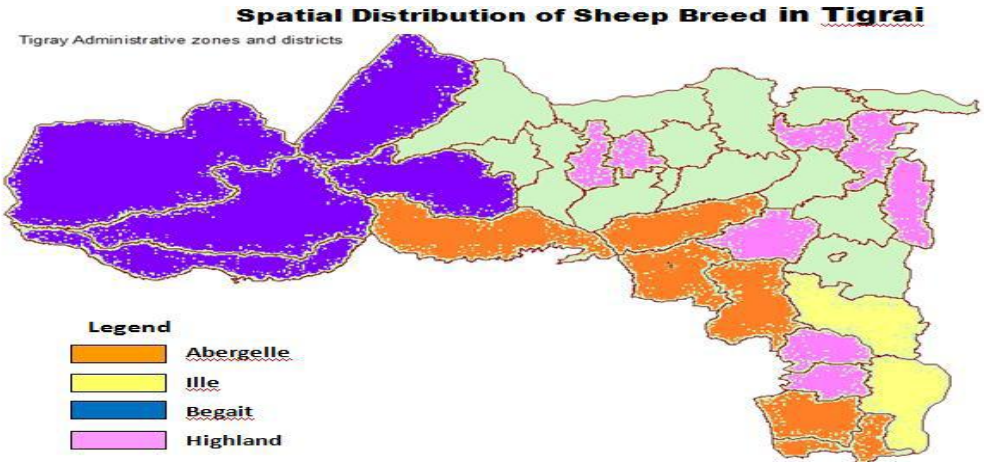

Figure 2. Spatial distribution of sheep breeds in Tigray

Source: Zelalem Tesfay and Abreham Haftu, 2010

2.4. Highland Sheep Breed

Highland sheep is found in all agro-ecological zones of Tigray with major concentration in the eastern and southern zone highlands (Zelalem Tesfay and Abreham Haftu, 2010). It is classified as short fat tailed sheep (Mulata Hayelom *et al.*, 2014) .The breed is a dual purpose breed which is mainly kept for meat production and to some extent for milk production as well (Getachew Legesse *et al.*, 2014). Medium body size, promising body framework with wider loin area, Short and wide tail, red and gray coat colors, presence of horns and docile temper are identity of the breed. Average adult body weight of 28 kg for male and 23 kg for female was reported (Mulata Hayelom *et al.*, 2014).

It is a hardy breed which is capable of expressing its genetic performance by coping up with shortage of feeds and rainfall. Regarding to reproduction and production performance it is not as such prolific, single birth is the main feature and in rare cases it delivers twins (Alemayehu Tadesse and Tikabo Gebremariam 2010; Getachew Legesse *et al.*, 2014).

Figure 3. Typical Highland Sheep ewe and ram

2.5. On-Farm Monitoring

On-farm monitoring involves monitoring the productive and reproductive performance of a breed on selected representative village flocks or herd (Solomon Gizaw *et al*., 2014). Periodic monitoring of the population dynamics and flock structures of a breed is also suggested for the purpose of assessing the risk status of a breed (FAO, 2015). On-farm performance assessment concerned with the whole farm environment provides information in location specific production conditions that could lead to breed improvement options that are appropriate to the system (Getahun Legesse, 2008). However, unlike on station experiments, on-farm study is influenced by many factors which could not be controlled (Solomon Abegaz, 2013).

2.6. Growth Performance of Sheep

Growth performance is the most important trait in sheep production affecting the contribution of the sector to the farm household through live animal sale and meat production (Zeleke Mekuriaw, 2007; Tesfaye Getachew *et al.,* 2009*;* Belay Deribe and Mengistie Taye, 2013). It may be separated in pre-weaning and post weaning weights (Solomon Abegaz, 2013). Knowing the body weight of a sheep is important for a number of reasons, related to breeding (selection), feeding, health care and for market age determination since it is an important growth and economic trait (Tesfaye Getachew *et al.,* 2009). Growth rate of lambs particularly during the early stages of growth, is strongly influenced by breed (genotype), milk yield of the ewe, the environment under which the animals are maintained including the availability of adequate feed supply in terms of both quantity and quality (Mengistie Taye, 2008). Parity, pre-mating weight of the dam, type of birth, sex, season and month of birth also contributes for growth performances of small ruminants.

2.6.1. Birth weight

Birth weight of animals is one of the most important factors influencing the pre-weaning growth of the young and has a positive correlation between birth weight and subsequent live body weight development (Kassahun Awgichew, 2000). However, this fundamental knowledge is often unavailable for sheep in the small scale farming sector, due to unavailability of scales (Zewdu Edea, 2008). Birth type and sex are sources of variation in lamb pre-weaning growth rate (Mengistie Taye *et al.,* 2009). Lambs which are heavier at birth are usually singles or are those produced by ewes with larger body sizes and good feeding conditions. The indication is that lambs heavier at birth have larger adult weight and higher growth capacity (Kassahun Awgichew, 2000; Mengistie Taye *et al.,* 2009). Parity can also affect pre-weaning growth rate, from birth to 30 days of age. Lambs from second and third parity dams grew better than first and fifth parities (Kassahun Awgichew, 2000; Markos Tibbo, 2006; Mengistie Taye *et al.,* 2009).

2.6.2. Weaning (3 month) weight

Weaning weight is a trait of great economic importance in meat sheep production since it has influence on growth rate and survival (Mengistie Taye *et al.,* 2009). Different values of weaning weight were reported by different authors. Thus, weaning weight and post-weaning growth rate of lambs is as important as the pre-weaning growth performances, mainly when the objective is producing meat through lamb production. Seasonal variation in growth rate is observed in tropics because feed supply varies remarkably (Kassahun Awgichew, 2000). Because of weaning shock, lower growth rate was observed at weaning time (Mengistie Taye *et al.,* 2009). Significant effect of season on post-weaning weight was reported on lamb's growth (Markos Tibbo, 2006; Mengistie Taye *et al.,* 2009), while there was non-significant effect of sex and birth type (Mengistie Taye *et al.,* 2009). Birth and weaning weights and pre-weaning Average Daily Gain (ADG) of some indigenous breeds are presented in (Table 3).

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

Breed	Management Type	BWT (Kg)	WWT (Kg)	ADG (g m/day)	Sources
Adilo	Traditional	2.29	11.18	98.77	Getahun Legesse, 2008
Arsi Bale	Traditional	2.89	12.23	102.01	Getahun Legesse, 2008
Bonga	Traditional	2.86	11.60	NA	Belete Shenkutie, 2009
Horro	On station	2.40	9.48	78	Markos Tibbo, 2006
Horro	On station	2.60	12.00	100.4	*Solomon Abegaz etal., 2002*
Menz	On station	2.06	8.64	72.6	Markos Tibbo, 2006
Menz	Traditional	2.90	14.38	105	Hassen *et al.,* 2004
Menz	On station	2.50	9.50	78	Demeke *et al.,*2004
Washera	Traditional	2.70	11.90	59.1	*Mengistie Taye et al., 2009*

BWT = birth weight, WWT = weaning weight and ADG = average daily gain

2.7. Reproductive Performance of Sheep

Reproductive performance is commonly evaluated by analyzing female reproductive traits (Aynalem Haile et al., 2011). Measures of reproduction commonly used in sheep include age at first lambing, lambing interval and liter size (Alemu Yami and Merkel, 2008; Aynalem Haile et al., 2011).Such traits are economically important (Ermias Belete, 2014***).***

2.7.1. Age at first lambing (AFL)

Age at first lambing can be defined as the age at which ewes give birth for the first time. AFP is an economically important trait because it determines rate of genetic progress and population turnover rate. The majority of studies report the age of first lambing for Ethiopian sheep within the range of 411-475 days (Mourad *et al.*, 2016). Ewes under village management conditions in southwestern Ethiopia, demonstrated a mean age of 404 days at first lambing (Belay Deribe and Aynalem Haile, 2009). The same pattern was found for Afar sheep under pastoral management (Solomon Gizaw *et al.*, 2013). Tsedeke Kochu (2007), reported 12.7 months for lambing months in Alaba southern Ethiopia. (Fsahatsion Hailemariam *et al.*, 2013) reported an average age at first lambing (AFL) of 12.4 months in Gamo Goffa Zone, Southern Ethiopia. (Mesfin Lakew *et al.* 2014*)* reported average AFL of 18.10 months at eastern Amhara region. The average age of sexual maturity 7.1 months reported by (Tesfaye Getachew, 2010) for Afar rams. According to Zewdu Edea *et al.* (2012), average age at first lambing of Bonga and Horro sheep were 14.9 months and 13.3 months, respectively. Those breeds perform better than most indigenous breeds and this is an opportunity for genetic improvement as greater population turnover and more rapid genetic progress could be obtained (Aynalem Haile *et al.*, 2012).

2.7.2. Lambing interval (LI)

Lambing interval is the interval between two parturitions that determines reproductive efficiency in small ruminant production. Lambing interval is one of the main components

of reproductive performance which is affected by season, year of lambing, parity of ewes, post-partum body weight and management practice, nutrition, type of mating and restrictions on breeding also prolong the interval between lambing(Mengiste Taye, 2008;) At least three times lambing is expected per two years under normal circumstances (Girma Abebe, 2008). To attain this lambing interval should not exceed 8 months (245 days). There are reports on the possibility of attaining three parturitions from indigenous small ruminants in two years (Getahun Legesse, 2008); 9.16 month for Washera sheep (Mengistie Taye, 2008) and 7.34 month (Fsahastion Hailemariam *et al.,* 2013).

According to (Solomon Abegaz, 2007), Gumuz breed had an average lambing interval of 6.64 months so the breed can produce three lambing in two years even under the traditional management system ,but the work of (Zewdu Edea *et al.* 2012) indicates that lambing interval of around 8.9 month for Bonga ewes and 7.8 month for Horro ewes. Among other breeds of sheep in Ethiopia that have short lambing interval are Menz (8 and half month) and Afar sheep 9 month (Tesfaye Getachew *et al.,* 2010*).*

2.7.3. Liter size (LS)

Prolificacy or litter size (LS) is largely determined by ovulation rate but is also modified by fertilization rate and embryonic and fetal losses. Litter size is influenced by genotype, parity, season, and ewe body weight at mating (Mukasa Mugerwa and Lahlou-Kassi, 1995). The management system was also a major source of variation in litter size as reported for Washera sheep (Shigdaf Mekuriaw *et al.* 2013).

Litter size varies between 1.08 and 1.75 with the average of 1.38 for tropical breeds (Girma Abebe, 2008). Liter size of Ethiopian sheep breeds like Menz and Afar sheep breeds is low which is almost close to one lamb per lambing (Tadele Mirkena, 2010), while breeds like Horro and Washera are more prolific with litter size of 1.35 and 1.2, respectively (Mengiste Taye*, 2008;* Solomon Gizaw *et al.* 2010*;* Tesfaye Getachew *et al.*, 2010) reported low twining rate of both Menz and Afar sheep breeds. According to Zewdu Edea *et al. (*2012), litter size of 1.40 and 1.36 were obtained for Horro and Bonga sheep breeds, respectively and the two breeds showed relatively better multiple births

under the existing feed shortages. Reproductive performance of some indigenous sheep breeds of Ethiopian are presented in (table 4)

Table 4. Reproductive performance of indigenous sheep breeds

Breed	Reproductive traits			Sources
	AFL	LI	LS	
Adilo	14.6	NA	1.42	Shigdaf Mekuriaw, 2014
Afar	13.52	9.02	1.49	*Tesfaye Getachew et al., 2010*
Arsi Bale	12.7	7.8	1.7	Shigdaf Mekuriaw, 2014
BHS	23.6	10.46	1.04	Fekerete Friew, 2008
Bonga	14.9	8.9	1.4	*Zewdu Edea et al., 2012*, Shigdaf Mekuriaw, 2014
Gumz	13.67	6.64	1.17	Solomon Abegaz, 2007
Horro	13.3	7.8	1.57	Zewdu Edea *et al.*, 2012; Hundie Demissu; Geleta Gobena, 2015
Menz	15.67	8.50	1.04	*Tesfaye Getachew et al., 2010*;
Washera	15.46	9.04	1.11	Mengistie Taye, 2008
Wollo	21.2	9.2	NA	*Tesfaye Getachew et al., 2010*

AFL= Age at first lambing; LI= lambing interval; LS=liter size; BHS= Black head Somali.

2.8. Sheep Production Opportunities in Ethiopia

High demand of the small ruminants in the local market as a result of population increase, urbanization and also all household member involvement in their management can be considered as an opportunity for the small ruminant production (Tsedeke Kocho, 2007).

The study of Okpebholo (2007), showed that low start-up cost as an important factor in providing opportunity for the development of a small ruminant production system by a small-scale farmer with limited resources. Similarly, incensement of mutton /chevon demand, as found in present study, was in agreement with finding reported by (Solomon

Gizaw *et al.*, 2010) indicating that sheep breeds in the lowlands of the country were in good demand in the Middle East markets. According to Tsedeke Kocho (2007) and Zewdu Edea *et al.* (2012), gender participation was reported as sheep production opportunity.

2.9. Sheep Production Constraints in Ethiopia

Major sheep production systems in Ethiopia are characterized by non-specialized multipurpose breeds, extensive production systems and little control of breeding animals (Adane Herpa and Girma Abebe, 2008*;* Solomon Gizaw *et al.*, 2008). Extensive systems are characterized by small flock sizes, communally shared grazing, uncontrolled mating, absence of recording, low productivity per animal, relatively limited use of improved technology, and use of on-farm by-products rather than purchased inputs (Addis Getu *et al.*, 2015). In mixed crop-livestock systems, relatively high inbreeding coefficient because of uncontrolled mating and absence of sharing communal land for communal herding might potentially increase the risk unless appropriate measure is taken (Zewudu Edea *et al.*, 2012). Flock management in groups due to resource endowment, parity, litter size, and season (due to seasonal fluctuations in both quantity and quality of feed) were important factors that need to be considered in the improvement plan of sheep.

The major problems in traditional management system were that the system is not market oriented, underdeveloped marketing and infrastructure system, and poor financial facility (Azage Tegegne *et al.*, 2006*;* Berhanu Gebremedhin *et al.*, 2006). The role of brokers in marketing small ruminants has two views; one group describes them favorably as they facilitate transaction between buyers and sellers while others see them as problems in marketing as they are the ones who mainly decide the price (Endeshaw Alemu, 2007; Tsedeke Kocho, 2007).

2.9.1. Feed shortage

Lack of adequate feed resources as the main constraint to animal production was more pronounced in the mixed crop-livestock systems, where most of the cultivated areas and high human population are located (Yenesew Abebe *et al.*, 2013).

Many authors described the seasonal feed shortages, both in quality and quantity, and the associated reduction in livestock productivity in different parts of the country (Getahun Legesse, 2008 and Yeshitila Alemu, 2007). Feed shortage problem was similar throughout the country, being serious in high human population areas where land size is diminishing due to intensive crop cultivation and soil degradation. Study of Mesay Yami *et al.(* 2013), in Lemu-Bilibilo district in Arsi zone reported that, shortage of feed at the end of dry season when all crop residues have been consumed and pasture growth is poor, was the major constraint for livestock production in the area. The feed shortage also appears even in the rainy seasons since more of the lands are occupied by crops.

2.9.2. Water shortage

Water shortage is a limiting factor in most lowland areas and to a limited extent in mid altitudes. In eastern, north-eastern and south-eastern part of the country there is also critical shortage of water; however, there are breeds adapted to lowland agro ecologies through their physiological adaptation mechanisms (Belete Shenkutie, 2009). Restrictions of water may result in poor nutrition and digestion, because there is a relationship that exists between water intake and consumption of roughages, particularly during dry season. Long distance travel of small and large ruminants in searching of water was another problem (Mesay Yami *et al.,* 2013).

2.9.3. Health constraints

Another serious constraint for sheep production in Ethiopia has been the high prevalence of diseases and parasites. This causes high mortality amongst lambs, diminishing the benefits of their high reproductive performance (Markos Tibbo, 2006). Animals with good adaptive potential are needed in these stressful environments to sustain the livelihoods of the communities (Solomon Gizaw *et al.,* 2010; Tadele Mirkena, 2010; Zewudu Edea *et al.,* 2012 and Helen Nigussie *et al.,* 2013).

2.9.4. Marketing constraints

The study of Yenesew Abebe *et al.* (2013) in Burie woreda, west Gojjam, reported that sheep sellers get market price information mainly from traders or their neighbors.

There is no public market information source in the area for the producers, traders or consumers in general. This reduces the marketing system transparency and efficiency. In the sheep markets there is no weighing or grading of animals at the time of sale. Buyers and sellers judge the sheep they buy/ sell through physical observation only (Juma *et al., 2010 and* Ramesh *et al.*, 2012). This was reported as disadvantage especially for sellers.

2.9.5. High sheep mortality rate

Pre-weaning mortality of some Ethiopian indigenous sheep is presented on (Table 6). Lamb losses before one year of age vary from 6.4 % to 45%. More than half of the causes of mortality were similar and attributed to pneumonia as reported from the study on Horro and Menz sheep of Ethiopian highlands (Markos Tibbo, 2006).Significant effect of season, flock size and sex of animals on survival was reported (Gemeda Dugma *et al.*, 2002) for Horro sheep. The same author reported that coughing (23.8%) and diarrhea (23.5%) are among the major clinical signs for mortality of sheep. Belete Shenkutie (2009) reported similar cases for Bonga sheep of south Western Ethiopia.

Table 5. Pre-weaning mortality of some Ethiopian indigenous sheep under different management conditions

Breed	Management type	Pre weaning mortality rate (%)	Sources
Adilo	Traditional	19.5	Getahun Legesse, 2008
Arsi Bale	Traditional	20	Getahun Legesse, 2008
Arsi Bale	Traditional	28.4	Tsedeke Kocho, 2007
Bonga	Traditional	20.87	Belete Shenkutie, 2009
Horro	On station	25.3	Markos Tibbo, 2006
Horro	On station	24.3	Kassahun Awgichew, 2000
Menz	On station	8.8	Markos Tibbo, 2006
Menz	On station	10.6	Kassahun Awgichew, 2000
Washera	Traditional	6.4	Mengistie Taye, 2008

2.10. Community Based Breeding Program (CBBP)

Overall productivity of sheep can be improved through the following interventions: selection of local breeds, crossbreeding with exotic breeds and improvement of environmental conditions which includes management and feed quality (Kasahun Awgichew and Gipson, 2009). One of the tools of improvement includes CBBP interventions.

Breeding programs are defined as systematic and structured programs to change the genetic composition of a population based on objective performance criteria (FAO, 2007; FAO, 2010; Kosgey *et al.,* 2006). It is an organized structure that is set up in order to realize the desired genetic improvement of the population (Solomon Abegaz, 2014). It should be implemented to achieve a certain clearly defined objective. It is one possible option in smallholder production system to bring about genetic gain in sheep and improve productivity with an ultimate goal to enhance famers' livelihoods.

Sheep keepers are responsible for the decisions on identification, priority setting and the implementation of activities in conservation and sustainable use of their animals (Tadelle Mirkana *et al.,* 2012). The first step in setting CBBP is to define objectives which are realistic and attainable. The methods employed in defining the breeding objectives in Ethiopia were choice experiments (Gemeda Duguma, 2011) and own-flock and group-animal ranking experiments (Tadelle Mirkana *et al.,* 2012*;* Solomon Gizaw *et al.,* 2013). Once it has started, more record keeping will be needed in order to execute the plan and assess progress (Aynalem Haile *et al.,* 2011). When assessing breeding objectives and designing breeding programmes, it is important to actively involve the farmers in the whole process (Mueller *et al.,* 2015).

2.11. Community Based -Breeding Program (CBBP) In Ethiopia

Institutionalized and centralized sheep genetic improvement efforts were made for the last six decades in Ethiopia and have often failed to yield significant impacts at the farm level (Gemeda Duguma, 2010). Improvement programs for sheep through breeding in Ethiopia will be focusing on between and within breed selection for traits such as growth, survival and fertility (Markos Tibbo, 2006).

The CBBP for indigenous sheep in Ethiopia was started after detailed studies (Zewdu Edea, 2008; Tesfaye Getachew *et al.*, 2009; Getachew Terfa *et al.,* 2013). According to Zelalem Gutu *et al.* (2015), community-based sheep breeding programs were first implemented in four sites (Bonga, Horro, Menz, and Afar) across four regional states of Ethiopia. After the end of the project the more successful breeding programs in Menz, Horro, Bonga have been continued under the CGIAR Research Program on Livestock and Fish by ICARDA, ILRI and the NARS and expanded to two new sheep sites, Doyogana and Atsbi Wenberta (Zelalem Getu *et al.*, 2015). Body size of sheep was the top ranked trait of sheep in the three project sites (Tadelle Mirkena *et al.,* 2012) and was, therefore, a target trait for improvement in the CBBP. For example while setting CBBP in Atsbi Wenberta district the following steps were followed (Getachew Legesse *et al.*, 2014):

- Community Consultation on designing sheep breeding objectives was facilitated
- Production system was characterized through rapid rural appraisal(RRA)
- Smallholder farmers who own sheep, neighbor to each other and shared grazing lands were selected (60 farmers from each PAs)
- Initial flock baseline identification was identified
- 2018 sheep were ear tagged, profile collected and documented.
- Young rams were purchased and distributed to beneficiary farmers
- Three enumerators were hired to facilitate data recording

Table 6. Summary of major opportunities and challenges of ongoing CBBPs in Ethiopia

Opportunities	Challenges	Source
Farmers' participation	feed shortage	Tadelle Mirkana *et al.,* 2012*;* Zelalem Getu *et al.,* 2015
Formation of breeding cooperatives	disease and poor veterinary service	Solomon Gizaw *et al.,* 2014; Zelalem Getu *et al.,* 2015
Awareness about inbreeding	Poor market linkage	Getachew Legesse *et al.,* 2014; Zelalem Getu *et al.,* 2015
Need & retaining for breeding rams	delay in selection of breeding rams	Zelalem Getu *et al.,* 2015
Better performance of sheep	uncontrolled mating	Solomon Gizaw *et al.,* 2014*;* Zelalem Getu *et al.,* 2015
Record keeping	wrong perception of farmers (e.g ear tag removal)	Aynalem Haile *et al.,* 2011; Gemeda Deguma *et al.,* 2011*;* Zelalem Getu *et al.,* 2015

Chapter 3. MATERIAL AND METHODS

3.1. Description of the Study Area

Three peasant associations (PAs) were selected purposely using the intervention of ongoing breeding program (i.e. Habes, Golgolneale and Gebrekidan) of Atsbi Wenberta district of Tigray Region. The district is found in Eastern Zone at about 65Km from Mekelle, regional capital city. It is bordered in north by SaeseTsaedaemba district, in the south by Enderta district, in the east by Afar Regional State and in the west by Kilteawlaelo district respectively.

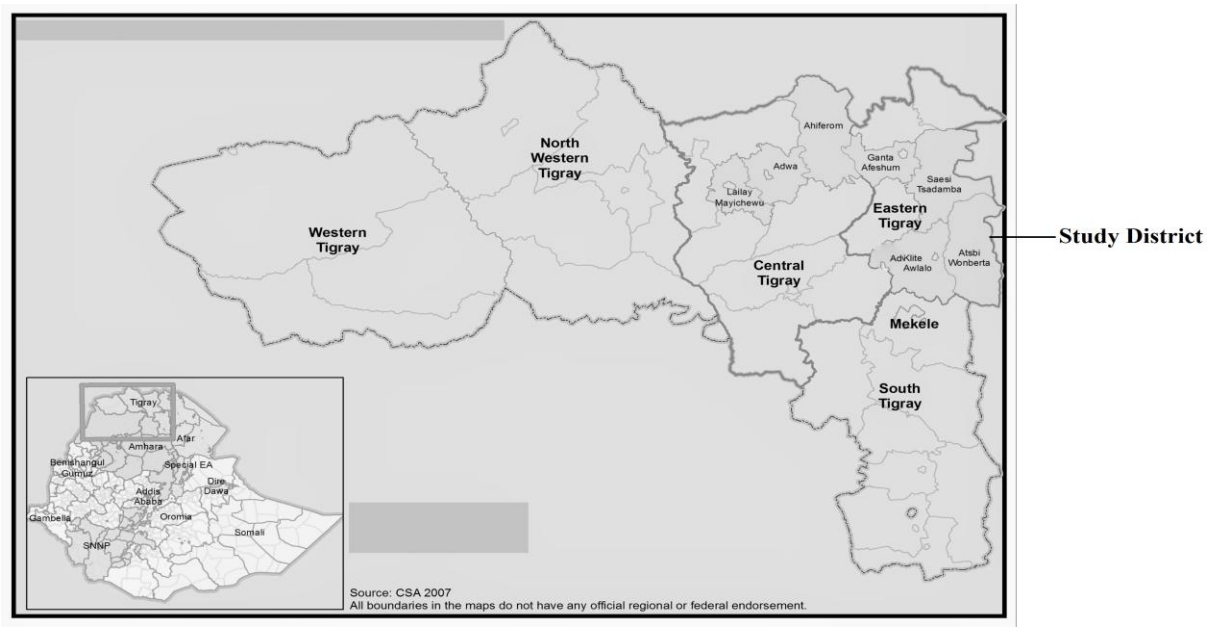

Figure 4. Location of Atsbi Wenberta district

Basic information of Atsbi Wenberta district is presented in (table 7).The district has both highland and mid land agro ecologies .It occupies a total area of about 1223 sq Km. Major types of land use are forest 89,185 ha, grazing land 8,742 ha, potential cultivated 35,305ha, cultivated 13,050.23ha (DBoA, 2017 personal contact).

Table 7. Summary of basic information about Atsbi Wenberta district

Location (latitude and longitude)	390 30' E - 390 45' E and 130 30' N- 130 45' N
Distance from Mekelle	75 Km North East
Altitude (highlands)	2400 to 3000 m (70%)
Altitude (midlands)	1800 to 2400 m (30%)
Total area	1223 KM^2
Avg. Rainfall	668 mm
Avg. Temperature	14.5^{O}C
Dominant cereal crops	Barley, wheat, tef, maize and sorghum
Human population	
Male	53,659 (49.1%)
Female	58,682 (50.9)
Total	112,341
Avg. Household size	5
% Female headed household	15-30

Source: (DBoA, 2017), personal contact

3.1.1. Temperature and rainfall trends of Atsbi Wenberta district

The average temperature of the district is about 14.5 ^{0}C (figures 5) and the weather ranges from cool to warm. Rainfall is usually intense and short duration, with an annual average of about 667.8 mm (figure 6).

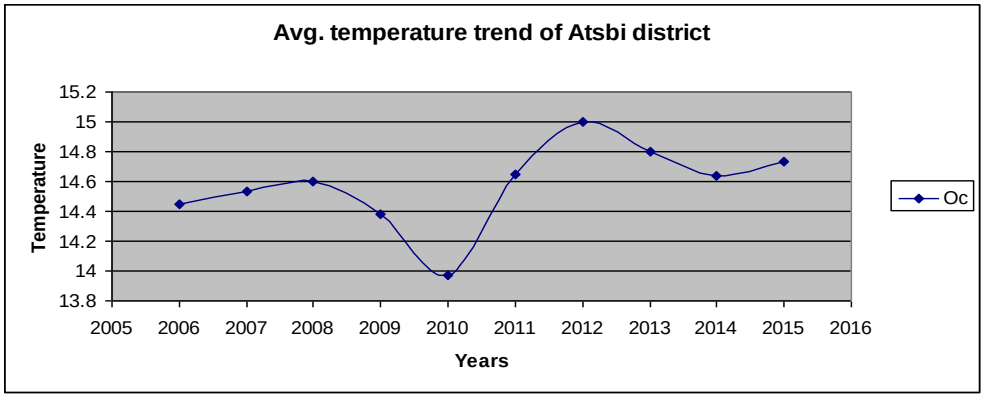

Figure 5. Average temperature trend of Atsbi Wenberta district for the last ten years

Source: (Esayas Meresa, 2017), personal contact

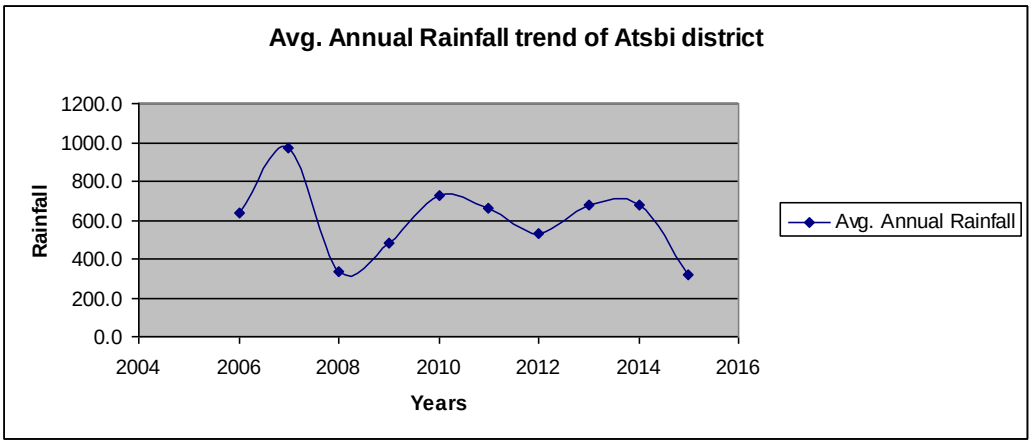

Figure 6. Average rainfall trend of Atsbi Wenberta district for the last ten years

Source: (Esayas Meresa, 2017), personal contact

3.1.2. Livestock population

As most of the district is in the highlands, it is suitable for sheep production. Livestock population of the study PAs and the district is given in (table 8).

Table 8. Livestock population of Atsbi Wenberta district and respective study PAs

Population	Atsbi	Habes	Golgolnealea	Gebrekidan	% share of the PAs
Cattle	64419	1861	3978	4815	16.54
Sheep	111655	4077	12764	8022	**22.23**
Goat	42905	172	524	652	3.14
Equine	11551	475	833	1016	20.12
Camel	76	12	-	-	15.6
Poultry	137245	8540	7320	23191	28.45
Bee colony	4908	210	367	432	20 .56

Source: (DBoA, 2017), personal contact

3.2. Animal Used for the Study

The study animals were Highland Sheep managed under both CBBP-participant and non participant households. Data generated from rams, ewes and their offspring were used for the study.

3.3. Data Sources and Methods of Collection

This thesis work comprised of two components (i) Performances (growth and reproductive) study of Highland Sheep flock (Quantitative study) (ii) survey study about sheep production system, its major opportunities and constraints, and perception of farmers about significance of CBBP intervention, its major challenges and opportunities.

3.3.1. Performance data

Both quantitative and qualitative data were generated from primary and secondary sources. Secondary data used in this evaluation was biological data collected by enumerators from the ongoing CBBP intervention from 2015-2017. Additional data was collected during the study period (monitoring data) from randomly selected flocks in CBBP and non-CBBP households. As part of the monitoring study a total of 892 births, 817 weaning, 751 six months, and 564 yearling weight records and for reproductive performance evaluation a total of 464 age at first lambing, 381 lambing interval and 461 liter size records were used for the analysis.

3.3.2. Survey data

Data were collected from both CBBP participants and non- participants. A total of 195 household (105 non CBBP -participants and 90 CBBP- participants) were randomly selected.

Structured questionnaires were prepared, pre-tested and administrated to collect information from selected farmers. Main points of the study were existing sheep production and husbandry practices, major challenges and opportunities, farmers' perception about the breeding program, its importance and the perceived impacts of the program and opportunities of the intervention and challenges faced in running the program.

3.4. Sampling Technique and Sample Size Determination

To select respondents from the total population, first the populations were stratified in to two groups as CBBP participants and non-Participants. Then from each group respondents were selected using simple random sampling technique. The sample size of respondents was calculated based on Yemane's formula (Yemane 1967)

$$n = \frac{N}{1+Ne^2}$$

Where, n= Sample size

N= Size of the population

e= Error of 5 percentage points

3.5. Data Management and Statistical Analysis

3.5.1. Quantitative (biological) data

Quantitative data were analyzed using the Generalized Linear Model (GLM) procedures of SAS (version 9.1). Data used for analysis include birth weight, three month weight, six month weight, yearly weight, age at first lambing, lambing interval, and liter size.

After data was coded and entered into the computer for analysis, preliminary data analysis like homogeneity test, normality test and screening of outliers were employed before conducting the main analysis.

Influence of fixed effects on production and reproduction performances of the breed was examined. The effects of fixed variables were expressed as Least Square Means (LSM) ± SE. Turkey Kramer test was used for multiple comparisons of effects with three or more levels which were significant in the least squares analysis of variance. Two-way interactions between the main effects was retained in the final model when found significant ($P<0.05$) in preliminary analysis. The fixed effects fitted include lamb sex (two levels: male and female), birth season (two levels: dry and wet), ewes' parity (five levels: 1, 2, 3, 4 and 5^{+}), birth type (two levels: single and twin), birth year (i.e. three levels: 2015, 2016, and 2017), PAs or location (three levels: Habes, Golgolneale and Gebrekidan) and type of management (two levels: CBBP and non-CBBP).

1. Model for Performance of two generation progeny of selected rams and their base flock under CBBP management

$Y_{ijkl} = \mu + S_i + L_j + G_k + LS_l + (S_i * L_j)_{ij} + e_{ijkl}$

Where: $Y_{ijkl\ the}$ observed live body weight (at birth, three and six months and yearling)

μ = overall mean

S_i = is the effect of i^{th} selection (i= base flock, progenies of selected rams)

L_j= is the effect of j^{th} location/PAs (J= Habes, Golgolneale, Gebrekidan)

G_k=is the effect of k^{th} generation (K= First, second)

LS_l= is the effect of L^{th} sex of lambs (L= Male, female)

$(S_i * L_j)_{ij}$ = Selection by location interaction effect

e_{ijkl} = Effect of the random error

2. Model for effect of fixed factors on growth Performance of Highland Sheep

$Yijklmno = \mu + M_i + L_j + S_k + BS_l + BT_m + BY_n + P_o + (L \times BS \times BY)_{jln} + e_{ijklmno}$

Where: $Yijklmno$ = Body weight at birth, weaning, six month & yearling respectively.

μ = Overall Mean

M_i = Fixed effect of the i^{th} type of management (i= CBBP, non-CBBP)

L_j =fixed effect of the j^{th} location/PAs (j= Habes, Golgolneale, Gebrekidan)

S_k = Fixed effect of the k^{th} sex of lamb (k = male, female)

BS_l = fixed effect of the l^{th} birth season (l= dry, wet)

BT_m = fixed effect of the m^{th} lamb birth type (m = single, twin)

BY_n = the fixed effect of n^{th} birth year (n = 2015, 2016, 2017)

p_o = fixed effect of the o^{th} dam parity (o = 1, 2, 3, 4, 5+)

$(L \times BS \times BY)_{jln}$ = Location by birth season and birth year interaction effect

$e_{ijklmno}$ = Effect of the random error

3. Model for reproductive performance of Highland Sheep ewes

$Yijkl = \mu + M_i + L_j + P_k + BS_l + BT_m + e_{ijklm}$

Where: Y*ijklm* = the observation for Age at First Lambing (AFL), Lambing Interval (LI), Litter Size (LS)

μ = Overall mean

M_i = Fixed effect of the ith type of management (*i* = CBBP, non-CBBP)

L_j = Fixed effect of the jth location/PAs (*j* = Habes, Golgolneale, Gebrekidan)

P_k = Fixed effect of the kth dam parity (*k* = 1, 2, 3, 4, 5+)

BS_l = Fixed effect of lth lambing season (*l* = dry, wet)

$BT_{m=}$ Fixed effect of the mth lamb birth type (m = single, twin)

e_{ijklm} = Effect of random error

3.5.2. Survey data

Data collected through questionnaire were described by descriptive statistics using Statistical Package for Social Sciences (SPSS 20.0 for windows). Indices were calculated to provide rankings of the purposes of keeping sheep, constraints and opportunity to sheep production, major challenges and opportunities of the ongoing CBBP intervention. Index = Sum of (6 X number of household ranked first + 5X number of household ranked second+ 4X number of household ranked third + 3 X number of household ranked fourth + 2 X number of household ranked fifth +1 X number of household ranked sixth) given for an individual reason, criteria or preference divided by the sum of (6 X number of household ranked first + 5X number of household ranked second + 4 X number of household ranked third+ 3 X number of household ranked fourth + 2 X number of household ranked fifth +1 X number of household ranked sixth) for overall reasons or ranks. In addition, Chi-square test was employed to see associations /relations between the two groups (CBBP participants and non- participant households).

Chapter 4. RESULT AND DISCUSSION

4.1. Growth Performance of Progeny of Selected Rams under CBBP Rearing

The result from the study PAs showed that body weight improvement had been observed due to selective breeding in both birth and weaning weights respectively. Generation of selected rams, sex and location (PAs) affected growth performances of Highland sheep with statistically significant differences (table 9). Birth weight of progeny of selected rams was found significantly heavier than base flocks (2.39± 0.14kg vs. 2.02±0.21 kg; $p<0.01$). Similarly, weaning weight had shown highly significant variation between the two groups (8.98 ± 0.24 kg vs. 8.51± 0.38; $p<0.01$). However, this effect becomes insignificant at six month and yearly weights respectively ($p>0.05$).

Progenies born from second generation rams were also found significantly heavier than first generation born rams at birth (2.43 ± 0.11 kg vs. 2.31± 0.03 kg; $p<0.05$) and three month weights (9.39± 0.18 kg vs. 8.57± 0.06 kg; $p<0.05$) respectively .This variation might indicate that body weight improvements were accumulated due to effects of selection of rams in the two rounds .With regard to six month and yearly weights, birth data from progeny of second round selected rams was not available due to the fact that second round ram selection was facilitated recently in the study PAs.

Similarly, males born from selected rams were found to be significantly heavier than female counterparts at birth (2.47 ± 0.14 kg vs. 2.26± 0.07 kg; $p<0.01$) and three month weights (9.64 ± 0.03 kg vs. 8.31 ± 0.16 kg; $p<0.01$) respectively.

Statistically significant difference was also observed due to the effect of locations (PAs) (table 9). Progenies born in Gebrekidan were found superior than that of Golgolnealea and Habes. This difference might be due to variations in availability of feed and ewe management practice of farmers. The PA is known for its comparative better feed resources and huge sheep population in Atsbi Wenberta district.

Table 9. Growth performance of base flock and progenies of selected rams

Factors	BW		3MW		6MW		YW	
	N	LSM± SE	N	LSM± SE	N	LSM± SE	N	LSM± SE
Overall	872	**	679	**	563	NS	409	NS
BF	296	2.02±0.21[a]	241	8.51± 0.38[a]	323	13.01±0.04	281	18.74± 0.04
PSR	576	2.39± 0.14[b]	438	8.98 ± 0.24[b]	240	13.16± 0.11	228	18.80± 0.01
Generation	576	*		*		NS		NS
1st	436	2.31± 0.03 [a]	480	8.57± 0.06[a]	396	13.07 ± 0.11	103	19.10 ± 0.07
2nd	140	2.43 ± 0.11[b]	126	9.39± 0.18[b]	-	-	-	
Sex	526	* *	438	* *	140	NS	128	NS
Male	244	2.47 ± 0.14[a]	187	9.64 ± 0.03 [a]	51	13.17 ± 0.06	55	18.35± 0.02
Female	282	2.26± 0.07[b]	251	8.31 ± 0.16 [b]	89	13.25± 0.12	73	18.31± 0.04
PAs (location)	576	*	422	*	394	NS	357	NS
Habes	153	2.29±0.11 [a]	105	8.64±0.37[a]	96	13.05±0.03	69	18.20± 0.4
Golgolnealea	203	2.33±0.01[a]	134	8.79±0.12 [a]	110	13.09±0.08	93	18.21±0.08
Gebrekidan	220	2.46±0.03 [b]	183	9.41±0.19 [b]	188	13.13±0.01	115	18.28±0.01

BF=base flock; CBBP=Community-based breeding program; PAs= Peasant associations; PSR= progeny of selected rams; BW= body weight; 3MW= three month weight; 6MW= six months weight; YW= yearly weight; **= $P \leq 0.01$; * = $P \leq 0.05$; ns= non significance; LSM= least square means; SE= standard error

The current study also demonstrated that, in all of the fixed factors (parameters) considered, performance of the breed at six month and yearly weights did not show significant variation between the two groups (table 9). This might be impacted due to gaps in taking timely body weight records from enumerators. This finding needs a closer investigation and further study.

The current result is in consistency with finding of Zelalem Gutu *et al*. (2015), who reported similar improvements under Bonga, Menz and Horro CBBP intervention sites in Ethiopia. Similarly, Solomon Gizaw *et al*. (2014) reported that appreciable genetic gain was achieved in Menz breeding intervention. He further reported that the growing interest to be member of the breeding program and demand for breeding rams might suggest tangible improvements made by the CBBPs. Unlike the current study result, analysis of biological data in Menz, Horro and Bonga revealed that good progress was achieved in performance at six month of age (Tadelle Mirkana *et al*., 2012; Zelalem Gutu *et al*., 2015). Body improvements can help to improve livelihood of farmers. According to Belay Deribe and Mengistie Taye (2013), growth is the most important trait in sheep production affecting the contribution of the sector to the farm household through live animal sale and meat production. Moreover, Mengistie Taye *et al*. (2009) stated that improvement in weaning weight is a trait of great economic importance in meat sheep production since it has influence on growth rate. The current level of on-farm productivity of indigenous breeds through selective breeding is a sustainable option to improve genetic merit of sheep (ESGPIP, 2009).

4.2. Effect of Fixed Factors on Growth Performance of Highland Sheep

The overall least squares mean birth, three month, six month and yearling weights of Highland sheep were 2.24, 8.73, 13.65 and 18.46 kg respectively (table10). In the current study, type of management, parity, sex of lambs, birth type, birth season and year were found as significant sources of variation for both birth and three month weights respectively. However, six month and yearling weights were significantly affected by sex of lambs and season of birth only at $p<0.05$ (table 10).

Under this investigation, lambs managed in CBBP participant households were found significantly heavier at birth (2.38 ±0.28 kg vs. 2.10±0.11 kg; $p<0.05$) and three month (8.94±0.73 kg vs.8.52±0.15 kg; $p<0.05$) than lambs managed under non-CBBP participant households. The variation might be an indication that lambs in CBBP had better management at early ages. The current result is in agreement with research finding of Zelalem Gutu et al. (2015), who reported similar improvement under Bonga CBBP. Similarly, the current result also coincides with the finding of Solomon Gizaw et al. (2014), who reported improvement in Menz breed under similar management.

Similarly, both weights from high parity dams were heavier ($p<0.05$) than their lower parity dam born lambs. This finding is in line with Mengistie Taye *et al.* (2010), who reported sustained increase in weights with dam age up to 6 years. This is due to favorable uterine environment provided by the older ewes (Markos Tibbo, 2006; Solomon Abegaz, 2007).

However, sex of lambs exerted statistically significant variation for birth weight only (2.44 ± 0.11 vs. 2.25±0.13 kg; $p<0.05$). The male Highland sheep over weighed their female counterpart indicating that the males have relatively large physical features and this is consistent with numerous earlier reports. However, in the current study, six month and yearly weights were not significantly influenced due to sex of offspring. The current result was inconsistent with finding of Mengistie Taye *et al.* (2009), who reported sex of lambs affected significantly all body weights including both weights at ($P< 0.001$).

On the other hand, type of birth of ewes had significant ($p<0.01$) effect on lambs weight at birth (2.41±0.26 vs. 2.10 ± 0.09 kg) and three months (10.01±0.13 vs. 8.84±0.45 kg), where single born lambs were heavier than twin born ones .This difference could be attributed to the fact that singles are the sole users of the milk from their dam (Markos Tibbo, 2006). Similarly, Benyi *et al.* (2009) reported superiority in weight of the single-born lambs increased only up to weaning and then declined such that twins had similar growth rate as singles. This current result is also in agreement with literature of *(*Mengistie Taye *et al.*, 2010*).*

The current study result also showed that season of birth highly impacted lamb birth weight at ($p<0.001$). Lambs born in the end of wet season were found heavier than those born in dry season (2.49 ±0.25 vs. 2.17±0.18) (figure 7).This might be due to variations in seasonal feed availability. Generally lambs born at the late rainy season had the advantage of season in which they got better feed that might help them to reach puberty at earlier age. Effect of season on lamb growth in Ethiopian condition is indicated in various findings (Mengestie Taye *et al*., 2010; Birhanu and Aynalem, 2011).

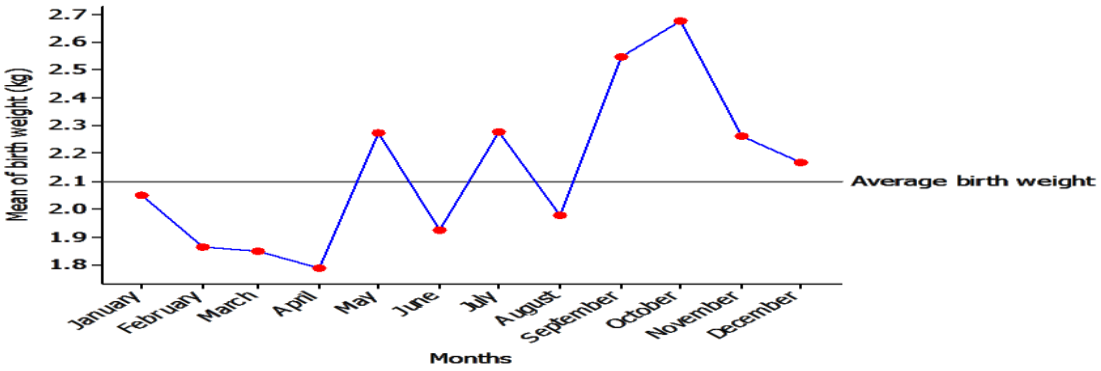

Figure 7. Observed variations in lamb birth weights across months

Birth year was a significant ($p<0.01$) source of variation for both weights. There was a decreasing trend in birth weight from year 2015 to 2017; lambs born in 2015 were heavier than the following years (2.54±0.11, 2.31±0.83 and 2.22±0.42 kgs respectively). The significant effect of year on birth weight indicates variation in feed available due to fluctuation of distribution of rainfall and a trend in decreasing pasture lands in study PAs. The significant effect of year on birth weight was reported (Mengistie Taye *et al., 2009*).

Generally finding of this study was also consistent with report of Solomon Gizaw *et al.* (2011), who indicated that growth performance of sheep is influenced by age of the dam, pre-mating weight of the dam, type of birth, sex, breed and season of birth. Birth and weaning weighs obtained in this study (CBBP management) was comparable to reports of Markos Tibbo (2006) for Menz (2.06 and 8.64 kg) and for Horro breeds (2.40 and 9.48 kg), but lower than reports of Belete Shenkutie (2009) for Bonga breed (2.86 and 11.60 kg) and Getahun Legesse (2008) for Arsi Bale breeds (2.86 and 12.23 kg) respectively.

Table 10. Least square means and standard error of Highland sheep for growth traits

Factors	B W		3MW		6MW		12MW	
	N	LSM ± SE	N	LSM± SE	N	LSM± SE	N	LSM± SE
Overall	892	2.24 ±0.17	817	8.73 ±0.03	751	13.65 ±0.11	564	18.46± 0.26
Management		*		*		NS		NS
CBBP	774	2.38 ±0.28[a]	538	8.94±0.73a	510	13.76±0.41	313	18.91 ± 0.67
Non-CBBP	118	2.10±0.11[b]	279	8.52±0.15[b]	241	13.53±0.17	238	18.57±0.21
Sex		*		NS		NS		NS
Male	361	2.44 ± 0.11[a]	236	9.15±0.03	232	13.59 ±0.22	176	18.11±0.03
Female	413	2.25±0.13[b]	302	9.07±0.07	278	13.31±0.17	388	18.96±0.07
Birth type		**		**		NS		NS
Single	696	2.41±0.26[a]	483	10.01±0.13	478	13.06±0.22	537	18.19±0.55
Twin	78	2.10 ± 0.09[b]	55	8.84±0.45	32	12.97±0.61	27	18.06±0.14
Birth season		***		***		*		*
Dry	415	2.17±0.18[a]	215	8.36±0.22[a]	198	13.12±0.43[a]	374	18.01± 0.05[a]
Wet	359	2.49±0.25[b]	323	9.07±0.73[b]	312	13.59±0.57[b]	190	18 .43±0.08[b]
Birth year		**		**		*		*
2015/2016	191	2.54±0.11[a]	169	9.06±0.53[a]	151	13.59±0.19[a]	161	19.06± 0.01[a]
2016/2017	329	2.31±0.83[b]	237	8.61±0.18[b]	211	13.30±0.37[b]	265	18.44±0.05[b]
2017/2018	254	2.22±0.42[b]	132	8.02±0.29[b]	146	13.22±0.14[b]	138	18.07±0.11[b]

Parity		*		*		*		NS
1	167	2.09±0.43 [a]	113	8.19±0.56 [a]	109	12.67±0.41 [a]	84	18.15±0.10
2	205	2.21±0.03 [ab]	137	8.51±0.11 [ab]	131	12.91±0.34 [ab]	99	18.19±0.04
3	171	2.37±0.21 [b]	134	8.94±0.63 [b]	128	13.22±0.17 [b]	61	18.22±0.01
4	103	2.49±0.17 [b]	88	9.20±0.25 [b]	84	13.36±0.01 [b]	57	18.26±0.07
>5	98	2.48 ±0.31 [b]	66	8.81±0.64 [b]	58	13.18±0.03 [b]	32	18.24±0.22
PAs (location)		*		*		NS		NS
Habes	248	2.26±0.04[a]	179	8.39±0.12[a]	173	12.98±0.04	108	18.45 ± 0.06
Golgolnealea	185	2.29±0.07 [b]	106	8.44±0.03[a]	98	13.02±0.11	52	18.49±0.09
Gebrekidan	341	2.48±0.01[a]	253	9.11±0.14[b]	239	13.11±0.53	153	18.53±0.13

BW= birth weight; 3MW= three month weight; 6MW= six months weight; 12MW= yearly weight; *** = P≤ 0.001; **= P ≤ 0.01; * = P ≤ 0.05; ns= non significance; LSM= least square means; SE= standard error; CBBP=community based breeding program PAs= peasant association

4.3. Reproductive Performance of Highland Sheep

The overall least square means reproductive performance of Highland sheep in terms of age at first lambing; lambing interval and liter size are presented in (table 11). Type of birth of ewes, parity and season of birth significantly affected AFL, LI and LS respectively. However, type of management was not found as significant source of variation for the reproductive parameters considered p>0.05.

Table 11. Reproductive performance of Highland sheep

Fixed effects	AFL (days)		LI (days)		LS	
	N	LSM±SE	N	LSM±SE	N	LSM±SE
Overall	464	494± 37. 31	381	266.7±11.07	461	1.12 ±0.15
Management		NS		NS		NS
CBBP	361	491.15 ± 44.84	289	254.33±16.74	359	1.16±0.22
Non-CBBP	103	497.04±49.06	92	258.99 ±9.17	102	1.07±0.99
Parity of dam		*		*		*
1	69	499.79 ± 40.31 [a]	58	271.35±12.79 [a]	69	1.01 ±0.02 [a]
2	94	493.65±37.19 [a]	72	266.04 ±10.08 [a]	84	1.05±0.00 [a]
3	101	486.21 ±35.76 [b]	66	258.93± 9.77 [b]	91	1.13±0.04 [ab]
4	53	483.10 ± 37.41 [b]	51	240.22 ±8.91 [c]	62	1.24±0.12 [b]
>5	44	475. 42±38.64 [c]	42	244.81±11.34 [c]	53	1.21±0.07 [b]
Season of birth		*		*		*
Dry	210	493.42±36.77 [a]	177	276.06±18.61 [a]	224	1.06±0.03 [a]
Wet	151	479.11 ±33.08[b]	112	251.55± 13.40 [b]	135	1.21±0.01 [b]
Birth type		NS		NS		*
Single	305	490.72± 39.22	257	253.41 ±10.19	312	1.28±0.09 [a]
Twin	56	492.15 ±40.14	32	257.08± 12.83	47	1.07±0.04 [b]

AFL= Age at First lambing, LI= Lambing interval, LS= Liter Size; * = P <0.05; ns= non significance; LSM= least square means; SE= standard error

4.3.1. Age at first lambing (AFL)

Least square means of age at first Lambing for Highland sheep was 494± 37. 31days (table 11). Type of birth of ewes, parity and season significantly influenced the parameter. However, type of management was not significant source of variation (P >0.05). Even though not statistically significant, ewes under CBBP management were lambed at earlier age than non-CBBP (491.15 ± 44.84 vs. 497.04±49.06 days).

In both managements ewes born at wet season had shorter age at first lambing than of these born at dry season (479.11 ±33.08 vs. 493.42±36.77 days) (table 11). In the study PAs, most of lambing occurred at the end of wet season followed by long dry season with scarce feeds. The current result is in line with finding of (Mengistie Taye *et al*. (2009), who found age at first lambing was significantly impacted by the season and birth type of ewes. He further explained that poor nutrition retarded the growth of ewes therefore, it prolonged the age at first lambing. According to Mourad *et al.* (2016), age at first lambing influences both productive and reproductive life of the ewes.

In comparison to other sheep breeds in Ethiopia, Highland sheep ewes performed a longer age at first lambing; this might be linked with growth performance of the breed. The current finding is comparable with previous works done on other breeds in different parts of Ethiopia and the majority of the studies reported within the range of 411- 475 days (Mourad *et al.,* 2016). Ewes under village management conditions in southwestern Ethiopia, demonstrated a mean age of 404 days at first lambing (Belay Deribe and Aynalem Haile, 2009). Solomon Abegaz (2011) reported age at first lambing of Gumuz sheep 410 days. Age at first lambing for Arsi-Bale sheep breed was reported within the range of 354-510 days (Getahun Legesse, 2008). According to Fourie et al. (2009*)*, Dorper ewes in South Africa had age at first lambing at 346 days.

4.3.2. Lambing interval (LI)

In the current study, lambing interval showed highly significant variation due to the effects of parity and lambing season. The younger ewes with parity one were performed significantly ($p<0.05$) extended interval than parity two, three, four and five respectively. This might be attributed to the fact that they are still on their stage of growth. The

scientific explanation is reproductive physiology of ewe is developing to be prolific as age and parity increased (Mourad *et al.*, 2016). However, this was not in agreement with report of Mengiste Taye (2008), who stated that as parity increases the lambing interval decreases.

Lambing interval was also affected by lambing season. Lambs growing at wet season had shorter LI compared to dry season (251.55± 13.40 vs. 276.06±18.61 days; $p < 0.05$). The result agrees with reports of Mengiste Taye (2008) and Mourad *et al. (*2016), who pointed out that lambing interval is influenced by several factors, such as previous litter size, parity, and lambing season. However; findings of the current study results revealed that there was no significant ($P > 0.05$) variation for the trait between the ewes reared in the two managements (CBBP and non-CBBP). This might be due to short life span of the CBBP intervention (i.e. 3 years).

Generally, the current study demonstrated that the breed can produce three lambing in two years under both managements (CBBP and non-CBBP). According to Girma Abebe (2008), at least three times lambing is expected per two years under normal circumstances. Yadeta Neme *et al.* (2016) reported lambing interval determines reproductive efficiency in sheep production. Similarly, Belay Deribe (2009) concluded that ewes with long lambing interval had lower reproductive efficiency. The figures reported in the current study were found comparable to reports of Solomon Gizaw (2008) for Afar breed (315 days) and 199.2 days for Gumz breed (Solomon Abegaz, 2007) respectively. According to Budai *et al.* (2013), lambing interval for Dorper sheep breed was reported 240 days.

4.3.3. Liter size (LS)

The overall least square means of liter size obtained in the current study was 1.12 ±0.15. Parity of ewes and birth season significant influenced liter size of Highland sheep (table 11). The current result indicated that liter size was increased as parity advanced. Ewes with parity five and four had higher litter size than parity three and the lower parties ($p < 0.05$). In conjunction with the current result, Mengistie Taye *et al.* (2010) explained that liter size increase with parity due to the fact that ewes physiologically mature with age.

Similarly, season of birth affected liter size significantly ($p<0.05$). Lambs born at the end of wet season were found heavier than dry season born ones (table 11). This agrees with earlier findings (Mengistie Taye *et al*. 2009; Mourad *et al.,* 2016).

The current study result showed that type of management was not found as major source of variation for litter size ($p>0.05$). The finding is not in line with report of (Shigdaf Mekuriaw *et al.,* 2013), who indicated performances were found significantly higher under farm management in comparison to on-station for Washera sheep. Similarly, Ermias Belete (2014) reported variations due to management for Dorper crossed sheep in Siltie and Wolaita Zones. However, the current result is in line with report of Getachew Legesse *et al*.(2014), who indicated that Highland sheep is not as such prolific, single birth is the main feature and in rare cases it delivers twins.

The average litter size obtained in the present study was comparable to the figure reported for most indigenous breeds. Liter size of Ethiopian sheep breeds like Menz, Afar and Washira was reported low which is almost close to one lamb per lambing (Mengiste Taye, 2008; Solomon Gizaw *et al.,* 2010; Tadele Mirkena, 2010; Tesfaye Getachew *et al.,* 2010). According to Zewdu Edea *et al.* (2012), litter size of 1.40 and 1.36 were obtained for Horro and Bonga sheep breeds and the two breeds showed relatively better multiple births under the existing feed shortages.

4.4. Respondents' Characteristics

4.4.1. Family size, land holding and age composition of respondents

Finding of the survey indicated that both CBBP- participants and non- participants had nearly equal mean family sizes. The average family size for CBBP- participants was 6.04 while for non participants 6.7 respectively (table 12). An independent sample t-test showed that the mean difference in family sizes of both groups were not significant ($t=0.243$). The survey result also showed that participant farmers had an average land holding 0.5ha while non-participants had land holding 0.35ha respectively (table 12).
An independent sample t- test conducted showed that there was no significant difference in the average land holding size of the two categories ($t=0.641$, $P<5\%$).

The overall age of the sample household heads was 44.46 years. Participant farmers had an average age of 43.22 years, while non-participants had an average age of 45.7years (table 12). An independent-sample t-test was conducted to test if there was significant difference in the mean age of participants and non-participants. The t-value (t=-1.144) indicated that there was no significant difference between the mean age of the two groups.

Table 12. Family size, land holding and age composition of respondent farmers

Descriptor	CBBP participants (N=90)	non- participants (N=105)	Overall (N=195)	t-value
	Mean (SD)	Mean (SD)	Mean (SD)	
Family size of HH	6.7 (2.03)	6.0 4 (1.92)	6.39 (1.08)	0.243(NS)
Land holding (ha)	0.43 (0.38)	0.5(0.13)	0.43(0.03)	0.641(NS)
Age composition	45.7(12.83)	43.22(11.90)	44.46(9.32)	1.144*

SD= Standard deviation, NS=non-significant, * represents level of significance at 5%

4.4.2. Sex composition, marital status and educational level of respondents

The overall female composition in the whole sample was 14.45% of which 8.9% for non-participants and 20% for participants respectively (table 13). The Chi-square test showed significant difference between male and female households ($x^{2=}$1.144).

Table 13. Sex composition, marital status and educational level of respondent farmers

Descriptor	CBBP participants (%)	non- participants (%)	Overall (%)	X^2-value
Sex composition				4.42**
Male	91.1	80	85.55	
Female	8.9	20	14.55	
Marital status				0.054(NS)
Married	94	95	94.5	
Single	1.4	0.9	1.15	
Divorced	1.2	1.1	1.15	

Widow	3.4	3.0	3.2	
Educational level				2.061*
Illiterate	55.3	51.6	53.45	
Literate	44.7	48.4	46.4	

NS=non-significant, * represents level of significance at 5%

Among the respondents 94.5 % were married while 1.15% single, 1.15% divorced and 3.2% widowed respectively. The chi-square test made with regard to marital status of households showed that there was no significant difference between the participants and non participants ($X^{2=}0.054$).

Regarding level of education, from the 105 CBBP non- participants, (55.3%) were found illiterate and out of the 90 CBBP participants only (51.6%) of them were illiterate. The chi-square test made with regard to education shows that there was significant difference between the participants and non participants with t = 2.061 at less than 5% probability level in educational status (table 13).

4.5. Sheep Production System of Study PAs

Sheep production system of the study PAs including livestock holding, sheep flock structure, purpose of sheep production, mating practices & seasonality of lambing, feed & water sources, housing and marketing discussed in the next sections .

4.5.1. Livestock holding

In all the study PAs average number of all livestock species in CBBP-participants and non-participant households did not show significant ($p>0.05$) differences except sheep number (Table 14).

Table 14. Livestock holding per household in the study PAs

Type of livestock	CBBP-participants	Non- participants	Overall	P-value
	N (mean ±SD)	N (mean ±SD)	N (mean ±SD)	
Cattle	4.14 (0.29)	5.03(0.46)	4.57	0.007
Sheep	20.3(0.77) [a]	15.1(0.34) [b]	17.7	0.002
Goat	2.50 (0.31)	2.79 (0.37)	2.65	0.083
Equines	2.87(0.54)	2.43(0.33)	2.15	0.051
Poultry	10.36 (0.28)	11.74(0.24)	11.05	0.076
Honey bee	3.12 (0.15)	4.05 (0.18)	3.59	0.089

Sheep production was the dominant livestock production system in the study PAs .The current survey result indicated that sheep were the most predominant and important species of livestock owned, followed by poultry, cattle, apiculture, equines and goats respectively. On average, a household owned 4.57 cattle, 17.7 sheep, 3.15 goats and 11.05 chickens respectively. This agrees with report of Solomon Gizaw *et al.* (2014), who reported sheep production has always been an integral part of the traditional subsistence mixed crop-livestock production system in Ethiopia.

The variation in sheep flock size between the two groups (CBBP participants and non-participants) could likely be attributed to the fact that the initial flock size required to be a member of the CBBP intervention (associations at the beginning) was at least five animals. Therefore, the larger flock size owned by CBBP participants could be due to various factors suggesting cautious interpretation of results.

The same result reported by Zelalem Gutu *et al.* (2105) for Horro, Bonga and menz CBBPs. He pointed out that such variations could be occurred due to shortage of breeding rams had been solved by the CBBP. In addition, better sheep husbandry practices in CBBP flocks were achieved due to training and continuous follow-up from implementers could also have impacted the flock size.

The average flock size of sheep found in the current study concur with report of Getachew Legesse *et al.* (2014) , who pointed out that households in Atsbi Wenberta district had an average 20 sheep which ranges from 15 up to 25 . Finding of this study also agree with reports of Birhanu Gebremedhin *et al.* (2007), who mentioned Atsbi Wenberta district as a highly potential area for sheep production. The current figure was higher than an average 7.98 ownership reported by Mengistie Taye *et al.* (2010) in western highlands of Ethiopia and an average flock size of 5.0 sheep of Alaba district Tsedeke Kochu, (2007) and Zewdu Edea *et al.* (2012) flock size of 11.3 for Bonga, but lower than reported by Tesfaye Getachew, (2009) for both Afar (23.0) and Menz (31.5) breeds, respectively.

4.5.2 Sheep flock structure

From (table 15) we can learn that sheep flock of CBBP- participant farmers had 16.8 % male lambs less than six months, 18.9 % female lambs less than six months, 10.3% males between six month to one year, 11.8 % females between six month to one year, 7.6 % males greater than one year (intact), 27.2 % females greater than one year and 2.5% castrated. The corresponding values for sheep flock of non-participants farmers were 17.6 %, 21.1 %, 9.6 %, 10.3 %, 9.6 %, 27.9 % and 0.2 % respectively (table 15).

Table 15. Number and Mean ($_{\pm}$SD) of each sheep classes per study PAs

Sheep classes by age and sexes	CBBP participant			non-participant			Overall		
	N	%	(mean $_{\pm SD}$)	N	%	(mean $_{\pm SD}$)	N	%	(mean $_{\pm SD}$)
Male lambs < 6 months	274	16.8	5.5(7.46)	196	17.6	4.4(5.33)	470	17.1	4.96(6.11)
Female lambs <6 months	309	18.9	5.1(9.19)	236	21.1	4.1(5.17)	545	19.9	4.6(7.19)
Male 6 month to 1year	168	10.3	3.1(7.32)	107	9.6	3.1(5.79)	275	10.1	3.1(5.12)
Female 6 month to 1 year	192	11.8	4.1(10.06)	115	10.3	3.4(8.84)	153	5.6	3.76(8.89)

Male > 1 year (intact)	123	7.6	2.6(1.90)	107	9.6	2.1(1.93)	115	2.35	2.32(1.51)
Female > 1 year	443	27.2	7.6(11.37)	312	27.9	5.6(9.85)	377	13.7	6.61(9.28)
Castrate	41	2.5	0.3(1.43)	43	3.9	0.2(1.13)	42	1.5	0.27(1.01)
Total	1630			1116			2746		

The overall percentage of male to female in both groups at the age of less than six months was found proportional (17.1 vs. 19.9). However, above six months female proportions were high especially at age of greater than one year (4.2 vs. 13.7). This is because of male sheep greater than one year is frequently sold whenever cash is needed in the household. Farmers in study PAs do not keep many aged ram in their flock, while they tend to keep aged ewe in their flock for breeding purpose. According to Getachew Legesse *et al.* (2014), farmers in Atsbi Wenberta keep rams for breeding purpose in their early age (1- 2 years) and sell when beyond two years age. For this reason it was difficult to get male sheep in the late age groups under the field conditions. Marketing young ram lambs because of the greater dependence on sheep production was reported in Ethiopia (Solomon Gizaw *et al.,* 2013).In both groups the number of rams (intact matured male sheep) kept per flock on average were very small. The maximum number of rams in a flock ranges from 0.81 to 3.83 with an overall average of 2.32.

The higher proportion of breeding ewe in the flock was in agreement with findings of (Zewdu Edea *et al.,* 2012; Mengistie Taye *et al., 2010*). A study result in north western lowland of Amhara region indicated that out of the total sampled Gumuz sheep under farmers management condition, about 42.58% were adult females, while the proportion of rams in a flock was only 5.8 % (Solomon Abegaz, 2007). According to CSA (2015), about 72.91 percent of the entire sheep populations in Ethiopia were females, and 27.09 percent were males.

4.5. 3. Purpose of sheep production

The primary reason of sheep keeping by the respondents was for source of income generation through the sale of live animals with an index value of 0.29. The second main reason was for meat production for slaughter with an index value of 0.23 and the keeping

of sheep production as means of saving, manure , milk production and prestige were ranked as third, fourth ,fifth and sixth with index values of 0.17, 0.14, 0.0.10 and 0.07 respectively(table 16). Finding of the current study concur with report of Birhanu Gebremedhin *et al*. (2007), who stated that Sheep production is an important source of cash income for smallholder farmers in Atsbi Wenberta district

About 92.4 percent of respondents reported they slaughter sheep for household consumption only on festival days. Easter, New Year and Christmas were the main occasions on which farmers slaughter sheep. Based on the survey result, male sheep at young age (from 6 to 12 months of age) were mostly slaughtered for home consumption. Respondents also reported that they get an average of 0.5 liter of milk from one sheep per day. They get comparatively higher milk during the high feed supply seasons of the year. According to the information obtained from farmers, milk from sheep is important for children and a person who has heart related diseases or complications.

Table 16. Purpose of sheep keeping ranked by the owner of sheep

Purpose	1st	2nd	3rd	4th	5th	Index	Rank
Source of income	104	8	3	1	0	0.29	1
Meat/slaughter	39	50	5	13	3	0.23	2
Saving	10	17	20	34	2	0.17	3
Manure	0	33	21	18	11	0.14	4
Milk	3	7	11	21	19	0. 10	5
Prestige (Social value)	0	3	2	5	8	0.07	6

Index= (6 for rank 1) + (5 for rank 2) + (4 for rank 3) + (3 for rank 4) + (2 for rank 5) + (1 for rank 6) divided by the sum of all weighed mentioned by the respondent

Generally the current result is consistent with reports of (Markos Tibbo, 2006; Tsedeke Kochu, 2007; Adane Herpa, 2008; Getahun Legesse, 2008; Zewdu Edea, 2008; Belete Shunkite, 2009; Shigdaf Mekuriaw *et al.*, 2013*;* Yenesew Abebe *et al.*, 2013 and Getachew Legesse *et al.*, 2014).

4.5. 4. Mating practices and seasonality of parturition /lambing/

Breeding and management techniques practices were reported traditional. Births were distributed throughout the year with peak lambing season occurring in December-January, and the highest number of lambs born in Gebrekidan and Habes PAs (Figure 8 and 9).The respondents (71.4%) revealed that mating occurs all year round usually in the field while grazing. Uncontrolled mating was reported as a common feature of sheep production system of the study PAs, especially for non-CBBP participant farmers. Few respondents replied they exercise controlled mating for their sheep. The finding is inline with that of Getachew Legesse *et al.* (2014), who reported uncontrolled breeding was a management tradition in AtsbiWenberta district with the hope to have and lambing distributed throughout the year in order to obtain year round output and reduce risk.

The survey result also discovered that circulation of rams was significantly used between the respondents. About 47.5% non- CBBP participant farmers reported they did not have breeding males of their own and they use their neighbors' breeding males for breeding purposes including rams from CBBP participants. In addition, most of the farmers use home grown males for breeding purposes. Promising rams and ewes were reported sold to the market because they fetch better price. The finding was in line with report of Birhanu Gibremedhin *et al.* (2007), who pointed out that due to sell of best rams the economic return fetched from the sector had remained minimal.

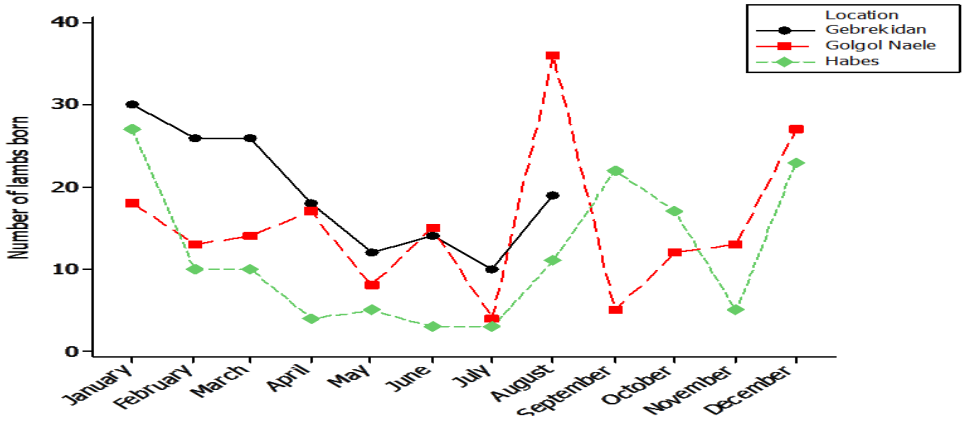

Figure 8. Seasonal pattern of birth by PA

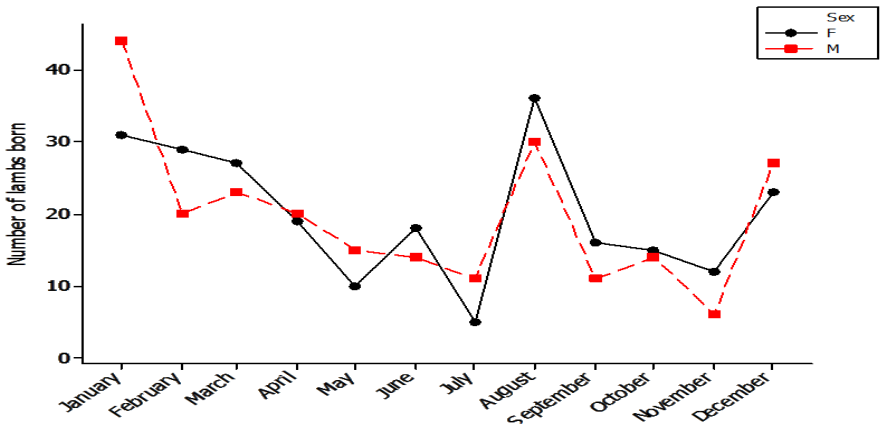

Figure 9. Seasonal pattern of birth by sex

4. 5. 5. Feed and water sources

The current survey result indicated that the main feed resources for sheep in the study PAs were natural pasture (100%), crop residue (80%), crop aftermath (38%), hay (15%), non conventional feeds (5.6%) and improved forage (3.5%) respectively (table 17). Sheep in the area were reported under nutritional stress throughout the year .The major supplementary feeds were hay, pulse crop residue, cereal crop residue, local brewery by-products, potato and some grains. Pasture lands, which were reported as usually communally owned, play the most significant role as being the major source of feed in both rain and dry seasons. They utilized as green feed in the form of cut and carry system. In the study PAs, most of the grazing fields were reported enclosed to encourage the rehabilitation of natural vegetation. Farmers collect grasses grown in the pasture lands and feed them to tethered animals around the homestead.

Crop residues of wheat, teff, barley and other cereals as well as crop aftermath were reported as significant contributors in supporting the animals. Even though not significant, improved forages legumes and trees such as cowpea, pigeon pea, lablab, alphalpha, lucenia& Susbania were introduced in the area some model farmers cultivate in their backyards and irrigated lands.

A few respondents reported supplementation especially during dry season. They pointed out that feed availability and abundance vary with rainfall patterns. Comparatively huge amount of feed resources were reported available in rain season whereas shortage occur during the prolonged dry season.

Table 17. Reported feed resources in the study PAs

Feed resources	N	%
Natural pasture	195	100
Crop residues	156	80
Crop aftermath	74	38
Hay	29	15
Non conventional	11	5.6
Improved forages	7	3.5

N= Number of farmers; PAs= peasant associations

Respondents reported main water sources were rivers and wells and watering frequency was mostly once a day in the wet season and twice a day in the dry season. Water shortage was not reported as a problem in the current study. Unlike the current finding, water shortage was reported as a challenge in mid altitudes of eastern, north-eastern and south-eastern part of the country (Belete Shenkutie, 2009). Long distance travel of sheep in searching of water was another problem reported (Mesay Yami *et al.,* 2013). Generally findings of the study agree with reports (Getahun Legesse, 2008; Mengistie Taye, 2008; Belete Shenkutie, 2009; Tesfaye Getachew 2009; Yenesew Abebe *et.al.,* 2013; Getachew Legesse *et al.,* 2014).

4.5. 6. Housing

In study PAs, two type of housing were reported. The first one is mostly used to confine sheep during rainy season known as 'Gebela' or"Afgebella" in Tigrigna (figure 10). It is three or two-side wall constructed from local materials such as stone or wood and partially roofed .Farmers with this sort of housing keep all types of animals. The second and most commonly used pen constructed was open ended with/with out roof which is

usually used to confine sheep during dry season and it is locally called “Dembe” or “Merebeae” (figure 11). 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 Taye, 2008; Tesfaye Getachew, 2008; Belete Shenkute *et al.,* 2010)

Figure 10. Gebela or Afgebella

Figure 11. Dembe or Merebeae

4.5.7. Marketing

In the study PAs, sheep were reported more often sold to earn income for regular expenses throughout the year and peaks during religious festivals. There were also specific months in which most of the farmers sell their animals. September, December and April were months of the year which supplied higher number of sheep from the study PAs. The types of sheep farmers sell include young male, old ewe, young female and castrated male. From these, respondents pointed out that they commonly sell young male sheep and old ewe in most of the cases. This is due to the reason that young male sheep could be sold at higher price and old ewe sheep should be replaced by young breeding stock. Respondents indicated that around 40% of the sheep farmers supplies to market were young male sheep and about 30% were old ewe. Mostly young ewes were used as replacement stock and usually maintained on the farm (Figure 12). Generally the current result agrees with findings of (Mengistie Taye *et al.,* 2010; Tsedeke Kochu *et al.,* 2011*;* Getachew Legesse *et al.,* 2014).

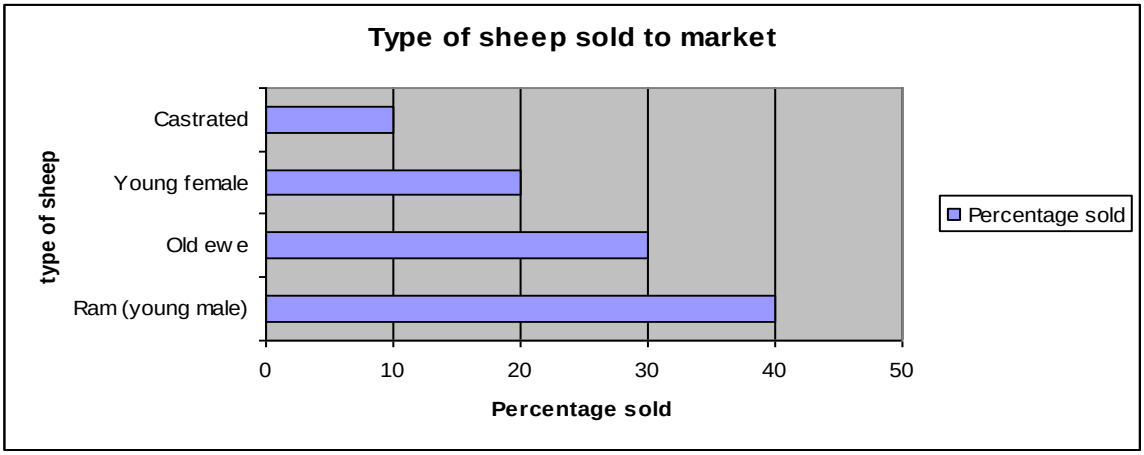

Figure 12. Type and percentage of sheep sold to market

4.6. Opportunities to Sheep Production in the Study PAs

Mutton taste of HS , Abergelle abattoir , high consumers demand, proximity to Mekelle, and gender participation were among the reported sheep production opportunities in the study PAs with index values of 0.30,0.26,0.19,0.16 and 0.09 respectively (table 18).

Table 18. Major opportunities to sheep production as identified by respondents

Opportunities	1st	2nd	3rd	4th	5th	index	rank
Mutton taste of HS	41	21	15	3	0	0.30	1
Abergelle abattoir	26	31	13	4	1	0.26	2
High consumers demand	17	6	24	10	9	0.19	3
Proximity to Mekelle (Regional capital)	8	1	17	12	2	0.16	4
Gender participation	3	1	0	1	7	0.09	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 respondents, HS= Highland Sheep

Respondents pointed out that Highland sheep is famous for its mutton taste and demand for its product is high in the market. Medium body size, promising body framework with wider loin area enabled the breed to be preferred by consumers. This agrees with finding of (Getachew Legesse *et al.,* 2014).

Presence of Abergelle international export abattoir in regional capital, Mekelle was mentioned as another sheep production opportunity. The study PAs are located at distance of 65 Km from Mekelle and their vicinity to the regional capital was mentioned as comparatively advantageous. This concurs with report of Birhanu Gebremedhin *et al.* (2007) that Atsbi Wenberta ditrict is an important supplier of Highland sheep especially to the regional capital town of Mekelle particularly during festive periods. Despite this opportunity, production was reported yet very traditional and lack to meet the standards of both local and export markets.

The increasing human population was also pointed out as opportunity that brings about the increase demand for sheep products in the study PAs. Last but not least, sheep production was reported as a means of survival particularly for the landless youth and female-headed households. This agrees with report of Zewdu Edea *et al.* (2012) in western and south-western Ethiopia, gender participation was indicated as opportunity to sheep production. Generally finding of the current study is in agreement with reports of (Tsedeke Kocho, 2007; Alemu Yami and Merkel, 2008; Sisay Lemma, 2010; Ameha Sebsibe *et al.,* 2011).

4.7. Major Constraints to Sheep Production in the Study PAs

Reported major constraints to sheep production in the study PAs were feed shortage, health constraints, high sheep mortality rate, inadequate extension support and poor marketing linkages with respective index values of 0.33, 0.29, 0.19, 0.13 and 0.06 (table 19).

Table 19. Major Constraints to sheep production as identified by respondents

Constraints	1st	2nd	3rd	4th	5th	index	rank
Feed constraints	84	77	13	3	10	0.33	1
Disease and sheep mortality	67	55	29	12	15	0.29	2
Inadequate veterinary and extension support	27	24	54	28	2	0.19	3
Breeding constraints	3	17	32	51	22	0.13	4
Poor marketing linkage	2	8	7	25	23	0.06	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

Detail discussion of each constraint given below. Generally finding of the study agrees with report of Solomon Gizaw *et al*. (2014) , who stated that sheep production in Ethiopia is constrained by inadequate feeds (quality and quantity), animal diseases, inferior genotype, market system and infrastructure. In addition, the current result concurs with findings of (Markos Tibbo, 2006; Adane Herpa and Girma Abebe, 2008*;* Solomon Gizaw *et al.,* 2008; FAOSTAT, 2010; Tadelle Mirkana, 2012 ; Getachew Legesse *et al.,* 2014*;*Addis Getu *et al.,* 2015).

4.7.1. Feed constraints

Feed shortage both in terms of quality and quantity was reported as major problem hindering the productivity of sheep in the study PAs. Nowadays; the problem was mentioned as more aggravated due to the erratic and unreliable nature of rainfall. Pasture land was reported reducing from time to time. According to Zelalem Tesfay *et al.* (2012), currently most of the available pasture lands of Tigray are either totally changed to bare lands or highly overgrazed. According to the respondents, the feed shortage also appears even in the rainy seasons since more of the lands are occupied by crops. Even the available feed was reported poor in nutritive content and digestibility as well as unpalatable during major portion of the year. According to Azage Tegne *et al*. (2010), poor nutrition leads to slow growth rate in growing animals and low production and reproduction performance .It also leads to delayed age of onset of puberty, long parturition intervals low conception rates and low over all reproductive performance (Mourad *et al.,* 2016). Lack of adequate feed resources as the main constraint to animal production was more pronounced in the mixed crop-livestock systems, where most of the cultivated areas and high human population are located (Getahun Legesse, 2008; Mesay Yami *et al.* 2013; Yenesew Abebe *et al.*, 2013).

4.7.2. Disease constraints

Major diseases reported were Ceonurosis (Azurit), Kurdid (external parasites), Mieta (pastorolosis), Wekei (blackleg) and Hasakut (internal parasites) as the farmers pointed

out with index values 0.24, 0.22, 0.21, 0.19 and 0.13 respectively (table 20). Prevalence of diseases and parasites were mentioned as one of the most important constraints that caused high mortality and morbidity of sheep in study PAs. More specifically, respondents emphasized that Coenurosis locally known as 'Azurit/Zarti' was the major disease which caused them to lose large number of flocks and stressed the need for urgent interventions. Other reported important health constraints were external parasites, Pasteurellosis, Internal parasites and Blacklag in their order of importance respectively.

Table 20. Disease and parasites that affect sheep production as ranked by the respondents

Disease name								
Local name	Common name	1st	2nd	3rd	4th	5th	Index	Rank
Azurit/Zarti	Coenurosis	35	58	55	23	0	0.24	1
Kurdid/kumal /kunchie	Ext.parasites	40	31	33	41	21	0.22	2
Mieta	Pasteurellosis	22	45	55	34	2	0.21	3
Hasakut	Int. Parasites	26	23	17	12	2	0.19	4
Wekie	Blacklag	34	21	14	10	9	0.13	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

This result is in line with the research finding of Getachew Legesse *et al.* (2014), who emphasized that next to feed shortage, diseases and parasites were the major bottle necks to sheep production in Atsbi Wenberta district. According to Markos Tibbo (2006), high prevalence of diseases and parasites cause high mortality that diminishes the benefits of reproductive performance of sheep. Other authors also pointed out that diseases and parasites were among the top challenges in sheep production in Ethiopia (Zewudu Edea *et al.*, 2012; Helen Nigussie *et al.*, 2013).

4.7.3. Sheep mortality constraints

Drought (feed shortage), diseases and parasites, poor mothering ability of ewes and accidents were reported as major causes of sheep mortality with index values of 0.39, 0.34, 0.20 and 0.7 respectively (table 21).

Table 21. Reported major causes of sheep mortality as ranked by the respondents

Constraints	1st	2nd	3rd	4th	Index	Rank
Drought /feed shortage	31	42	35	0	0.39	1
Diseases and parasites	26	31	33	1	0.34	2
Poor mothering ability	12	3	27	12	0.20	3
Accidents	4	11	12	1 9	0.7	4

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

Shortage of feed (drought) was reported as a major cause of sheep mortality and poor performances of Highland sheep. Respondents pointed out that mortality could reach up to 40% especially during periods of drought and feed shortages. Mortalities due to feed shortage and malnutrition were reported very common especially during the late dry seasons (March to June). Similar works on other breeds of Ethiopia in different locality under farmers' management condition also reported mortality rates greater than 20% for Horro and Menz sheep breeds (Markos Tibbo, 2006; Tsedeke Kochu, 2007). Next to feed shortage, diseases were ranked as major cause of sheep mortality in the study PAs. Poor mothering ability of ewes and different accidents were also mentioned as significant causes of sheep loss. Similar cases were mentioned in Ethiopian by various researchers (Belay Birhanu and Aynalem Haile, 2009 ; Mengestie Taye *et al.*, 2011).

4.7.4. Veterinary service constraints

Inadequate veterinary service, shortage of veterinarian, shortage of drugs, few veterinary clinics and expensive drug price were mentioned as major bottle necks with corresponding index values 0.24, 0.22, 0.21, 0.19 and 0.13 respectively (table 22).

Table 22. Reported veterinary service related constraints by households

Constraints	1st	2nd	3rd	4th	5th	Index	Rank
Inadequate veterinary service	41	58	55	23	0	0.24	1
Shortage of veterinarian	40	31	33	41	21	0.22	2
Shortage of drugs	22	45	55	34	2	0.21	3
Few veterinary clinics	26	23	17	12	2	0.19	4
Expensive drug price	34	21	14	10	9	0.13	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

The district office of agriculture was mentioned as the only provider of veterinary service. Two private drug shops were reported in the district. Inadequate man power and logistics, scarce and erratic supply of drugs, high cost of drugs and equipments were emphasized by respondent farmers. According to respondents, 1 veterinarian is available at district level, hence; he could not address the veterinary service to the study PAs. Reported kinds of services offered to farmers were vaccination once or twice in a year (which was mentioned as insufficient), treatment of diseased animals even if it is not on time consistent and efficient and training with regard to health service was reported very rare. Finding of this study was in line with report of Getachew Legesse *et al.* (2014), who mentioned veterinary related constraints as one of the major constraints in Atsbi Wenberta district.

4.7.8. Extension support constraints

Lack of training /capacity development, low frequency of contact/support and poor facilitation of market linkage were reported as major bottle necks with regard to extension support in the study PAs with calculated index values of 0.54, 0.29 and 0.17 respectively (table 23).

Table 23. Reported extension support related constraints by households

Constraints	1st	2nd	3rd	Index	Rank
Lack of training/ Experience sharing	71	58	2	0.54	1
Low frequency of contact/support	46	63	6	0.29	2
Poor facilitation of market linkage	29	18	51	0.17	3

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

The district bureau of agriculture was reported as the major source of agricultural information and knowledge for farmers. According to the respondents, five or six years ago trainings about improved feeding, health and animal husbandry were very common, but now a day, the frequency was indicated as very rare. The study PAs were reported suffering from poor extension system and lack of trainings in improved production system. Low frequency of contact by district experts and development agents was another problem raised by the respondents. High frequency of staff turnover was mentioned as a major cause of such challenge.

Respondents pointed out that they sell sheep individually to nearby consumers and traders, and stressed that if there were market facilitation by the extension system they could have been benefited a lot. The presence of Abergelle abattoir in the vicinity was mentioned as an opportunity. Different authors have indicated that farmers' frequency of contact with extension agents has a direct relationship with effectiveness of extension service (Azage Tegegne *et al.,* 2010). According to FAOSTAT (2010), institutions that involve in research, extension and services so far failed to yield a positive influence on the traditional sheep husbandry practices in Ethiopia.

4.7.9. Breeding constraints

Major breeding related constraints identified were shortage of breeding rams, selling best rams, indiscriminate cross breeding and uncontrolled breeding with corresponding index values 0.53, 0.21, 0.15 and 0.11 respectively (table 24).

Table 24. Reported breeding related constraints by households

Constraints	1st	2nd	3rd	4th	Index	Rank
Shortage of breeding rams	61	43	15	3	0.53	1
Selling best rams	26	14	7	0	0.21	2
Indiscriminate crossbreeding	5	21	37	3	0.15	3
Uncontrolled breeding (inbreeding)	2	8	25	1	0.11	4

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

Respondents stressed that they did not retain enough number of rams in their flock. As a result of economic difficulties, they sell best rams because they fetch higher price in the market. Selling rams and ewes which are fast growing and well body conformed was reported highly practiced in the study PAs. According to Kassahun Awgichew and Gipson (2009), long term availability of breeding stock which meets sustainable breeding goals, can be seen as one of the factors leading to sustainable animal production.

Respondents also mentioned that Highland sheep are known for their mutton taste, but due to introduction of Dorper and Elle breeds, the quality of the breed was indicated as being under threat/risk. Findings of this study concur with report of Getachew Legesse *et al.* (2014), who observed that uncontrolled mating, indiscriminate crossbreeding and shortage of breeding rams were among the major problems in Atsbi Wenberta district. According to Marshall (2014), crossbreeding of indigenous sheep breeds with improved exotic or local breeds is a usually quick means of genetic improvement but, indiscriminate crossbreeding without prior analysis of suitability of crossbreds for a given production environment and without clear breeding objectives presents a potential threat to better adapted indigenous breeds (Emelie *et al*., 2015; Getachew Legesse *et al.,* 2014). Similarly, Solomon Gizaw *et al.* (2013) stated that indiscriminate cross breeding threatened to dilute the sheep genetic diversity in the country.

The survey result indicated that uncontrolled breeding was very common in the study PAs. Mating within close relatives, especially sire daughter and ewe was indicated as

very common phenomena. According to Shigdaf Mekuriaw and Aynalem Haile (2014), inbreeding results from mating of related individuals has a negative effect on health and reproduction. Similarly, Philipsson et al. (2011) pointed out that it can also result in developmental disruption, higher infant mortality, a shorter life span and reduction of immune system function performance in several characters, particularly those concerned with reproduction and survival, declines following the mating of close relatives. Zewudu Edea *et al.* (2012) stressed that in mixed crop-livestock systems, relatively high inbreeding coefficient exists due to uncontrolled mating and absence of sharing communal land for communal herding might potentially increase the risk unless appropriate measures are taken. According to Birhanu Gibremedhin *et al.* (2007), due to poor management and uncontrolled breeding system the economic return fetched from the sector had remained minimal in Ethiopia.

4.7.10. Marketing constraints

Major marketing related constraints were lack of marketing information , frequent animal taxation, lack of sheep marketing cooperatives and lack of market- orientation with respective index values of 0.34, 0.27, 0.22 and 0.17 respectively(table 25).

Table 25. Reported marketing related constraints by households

Constraints	1st	2nd	3rd	4th	Index	Rank
Lack of marketing information	58	18	15	6	0.34	1
Frequent animal taxation	19	23	17	12	0.27	2
Lack of sheep marketing cooperatives	7	21	23	11	0.22	3
Lack of market- orientation	2	5	15	2 9	0.17	4

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

Most of the respondents reported they usually take their animals for sell to small local markets which are only active once a week. Information on market price is lacking. Farmers get market price information mainly from their neighbors. According to the respondents there is public market information source called TAMPA at district level, but

it was reported as inefficient and not updated on regular basis. The study of Yenesew Abebe *et al*. (2013) in Burie woreda, west Gojjam concurs with the current finding.

Another marketing related constraint mentioned was frequent animal taxation and this was reported as extra expense they were incurring. According to the respondents, they pay one birr/sheep as entrance fee to the market places even if they did not sell any of their animals. Respondents emphasized that they do not have sheep marketing cooperatives or association, they operate individually. They stressed that if they get the opportunity to organize under cooperatives, their bargaining power could be improved and the volume of sell could be raised as well. Generally they reported that market orientation is not very common except for few farmers. The current finding is in line with reports of (Azage Tegegne *et al.,* 2006; Berhanu Gebremedhin *et al.,* 2006). According to Addis Getu *et al.* (*2015*), market-oriented or commercial production is almost nonexistent in extensive systems in Ethiopia.

4.8. Farmers Perception Towards the Ongoing CBBP Intervention

Perception on body size of new born, twinning rate ewes ,trend of mutton consumption, volume of sheep sold, improvements in breeding practices, benefits of CBBP, sustainability of the program, adequacy of support and participation of women were assessed in the current study (table 26).

Table 26. Farmers' perception on different attributes of CBBP intervention

		CBBP-participants	non-participants	overall	x^2
Attributes	Description	N (%)	N (%)	N (%)	
Body size of new born sheep	Increased	58(61)	52(50)	110(55)	5.33**
	No change	14 (15)	19(18)	33 (16.5)	
	Decreased	7 (7)	2(2)	9 (4.5)	
	I don't know	16 (17)	32(30)	48 (24)	
Twining rate of ewes	Increased	15 (16)	10(10)	25(12.5)	1.095(ns)
	No change	42 (44)	31(29)	73 (36.5)	

	Decreased	1 (1)	1(1)	2 (1)	
	I don't know	37(39)	63(60)	100(50)	
Mutton consumption	Increased	53(56)	38(36)	91(46)	4.754*
	No change	21 (22)	14(13)	35 (17)	
	Decreased	4 (4)	6 (6)	10(5)	
	I don't know	17(18)	47 (45)	64 (32)	
Sheep sold	Increased	44 (46)	36 (34)	80 (40)	4.361*
	No change	26 (28)	27(26)	53 (27)	
	Decreased	7 (7)	4 (4)	11 (5)	
	I don't know	18 (19)	38(36)	56 (28)	
Breeding practices	Improved	78(82)	83(79)	161(80.5)	6.32**
	No change	17(18)	22(21)	39(19.5)	
CBBP benefits farmers	Yes	62 (65)	57(54)	119(59.5)	4.418*
	No	12 (13)	7(7)	19 (9.5)	
	I don't know	21(22)	41(39)	62 (31)	
Sustainability of CBBP without external support	Sustainable	18(19)	10(10)	28 (14)	6.127**
	Not sustainable	61 (64)	65(62)	126(63)	
	I don't know	16 (17)	30 (28)	46 (23)	
Support from researchers, enumerators & extension	Good	27(28)	44 (42)	71(35.5)	3.592*
	Poor	68(72)	61(58)	129(64.5)	
Women's composition	Adequate	3 (3)	12(12)	15(7.5)	2.458(ns)
	Inadequate	81 (85)	57(54)	138 (69)	
	I don't know	11 (12)	36 (34)	47 (23.5)	

Ns= not significant, $p<0.05$, *= significant at $p<0.05$ ** = significant at $p<0.01$

4.8.1. Perception on body size of new born sheep

While setting the CBBP intervention in the study PAs, body size of sheep was the top ranked trait preferred for improvement. This concurs with report of Tadelle Mirkena *et*

al. (2012), who stated that the same target trait was selected in Horro, Bonga and Menz CBBPs interventions in Ethiopia. About 58% of CBBP participant respondents thought body size of new-born lambs in their sheep flock showed improvement as result of the intervention and it was also evident from the interviews with non-members (52%) reported they perceived improvement in body size of sheep owned by CBBP members. The Chi square test indicated that highly significance association between the two respondent groups at ($P<5\%$; $x^2 = 5.33^{**}$). The growing interest to be member of CBBP and demand for breeding rams might indicate improvements made by the intervention. Result from analysis of biological data collected for the last three years also revealed progress was achieved in performance at birth and weaning weights respectively. Finding of the current study agrees with reports of (Solomon Gizaw *et al.,* 2014*;* Zelalem Getu *et al.,* 2015), who reported similar improvements in Menz, Horro and Bonga CBBPs in Ethiopia.

4.8.2. Perception on twining rate of ewes

Distribution of CBBP participants and non-participants by their perception about improvements on twinning rate of ewes in their flocks was assessed. A large majority of the farmers (both CBBP participant and non-participants) reported that their ewes would give mostly single birth. 16% of participants and 10% non-participants responded that twinning rate of ewes showed improvement after the intervention. Majority of respondents reported there were not improvement with regard to twinning rate this might have related to short period of CBBP intervention in the study PAs (3 years). Findings of the current study disagree with report of Zelalem Gutu *et al.* (2015) that flocks of participant farmers were superior to non-participants in Horro and Bonga CBBP sites in Ethiopia.

4.8.3. Perception on mutton consumption /slaughtering frequency/

The majority of CBBP participants (56%) reported that mutton consumption in the household had increased after the introduction of intervention, but there were also a considerable proportion of households replied no change in mutton consumption (22%). Non- participants also reflected their perception; accordingly 36% reported that they

perceived mutton consumption in participants households increased as a result of the intervention. The Chi square test declared significance at (x^2 =4.754*).

A possible explanation for increased mutton consumption could be due to the breeding program resulted in increased productivity and hence income from sheep production and consumption of mutton increased. According to Zelalem Gutu *et al.*(2015), it is also important to take into account the fact that initial selection of CBBP participants had favored better off households as only farmers with a sheep flock size of greater than or equal to four were considered for membership.

4.8.4. Perception on number of sheep sold

46% participants and 34 % non-participants perceived that market participation of CBBP participants measured by the number of sales of sheep per year was improved after CBBP intervention. The Chi square test showed significance at (x^2 =4.361*). It is also important to take into account the fact that initial selection of CBBP participants had favored better households as only farmers with a sheep flock size of greater than or equal to five were considered for membership.

4.8.5. Perception on improvement of breeding practices

Major proportion of farmers in both groups (82% participants and 79% non-participants) reported improvements of breeding practices in the study PAs. Respondents indicated that they would rarely keep rams for breeding purpose prior to the implementation of the CBBP. They are now aware of the importance of breeding rams and they believe breeding rams are as important as breeding ewes. Farmers select rams based on the performance of their ancestors and based on the body conformation and growth rate they manifest in their course of development. Members of the CBBP mostly depend on selected breeding rams. They rotate the selected breeding rams among the ram users group and reduce mating between relatives significantly. It was indicated that they now have better knowledge about inbreeding and measures to be taken to reduce it. They sell unselected rams from their flocks to avoid inbreeding. Mating within close relatives, especially sire daughter and ewe-offspring-could lead to inbreeding, which might have

resulted in increased mortality (Philipsson et al., 2011; Shigdaf Mekuriaw and Aynalem Haile, 2014).. The Chi square test declared significance association between respondent groups at (P>5%; x^2 = 6.32**). Finding of the study is line with reports of (Solomon Gizaw *et al.,* 2013; Zelalem Gutu *et al.,* 2015).

4.8.6. Perception on benefits of CBBP intervention

65% participants and 54 % non- participants expressed their perception that CBBP have benefited members. Participants reported they had been continuously participating in the intervention since its inception. They indicated that there have been requests from non-members to join the intervention. They reported trends of improvement in flock size of sheep. Here it is important to take in to consideration the fact that better sheep husbandry practices in CBBP flocks due to training and continuous follow-up from implementers could also have impacted the flock size. It is also important to understand the fact that the initial flock size required to be a member of the CBBP was at least five sheep. Benefit from the sale of breeding rams after service years was mentioned as benefit due to the intervention. The revolving fund is being used by participant farmers to purchase selected breeding rams. CBBP participant respondents expressed their hope to organize in to sheep marketing cooperatives in the near future. The Chi square test showed significance association between the two respondent groups at (P< 5%; x^2 = 4.418*) Similar benefits in other CBBPs sites were reported in Ethiopia (Solomon Gizaw *et al.,* 2014; Zelalem Gutu *et al.,* 2015).

4.8.7. Perception on sustainability of the CBBP intervention

About 64% CBBP participants and 65% non-participants thought they could not sustain the program without external support and they have some justifications. Some of their reasons were lack of adequate skill and capital, poor educational background, animal health problems, lack of support from the extension and research, and poor capacity to find market. The Chi square test showed very strong association between the two groups (P<5% x^2 =6.127**). It is, therefore, necessary for responsible stakeholders to devise short to medium term support mechanisms in order to realize positive changes in the livelihood of participant farmers.

4.8.8. Perception on support from researchers, enumerators and extension staff

In all CBBP sites, one enumerator was employed to keep record of specified biological data of the sheep flocks owned by members of the CBBP. The data routinely collected by the enumerators is periodically compiled and entered in to excel sheets. Researchers in Mekelle Agricultural Research Center support and follow-up functioning of the intervention and record keeping practice of the enumerator. About 72% participants and 64.5% non- participants believe follow-up and commitment from the respective enumerators and researchers were inadequate. The Chi square test showed significant association between the two groups at ($P < 5\%$; $x^2 = 3.592$*). Involvement of the extension system in the process was reported limited and was not fully involved. It was found that there was very poor cooperation with the district offices of agriculture in terms of giving technical support to members of the CBBP. According to Aynalem Haile *et al. (*2011), government commitment and support is essential for sustainability of breeding programs. Better monitoring system should also ensure flow of information among stakeholders. Farmers strongly complained about the challenge and pointed out that urgent corrective measure should be taken.

4.8.9. Perception on women's composition /participation/

At initial stage of the intervention 30% women's presentation was set as criteria, but after three years of intervention the figure reported very low. 85% participants and 54% non-participants expressed presentation of women as inadequate. According to Zelalem Gutu *et al*. (2015), CBBP intervention in Ethiopia focused on sheep breed improvement and did not take any gendered approach. Sheep production was reported as a means of survival particularly for female-headed households in the study PAs, Possible reason for barley presentation could be that women are loaded by domestic works but due to burdens of household works they dropped out from CBBP membership.

4.9. Reported Major Opportunities of the CBBP Intervention

Improved breeding practices, better performance of sheep, possessing best rams, presence of revolving fund and collaboration among stakeholders were mentioned as opportunities

due to the CBBP intervention with index values of 0.34, 0.30, 0.18, 0.13, and 0.08 respectively (table 27).

Table 27. Reported opportunities of CBBP intervention as identified by respondents

Opportunities	1st	2nd	3rd	4th	5th	index	rank
Improved breeding practices	38	17	20	7	4	0.34	1
Better performance of sheep	31	19	11	10	7	0.30	2
Possessing best rams	22	10	11	5	4	0.18	3
Revolving fund	13	4	7	7	0	0.13	4
Collaboration among stakeholders	9	2	4	1	1	0.08	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 respondents

Respondents emphasized that they would rarely keep rams for breeding purpose prior to the implementation of the CBBP. They are now aware of the importance of breeding rams and they believe breeding rams are as important as breeding ewes. Members of the CBBP mostly depend on selected breeding rams. It was reported that members rotate the selected breeding rams among the ram users group and avoid mating between relatives to a great extent. They believe they now have better knowledge about inbreeding and measures to be taken to reduce it. Most of the time, they sell unselected rams from their flocks to avoid inbreeding. They reported that they practice culling of male and female sheep that poorly performed in the flock. One enumerator was employed for each PA for record keeping. These enumerators live within the community and follow-up the breeding program and this was mentioned as crucial to run the CBBP where vast majority of farmers were reported illiterate.

Improvement in body size of newborn lambs was predominantly reported by farmers in the CBBP interventions. As a result of such improvement, some respondents indicated that their income improved through the sell of live sheep.

Respondents stressed that prior to formation of the CBBP, they would usually sell fast growing rams and shortage of breeding rams was a problem. The community now has managed to keep the best rams for breeding purpose in the community up to optimum service year 2-3 years. In addition, members reported that they receive requests from non-members for exchange of rams.

Presence of revolving fund was reported as opportunity of the CBBP intervention. Benefit from the sale of breeding rams after service years serve as source of revolving fund. The revolving fund was being used by participant farmers to purchase selected breeding rams. Farmers expressed their hope to organize in to cooperatives. Enabling farmers for better breeding practice, through financial support and awareness creation, was part of the intervention in the breeding programs across Ethiopia (Zelalem Gutu *et al.,* 2015).

Last but not least**,** collaboration among the different implementers (ICARDA/ LIVES /ILRI/ MARC/TARI/ DBoA) was mentioned as opportunity of the intervention. It was reported that TARI/ MARC had been providing technical backups and monitors the operations of the breeding program while ICARDA/ILRI supported and follows up the program. This was in accordance with Getachew Tesfaye *et al.,* (2016), who explained success of any breeding program mainly depends on full farmers' participation, continuous commitment and integrated effort of institutions.

4.10. Reported Major Challenges of the CBBP Intervention

In the current study gap in follow up & support, financial limitations, breeding related constraints, wrong perception of farmers, limited presentation of FHH and land less youth were reported as a major challenges with index values of 0.41,0.31, 0.17, 0.07 and 0.05 respectively (table 28).

Table 28. Reported challenges of CBBP intervention as identified by respondents

Constraints	1st	2nd	3rd	4th	5th	index	rank
Gaps in follow up & support	42	29	18	7	4	0.41	1
Financial limitations	30	17	8	11	5	0.30	2
Breeding related constraints	19	6	13	5	2	0.17	3
Wrong perceptions of farmers	7	4	0	1	1	0.07	4
Limited participation of FHH and landless youth	4	2	1	1	2	0.05	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 respondents; FHH= Female headed

About 69 % respondents mentioned gaps in follow up from regional research and district office of agriculture. Average frequency of visit was reported to be once every three months. Recent cooperation among implementers in terms of giving technical support to the members was reported as a potential set up that needs immediate corrective measure. Active and regular involvement of the regional research in community-based breeding program could have helped enumerators and farmers to acquire technical skill and appropriate data recording knowledge (mechanisms) through training and working closely with researchers.

Genetic improvement is usually viewed as a complex task that needs a high level of organization (Mueller *et al.,* 2015). According to Aynalem Haile *et al.* (2011), government commitment and support is essential for sustainability of breeding programs. He further stated that an integral component of a functional community-based breeding program is monitoring technical and management issues related to the implementation of the breeding program.

Another challenge reported by respondents was financial limitation to buy breeding rams. It was reported as main problem related to frequency of selection as members of the CBBP are resource poor smallholder farmers and partly rely on cash income from sell of sheep. They indicated that when they are in need of cash, they cannot postpone sell of sheep for longer period. Farmers usually practice early sell of fast growing rams that are

potentially ‘best’ breeding ram and this resulted in negative selection (Solomon Gizaw *et al.*, 2014).

Shortage of breeding rams was another challenge mentioned by the respondents and this was related to frequency of ram selection. Farmers reported that shortage of breeding rams pronounced during rainy season due to the fact that comparatively high feed availability and ewes display heat. The problem was mentioned as a crucial in Golgolnealea due to the fact that second round ram purchase was not facilitated unlike the other PAs. Selling of selected rams was also reported in Gebrekidan PA afterwards, appropriate corrective measures were taken.

Breeding related constraints such as mating of ewes owned by members by unselected rams was reported. Rams from non-member neighbors still mix with and may mate the ewes of members of the CBBP. Farmers are concerned about this as control is not possible in areas where members and non-members share pasture land.

Uncontrolled breeding was reported common in the field and this might overshadow goals of the intervention. Another challenge reported was wrong perception among farmers that sheep were dying because they were ear tagged. Members believed that ear tags used at the beginning infected ears, and were not appropriate. Corrective measures, changing the ear tag, were taken after the problem had been identified but, the problem was reported still continuing. In addition some farmers were mentioned not willing to put their sheep on weighting scale specifically at birth. It was indicated that there was a wrong beliefs such as putting sheep on weighing scale could affect their growth.

Significant numbers of dropouts were also reported since inception of the intervention (15 in Habes, 10 in Golgolnealea and 17 in Gebrekidan PAs respectively). Reasons for dropouts included wrong perception of farmers about ear tag and relating it as cause of death as well emaciating their flocks, but currently respondents replied that now they are aware about significance of the intervention and indicated they are very committed to the terms and rules of the intervention.

According to respondent farmers, participation of women was perceived very low; currently six women in each CBBP were reported. At initial set up of the CBBP intervention 30% were women, but the figures drop dramatically as a result of significant drop outs. Possible reasons forwarded for dropping out include women are loaded by domestic works. As a result of burdens of household works, it was indicated that they dropped out from CBBP membership. Women farmers in Tigray are considered very poor in many aspects due to many reasons like, cultural and load of work and this make them to seem unable to work with male and equal to male. This weak tradition can be reduced by capacitating women through intensive training and experience sharing. Generally sheep are owned by poorer sector of the community. Any intervention that improves the productivity of sheep is important in creating wealth and improving the standard of living of resource poor farmers particularly women .There is a room for further study to identify the actual reasons behind this problem. Generally finding of the study is in line with literatures of (Solomon Gizaw *et al.,* 2014*;* Zelalem Gutu *et al.*, 2015).

Chapter 5. CONCLUSIONS AND RECOMMENDATIONS

- Growth performances of progeny from selected rams were found superior to base flocks. Body weight improvements under CBBP management had been observed. Lambs under CBBP management were significantly heavier at birth and three month than lambs managed under non-CBBP participants households. However, the variation discontinued at six month and yearling weights respectively.

- The study also demonstrated that fixed factors exerted a significant effect on productive and reproductive performances of Highland Sheep breed.

- In the current study, the overall production system of the study PAs was characterized as extensive production system.

- Mutton taste of the breed, presence of Abergelle abattoir, high consumers demand, proximity to Mekelle, and gender participation were mentioned as sheep production opportunities. On the other hand, feed shortage, health constraints, high sheep mortality, inadequate extension support and poor marketing linkages were reported major constraints to sheep production in the study PAs.

- Improvements on body size of new born lambs, mutton consumption, improved breeding practices and market participation were perceived as impact of the CBBP intervention. On the other hand, significant proportion of respondents thought twinning rate was not improved, it is impossible to sustain the program without external support and believed follow-up and commitment from the respective enumerators and researchers and representation of women were inadequate.

- Generally improved breeding practices, better performance of sheep, possessing superior rams, presence of revolving fund and room for collaboration among implementers were mentioned as opportunities of the CBBP intervention. While major challenges include gap in follow up & support, financial limitations, breeding related constraints, wrong perception of farmers, limited presentation of female headed households and land less youth respectively.

According to the result of this study, some of the suggested issues that require consideration are high lightened below:

- Body weight of Highland sheep in CBBP and non-CBBP flocks did not show significant variations at six month and yearling weights, respectively. Detail future study and cautious interpretation of results is vital for identifying the reasons.

- Based on the current study, implementers can take corrective measures against shortcomings and strengthen positive outcomes of the CBBP for benefit of the communities at large. It is, therefore, necessary for responsible stakeholders to devise short to medium term support mechanisms in order to realize positive changes in the livelihood of farmers

- There are specific opportunities of Highland sheep production like appreciable mutton taste and proximity to Mekelle city, but marketing linkage was reported poor. This is one area in which implementers could engage themselves for the benefit of the communities at large.

- There are rooms for future detail studies with regard to feed shortage, disease and marketing. Feed shortage is more aggravating due to the erratic and unreliable nature of rainfall and pasture lands are reducing from time to time. Similarly, a disease in particular, Coenurosis locally known as 'Azurit/Zarti' is a major disease in the study areas. Detail studies can be done to solve the challenges.

REFERENCE

Alemayehu Tadesse and Tikabo Gebremariam. 2010. Application of Linear Body Measurements for Live Body Weight Estimation of Highland Sheep in Tigray Region, Ethiopia. Journal of the Drylands, 3(2): 203-207.

Alemu Yami and R.c. Merkel. 2008. Ethiopian Sheep and Goat productivity Improvement Program. Addis Ababa, Ethiopia. Pp: 348.

Adane Hirpa and Girma Abebe. 2008. Economic significance of sheep and goats in Sheep and Goat Production Handbook for Ethiopia. In A. Yami and R.C. Markel, Eds. Addis Ababa, Ethiopia, pp. 1-24.

Addis Getu, Adina Kefale and Jemberu Arega. 2015. A Review Work on Breed Types and Breeding Strategies of Sheep Production systems in Ethiopia. International Journal of Agriculture and Veterinary Sciences, 1(1): 27-32.

Ameha Sebsibe. 2008. Sheep and Goat Meat Characteristics and Quality. In: Alemu Yami and R.C. Merkel (eds.) .*Sheep and Goat Production Handbook for Ethiopia.* Ethiopian Sheep and Goat Productivity Improvement Program (ESGPIP), Addis Ababa, Ethiopia. Pp: 345.

Asresu Yitayew, Mengistie Taye, Agraw Amanie and Getenet Zeleke. 2013. Community-based improvement scheme for washera sheep: Lessons from Yilmanadensa and Quarit Districts in Westren Amhara Region, Ethiopia. Global Journal of Animal Sci. 1(1): 1-7.

Assen Ebrahim and Aklilu Hailemichael. 2012. Sheep and goat production and utilization in different agro-ecological zones in Tigray, Ethiopia. Livestock Research for Rural Development, 24 (1): 3-5.

Aynalem Haile, Maria Wurzinger, Joaquín Mueller, Tadele Mirkena, Gemeda Duguma, Okeyo Mwai, Johann Sölkner and Barbara Rischkowsky. 2011. Guidelines for

Setting up Community-based Sheep Breeding Programs in Ethiopia. ICARDA - tools and guidelines No.1. Aleppo, Syria. 45 pp.

Azage Tegegne, Berhanu Gebremedhin and Hoekstra D. 2010. Livestock input supply and service provision in Ethiopia: Challenges and opportunities for market oriented development. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 20. 48 pp.

Azage Tegegn, Berhanu Gebremedhin and Dirk H. 2006. Institutional arrangements and challenges in market-oriented livestock agriculture in Ethiopia. Proceedings of the 14th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia. Pp: 1-20.

Belay Berhanu and Aynalem Haile. 2009. Reproductive performance of traditionally managed sheep in the south western part of Ethiopia Liv. Res. Rur. Dev. 21 (9): 1-4.

Belay Deribe and Mengistie Taye. 2013. Evaluation of growth performance of Abergelle goats under traditional management systems in Sekota District, Ethiopia. Pak. J. of Biol. Sci. 16(14): 692-696.

Belete Shenkute. 2009. *Production and marketing systems of small ruminants in Gomma district of Jimma zone, western Ethiopia*. M.Sc Thesis. Hawasa University, Awassa, Ethiopia, Pp: 144.

Benyi K., Norris D., Karbo N. and Kgomo K.A. 2009. Effects of genetic and environmental factors on pre-weaning and post-weaning growth in West African crossbred sheep. *Trop. Anim. Health Prod*. 38, 547-554.

Berhanu Gebremedhin, Hoekstra D and Samson Jemaneh. 2007. Heading towards commercialization. The case of live animal marketing in Ethiopia. Improving Productivity and Market Success (IPMS) of Ethiopian Farmers. Nairobi, Kenya. 73 pp.

Budai, C., Gavojdian D., Kovács A., Negrut F., Oláh J., Toma L., Cziszter, Kusza S., Jávor A., (2013): Performance and Adaptability of the Dorper Sheep Breed under Hungarian and Romanian Rearing Conditions. *Anim. Sci. Biotech.* 46: 344-350.

CSA (Central Statistical Authority) .2016. Ethiopian agricultural sample survey. Vol II. Report on livestock and livestock characteristics. Addis Ababa, Ethiopia. Statistical Bulletin 578. 194 pp.

DAGRIS (Domestic Animal Genetic Resources Information System). 2006. (eds Ed Rege, Workneh Ayalew, Ephrem Getahun, Olivier Hanotte and Tadele Dessie). ILRI, Addis Ababa, Ethiopia. (http://dagris.ilri.cgiar.org).

Deribe Gemiyu. 2009. *on-Farm Performance Evaluation of Indigenous Sheep and Goats in Alaba, Southern Ethiopia*. MSc Thesis. Haramaya University, Ethiopia. 163pp.

Emelie K., Tadele Mirkena, Erling S., James A., Julie O., Birgitta M., Mwai O., and Jan P., 2015. Participatory definition of breeding objectives for sheep breeds under pastoral systems—the case of Red Maasai and Dorper sheep in Kenya. 254 pp.

Endeshaw Assefa. 2007. *Assessment on production system and marketing of goats at Dale district, Sidama Zone*. MSc Thesis. Hawasa University, Awassa, Ethiopia. 178pp.

Ermias Belete. 2014. *On- farm performance evaluation of Dorper sheep breed crosses in Siltie and Wolaita Zones, Southern Ethiopia*. MSc thesis. Addis Ababa University, Ethiopia. 153 pp.

Esayas Meresa. 2016. Metrological data of Atsbi Wenberta district, personal communication. Mekelle Agricultural Research Center, Metrology Case Team.

ESGPIP (Ethiopia Sheep and Goat Productivity Improvement Program). 2009. Sheep and goat pox: Causes, prevention and treatment. Technical bulletin. 29 pp.

FAO (Food and Agriculture Organization of the United Nations). 2015. The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture,

edited by B.D. Scherf & D. Pilling. FAO Commission on Genetic Resources for Food and Agriculture Assessments. Rome (available at http://www.fao.org/3/a-i4787e/index.html).

FAO (Food and Agriculture Organization of the United Nations). 2010. Breeding strategies for sustainable management of animal genetic resources. Animal Production and Health Guidelines 3. Rome, Italy.

FAO (Food and Agriculture Organization of the United Nations). 2007. The State of the World's Animal Genetic Resources for Food and Agriculture. Rome, Italy. Pp: 381-427.

FAOSTAT (Food and Agricultural Organization of the United Nations). 2010. Available at http://faostat.fao.org/default.aspx.

Fsahatsion Hailemariam, Aberra Melesse and Sandip B. 2013. Traditional sheep production and breeding practice in Gamogofa Zone, Southern Ethiopia. Internation al Journal of Livestock Production Research. 1(3): 26 – 43.

Fourie, J., Vos P. and Abiola S. 2009. The influence of supplementary light on Dorper lambs fed intensively. *South Afr. J. Anim. Sci*. 39: 211-214.

Gemeda Duguma. 2011. *Participatory definition of breeding objectives and implementation of community based sheep breeding programs in Ethiopia*. PhD thesis, Austrian University of Natural Resource and Applied Sciences (BOKU), Vienna. 101 pp.

Getachew Legesse, Aynalem Haile, Duncan A., Tadelle Dessie, Solomon Gizaw and Rischkowsky, B. 2014. Sheep and goat value chains in Ethiopia: A synthesis of opportunities and constraints. ICARDA/ILRI Project Report. Nairobi, Kenya. 78 pp.

Getachew Terfa, Aynalem Haile, Baker D. and Girma Kassie. 2013. Evaluation of traits of indigenous sheep using hedonic pricing in Central Ethiopia. Agricultural and Food Economics: 1-6.

Getahun Legesse. 2008. *Productive and Economic performance of Small Ruminant productionin production system of the Highlands of Ethiopia*. PhD Dissertation Universityof Hohenheim, Stuttgart-Hoheinheim, Germany. 112 pp.

Girma Abebe. 2008. Reproduction in sheep and goats. Alemu Yami and R.C. Merkel (Eds.) In: Sheep and goat Production Hand Book for Ethiopia. Ethiopia sheep and goats productivity improvement program (ESGPIP), Addis Ababa, Ethiopia. Pp. 57-72.

Helen Nigussie,Yoseph Mekasha, Kefelegn Kebede, Solomon Abegaz and Sanjoy K. 2013. Production objectives, breeding practices and selection criteria of indigenous sheep in eastern Ethiopian Livestock Research for Rural Development. 25(9): 3-5.

Hundie Demissu and Geleta Gobena. 2015. Assessment on production situation and breeding practices of Horro sheep under traditional management in Horro Guduru and East Wollega Zones, West Ethiopia. Global Journal of Animal Breeding and Genetics, 3(3):146-152.

Juma G., Ngigi M., Baltenweck I., and Drucker G. 2010. Consumer demand for sheep and goat meat in Kenya. Small Ruminant Research 1(3): 135-138.

Kassahun Awgichew, Gipson A. 2009. Overview of Genotype Program Activities: Achievement, Challenge and Sustainability. Proceedings of mid-term conference of the Ethiopian Sheep and Goat Productivity Improvement Program. Hawassa, Ethiopia. 52 pp.

Kassahun Awgichew. 2000. *Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding conditions*. PhD dissertation, Humboldt University, Berlin, Germany. 159 pp.

Kosgey IS., Rowlands GJ., Van Arendonk JAM., Baker RL .2008. Small ruminant production in smallholder and pastoral/extensive farming systems in Kenya. Small Rumin. Res. 77: 11–24.

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

Livestock Master Plan (LMP). 2011. The Ethiopian Livestock Sector: Role, constraints and opportunities towards a strategy and action Plan. GOE/MOA/Livestock Development Sector and ILRI /Bill & Melinda Gates Foundation (BMGF). 117 pp.

Marshall K. 2014. Optimizing the use of breed types in developing country livestock production systems: a neglected research area. Journal of Animal Breeding and Genetics. 5: 329–340.

Markos Tibbo. 2006. *Productivity and health of indigenous sheep breeds and crossbreds in the central Ethiopian highlands*. PhD dissertation. Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden.pp

Mengiste Taye, Girma Abebe, Sisay Lemma, Solomon Gizaw, Marikos Tibbo. 2010. Traditional management systems and linear body measurements of Washera sheep in the western highlands of the Amhara National Regional State, Ethiopia. Livest. Res. Rural Dev. 22(9):1-5.

Mengiste Taye, Girma Abebe, Solomon Gizaw, Sisay Lema and Markos Tibbo. 2009. Growth performances of Washera sheep under smallholder management systems in Yilmanadensa and Quarit districts, Ethiopia. Trop. Anim. Health. Prod. DOI, 10.1007/s11250-009-9473-x.

Mengiste Taye. 2008. *On-farm performances of Washera sheep at Yilmanadensa and Quarit districts of the Amhara National regional state*. MSc Thesis. Hawassa University, Awassa, Ethiopia. pp.122.

Mesay Yami, Bedda Begna, Teklemedhin Teklewold. 2013. Enhancing the productivity of livestock production in highland of Ethiopia: Implication for improved on –farm

feeding strategies and utilization, Ethiopian Institute of Agricultural research (EIAR), Assela, Ethiopia. 32 pp.

Mesfin Lakew, Mussie Haile-Melekot, Getinet Mekuriaw Solomon Abreha and Haimanot Setotaw. 2014. Reproductive Performance and Mortality Rate in Local and Dorper × Local Crossbred Sheep Following Controlled Breeding in Ethiopia. *Ethip. An. Sc.* 4: 278-284.

Mourad R., Aynalem Haile, Zeleke Mekuriaw, Ayele Abebe, Barbara R. and Imene BS. 2016. Review of the reproductive performances of sheep breeds in Ethiopia.2016. ICARDA working paper 23. 92 pp.

Mueller J.P., Rischkowsky B., Aynalem Haile., Philipsson J.,Mwai O., Besbes B., Valle A., Markos Tibbo , Tadelle Mirkena and Gemeda Duguma. 2015. Community based livestock breeding programmes: essentials and examples. Journal of Animal Breeding and Genetics 132: 155–168.

Mukasa-Mugerwa and Lahlou K. 1995. Reproductive performance and productivity of Menz sheep in the Ethiopian highlands. Small Rumin. Res. 17: 167–177.

Mulata Halefom. 2013. Management practice and constraints of sheep production in southern, south eastern and eastern zones of Tigray, northern Ethiopia. World Journal of Animal Science Research 1(1): 1 -17.

Okpebholo Fidelis, Tyrell Kahan. 2007. Opportunities and Challenges for Developing Small Ruminant Systems. A&M University, Tallahassee, Florida. 22(4): 2-4.

Philipsson J., Zonabend E., and Okeyo AM. 2011. Sustainable breeding programmes for tropical low- and medium input farming systems. Animal Genetics Training Resource 3. Pp: 21-32.

Ramesh D., H R Meena and K L Meena. 2012. Analysis of Small ruminant market system in different agro-climatic zones of Southern India. Vet. World .5 (5): 288-293.

Rege J.E., Marshall K., Notenbaert A., Ojango J.M.K., and Okeyo, A.M. 2011. Pro-poor animal improvement and breeding. Livestock Science. 136: 15–28.

Shigdaf Mekuriaw and Aynalem Haile. 2014. Genetic parameter estimates for growth and reproductive traits of Sheep for genetic improvement and designing breedingprograminEthiopia.A Review. Open Access Library Journal, 1:e589. http://dx.doi.org/10.4236/oalib.1100589.

Shigdaf Mekuriaw, Zeleke Mekuriaw, Mengiste Taye Hailu Mazengia, Getnet Assefa and Aynalem Haile. 2013. Reproductive performance and survival rate of Washera and Farta sheep breeds under traditional management systems in Farta and Lay Gayint Districts of Amhara Regional state, Ethiopia. Ethiop. J. Anim. Prod. 13: 65- 82.

Solomon Abegaz. 2013. *Design of community based breeding programs for two indigenous goat breeds of Ethiopia*. PhD dissertation. BOKU-University of Natural Resources and Life sciences .Vienna, Austria. 100 pp.

Solomon Abegaz. 2007. In situ characterization of Gumuz sheep under farmer's management in north western lowland of Amhara region. M.Sc. Thesis. Alemaya University, Ethiopia. 89 pp.

Solomon Abegaz, Gemeda Duguma, Getachew Terefe, and Rege, J.E.O. 2002. Factors affecting reproductive performance and estimates of genetic parameters of litter size in Horro sheep. Journal of Agricultural Sci. 139: 79-85.

Solomon Gizaw, van Arendonk, J.A.M., Valle-Zãrate, A., Haile, A., Rischkowsky, B., Dessie, T., and Mwai, A.O. 2014. Breeding programmes for smallholder sheep farming systems: Optimization of cooperative village breeding schemes. J. Anim. Breed. Genet.1–8.

Solomon Gizaw, Komen H, Hanotte O, Van Arendonk JAM . 2008. Indigenous sheep resources of Ethiopia: production systems and farmers preferences. AGRI 43:25-39.

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

Tadelle Mirkana, Gemeda Duguma, Willam, A., Wurzinger, M., Aynalem Haile, Rischkowsky, B., Okeyo, A.M., Markos Tibbo, M., and Solkner, J. 2012. Community-based alternative breeding plans for indigenous sheep breeds in four agro-ecological zones of Ethiopia. J. Anim. Breed. Genet. 129: 244–253.

Tsedeke Kochu, Girma Abebe, Azage Tegne, Berhanu Gebremedhin . 2011. Marketing value- chain of smallholder sheep and goats in crop-livestock mixed farming system of Alaba, Southern Ethiopia. Official J. Int. Goat Ass. 96: 102-105.

Tsedeke Kocho. 2007. *Production and marketing system of sheep and goat in Alaba, southern Ethiopia*. MSc Thesis. Hawassa University, Awassa, Ethiopia. 159 pp.

Tesfaye Getachew, Aynalem Haile, M. Wurzinger, B. Rischkowsky, Solomon Gizaw, and J.Sölkner.2016. Review of sheep crossbreeding based on exotic sires and among indigenous breeds in the tropics: AJAR. 11(11): 901-911.

Tesfaye Getachew, Aynalem Haile, Markos Tibbo, Sharma, A.K., Kifle, A., Terefe, E., Wurzinger, M., Sölkner, J. 2009. Morphological characters and body weight of Menz and Afar sheep within their production system. Ethio. Journal of Animal Prod. 9(1): 99-115.

Yadeta Neme. 2016. Study of Productive and Reproductive Performances and Farmers ' Traits Preferences for Breeding of Small Ruminants in Ada Barga and Ejere Districts of West Shoa Zone , Oromia .49 :1–10.

Yenesew Abebe, Solomon Melaku and Azage Tegegne. 2013. Assessment of sheep marketing system in Burie district, North Western Ethiopia. International Journal of Livestock Production Research. 1(3): 26 – 43.

Zelealem Tesfay , Anal, A. K. & Gebrezgiher Gebreyohanis. 2012. Assessment of the sheep production system of Northern Ethiopia in relation to sustainable productivity and sheep meat quality. I.J.A.B.R. 2(2): 302-313.

Zelealem Tesfay and Abreham Haftu. 2010. Sheep breeds/types of Tigray. Report submitted to Tigray Agricultural Research Institute, Mekelle, Ethiopia. 29 pp.

Zelalem Gutu, Aynalem Haile, Rischkowsky B., Mulema A.A., Kinati W. and Girma Kassie. 2015. Evaluation of community-based sheep breeding programs in Ethiopia. Addis Ababa: ICARDA. 44 pp.

Zeleke Mekuriaw. 2007. Environmental influences on pre-weaning growth performances and mortality rates of extensively managed Somali goats in Eastern Ethiopia. *Livestock Research for Rural Devel.* 19(12).

Zewudu Edea, Aynalem Haile, Markos Tibbo, A.K, Sharma, Dejene Assefa, Johann Sölkner, Maria Wurzinger. 2012. Sheep production systems and breeding practices of smallholders in western and south-western Ethiopia: Implications for designing community-based breeding strategies. Livestock Research for Rural Development 24 (7).

Zewudu Edea. 2008. *Characterization of Horro and Bonga indigenous sheep breeds of small holders for designing community based-breeding strategies*. M.Sc. Thesis. Haramaya University, Ethiopia. 107 pp.

APPENDIX

Appendix Table 1**.** Questionnaire to CBBP participants and non-participants

INSTRUCTION TO THE ENUMERATOR

Please introduce yourself before starting question to the farmer by name, the purpose and objective the study. Pleas ask each question patiently until the farmer gets the point. For open questions, fill the farmer response in short and for closed once circle or mark ( ) where necessary.

1. General information

1.1 Questionnaire Number/code: _____
1.2 Date of interview: Day: _____ Month _____ Year: _____
1.3Name of the interviewee_____ signature_____

2. Household profile

2.1 Wereda_____
2.2 PA/kushet_____
2.3 Name of the respondent_____
2.4 Relation to head: 1. Head 2.Spouse 3.Son 4.Daugther 5. Other/specify
2.5 Sex of the household head: 1. Male 2. Female
2.6 Age of the household head_____
2.7 Marital Status of the household head: 1. Single 2. Married 3. Divorce
2.8Family size of the respondent: 1. Male_____ 2. Female _____ Total _____
2.9 Educational level of respondent: 1. Illiterate 2. Read and write only 3. Elementary
4. High school 5. Other/specify_____
2.10 Land holding size_____

3. Livestock production

3.1 How many livestock do you own?

Livestock type	Number(s)
Cattle	
Sheep	
Goats	
Donkeys	

Mule		
Camel		
Poultry		
Honey Bee	Traditional	
	Modern	
Others (specify)		

4. Sheep flock structure

4.1 Average flock size	Number owned
Ewes	
Ewe lamb	
Rams	
Ram lambs	

5. Sheep production

5.1 What are the purposes of keeping sheep?

purpose	meat	Milk	income	Wealth status	manure	saving	gift
Rank							

Others(specify)_____

5.2 What are the major sources of feed in the area?

1. Natural pasture 2. Crop residue
3. Improved fodder crops 4. Agro-industrial by-products
5. Other (*specify*) _____

5.3 What type of grazing system do you use most of the time ?

1. Free grazing 2. Zero grazing 3. Control grazing 4. All of them

5.4 What is the status of grazing land in your area?

1. Decreasing 2. Increasing 3. No change 4. Other (specify)_____

If it is decreasing, why?_____

5.5 Is there any kind of supplementary feed that you give to your sheep at the time of feed shortage? 1. Yes 2. No

5.5.1 If 'yes', at what season?

1. Raining season 2. Dry season 3. Other (*specify*) _____

5.5.2 If 'yes', from where do you get the supplemental feed?

1.Purchasing 2. Enclosed land 3. Crop residue 4. Others (*specify*)

5.5.3 If 'no', why? 1. Not available 2. Expensive 3. Not want to offer 4. Other (*specify*) ____

5.6 Do you have separate housing for sheep? 1. Yes 2. No

5.7 Do you keep younger lambs with the flock over night? 1. Yes 2. No

5.8 How do you provide water to your sheep?

1. Trek them to water source 2. Provide at home 3. roam freely

6. Breeding practices

6.1 Which mating system do you use to your sheep? 1.Controlled 2. Uncontrolled (hand mating) 3. Uncontrolled (natural mating)

6.2 Why mating go uncontrolled? 1. Scarcity of labor 2. Shortage of grazing lands 3. Lack of awareness 4. Others (specify) _____

6.3 Did you select sheep for breeding purpose?1.Yes 2. No

6.3.1 If 'yes' on what basis do you select your sheep for breeding? Prioritize?

1. Body size 2. coat color 3. Fertility 4. Parent history 5. Others----------

6.4 In which sex do you practice selection 1. male 2. female 3. Both

6.5 Which season of the year you prefer for mating/breeding and birth (lambing) your sheep and what are the reasons?_____

6.6 Do you have breeding ram & ewe in your flock? 1. Yes 2. No

6.7 Source of breeding ram?

1. Born in the flock 2. Purchased 3. Neighbors' 4. Communal 5. Others(specify)_____

6.8 Source of breeding ewe?

1. Born in the flock 2. Purchased 3. Neighbors' 4. Communal 5. Others(specify)____

6.9 At what age do you select a breeding ram? (In months)_____

6.10 At what age do you select a breeding ewe? (in months)_____

6.11 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 _____

6.12 For how many years on average is the same breeding ram serving in your herd?

6.13 How many ewes can serve a breeding ram? Per day _____Per season _____ Per year _____

6.14 Do you face shortage of breeding rams? ----------

1=Yes 2=No

6.15 Do you purposely cull your sheep at any time?

(a) Yes (b) No

6.16 What factors determine which sheep you will cull?

1. Poor productivity 3. Sickness
2. Old age 4. Other (specify)

6.17 Culling age of breeding male_____years

6.18 Culling age of breeding female_____years

6.19 Did you observe inbreeding problem in your sheep flock? 1. Yes 2. No

6.19.1 If yes, how sever is the problem?

1. Very Critical 2. Critical 3. Bearable 4. Easily manageable

6.20 Do you think inbreeding is a problem among sheep flock in this area?

1.Yes 2. No 3. Not sure

6.21 Do you think inbreeding has impacted performance of productivity in your own sheep flock?

1. Yes 2. No 3. Not sure

6.22 What are the major breeding problems that affect the herd productivity in your area?

1._____

2._____

3._____

7. Disease & health

7.1 Is Highland sheep disease tolerant breed? 1. Very agree 2. Agree 3. Disagree 4. Strongly disagree

7.2 How frequent you get vaccination service to your farm? 1. Very frequently 2. Yearly

3. Only during out break of disease 4. Never 5. Other (Specific)_____

7.3 How many times do you deworm your sheep per year? _____

7.4 How many times you spray your sheep per year? _____

7.5 Which types of disease are frequent in your area?

Type of disease	Ranking	Easy to treat? 1= Yes 2= No	
1= Respiratory problems			
2= Diarrhea's			
3= Skin problems			
4= Calf mortality			
5= Reproduction (abortion, fertility)			
6= Feet problems			1= 1st 2= 2nd 3= 3rd 4= 4th
7= Internal parasites			
8= External parasites			
9= Others			

7.6 What are the seasons of occurrence for the disease indicated above in that order?

1. Wet 2. Dry 3. Not season specified

7.7 When one of your animals is sick: are those services available?

1=Service available and used 2=No service available 3 =Service available' but not used

If so, how many times did you use them last year?

	Access to services 1=Yes 2=No	Number of yearly visit 1= Onces 2= 2 times 3= 3 times 4= 4 times 5= No visit
Public veterinarian		
Vet. Of a coop. / association		
Private veterinarian		

7.8 How is the efficiency and affordability of the service? ----------

7.9 What are the major veterinary related problems? ----------

8. Reproductive performance

8.1 Average age at sexual maturity (Age at first service)? 1. male____ 2. Female_____

8.2 What is the average age at first lambing? _____months

8.3 Average lambing interval of ewe (months) _____

8.4 Average number of lambing per ewe life time_____

8.5 Most common type of birth (Rank) 1. single 2. twin 3.triplet

8.6 At what age do you wean the lambs mostly?

a. Female _____ months

b. Male) _____ months

8.7 Parity: Max .....Min ..... Avg.....

8.8 Could you able to identify the sire of a kid?

1. yes 2. No

8.9 If yes could you please identify the criteria used_____

8.10 Lambing pattern, occurrence of most births (tick one or more boxes then top three)

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

8.11 Top three months birth occur

1._____

2._____

3._____

8.12 Please fill the following table based on your ewe age structure and parity

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

9. Mortality rate

9.1 How many lambs were born in the previous months?

a. Male _____b. female_____

9.2 Has there been any death of sheep over the last 12 months?

1. Yes 2. No

9.2.1 If ' yes' How many of them died? a. male _____b. female_____

S.N	structure	died number	Sex		Reason of mortality (rank)	1. disease 2. feed shortage 3. predators 4. accident 5. Poisonous plant 6. unknown 7. others (specify) _____
			Female	Male		
1	Abortion					
2	<3 months (Pre-weaning)					
3	3-12 months (Post-weaning)					
4	>12 months (adults)					

9.3 What proportion of lambs survives to weaning? _____
9.4 What proportion of lambs survives to yearling? _____
9.5 What clinical signs did you observe before their death?
1. _____2. _____
3. _____ 4. _____
9.6 At what season your lamb die most frequently?
a. Autumn (Sep, Oct, Nov) c. spring (Mar, Apr, May)
b. Winter (Dec, Jan, Feb) d. summer (Jun, Jul, Aug)
9.7 On which reproductive parameters is mortality of lambs mostly observed?
9.8 Birth type: 1. Single birth 2. Twin birth 3. Triple birth
9.9 Parity**:** a. 1^{st} b. 2^{nd} c. 3^{rd} d. 4^{th} e. 5^{th} f. 6^{th} g.7^{th}
9.10 How do you see trend of mortality rate?
9.11 Why such trend was observed? _____
9.12 What is the trend of mortality in your lamb?
1. Increasing 2. Decreasing 3. no change 4. I don't know 5. others_____
9.13 If increasing what are the reasons_____
9.13.1 If decreasing what are the reasons_____
9.14 Did you slaughter any sheep for holiday consumption in the past one year?
1- Yes 2- No Ram_____ Ewe_____
9.15 Did you slaughter any sheep for regular consumption other than holidays in the past one year? 1- Yes 2- No If yes, how many? Ram_____ Ewe_____

10. Marketing

10.1 Did you sale sheep in the formal market during the past one year? 1. Yes 2. No
10.1.1 If yes, how many? Ram_____ Ewe_____ Calve_____
10.2 How long does it take for the lambs born in your flock to mature and be ready for market? Male _____ and Female_____ (Months).

10.3 Where do you sell most of your sheep?

Selling place		To consumers	To middle man	Shopping center	Hotels	Others
In the same village						
In neighboring village						
In the nearby town						

10.4 How do you sell your sheep?

1. As an individual .3 as a member of cooperative
2. As a member of informal group 4. other (specify) _____

10.5 When would you usually sell your sheep?

1. Any time they are matured for sell 2. Any time when need arise 3. Targeting festive seasons (Christmas, Easter, new year) 4. Others _____

10.6 Which sex is preferable for your market?

1. Male 2. Female

10.7 What age range is preferable for your market? 1. male_____ 2. female_____

Which sheep category would you usually target when you have to sell?

1.Breeding ram 2. Ewes 3. Ram (matured for meat/market) 4 . Ram lambs (young)
5. Ewe lambs (young) 6. Old ewes

10.8 Do you practice sheep fattening before selling the unselected rams?

1. Yes, always 2. Not started yet 3. Yes, sometimes

10.9 Do you usually castrate ram in your sheep flock at younger age for fattening purpose? 1. Yes 2. No

11. Perception of farmers (for CBBP participants)

11.11 How long you have been member of this CBBP?

1. One year 2. two years 3. Three years 4. others (specify)_____

11.2 How many group members do you have?

Male_____ female_____ total_____

11.3 How many rams are allocated in your group so far?_____

11.4 Number of sheep ear tagged in your sheep flock _____

11.5 Are your new born lambs ear tagged:

1. Always 2. Mostly 3. Rarely 4. Not at all

11.6 How often would you keep record performance of sheep born in the flock (characteristics and pedigree)? 1. Always 2. Most of the time 3. Rarely 4. Not at all

11.7 Do you have rules and regulation in the use of rams in CBBP ? 1. Yes 2. No

If yes , who formulated the rule?

1. The community itself 2. The organizations that participate
3. Learning from neighboring community 4. I don't know 5. Others (specify, if any)

11.8 How often did you use the best breeding rams selected by CBBP over the last two-three years?

1. Always 2. Sometimes 3. Very rarely

11.9 If you did not use the breeding ram always, what was the reason?

1. We only share the grazing land during some seasons of the year
2. The best rams are very far from me and had rare access
3. I did not think it would make significant difference
4. Other reasons

11.11 Do you have problem to access breeding ram in months when you don't have access to the breeding ram? 1. Yes 2. No

11.11 How much do you agree or disagree if I say that best rams selection is crucial for sheep breed improvement?

1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree

11.12 Does CBBP approach to improve sheep breed suit the locally established social norm? 1. yes 2. No

11.13 Is community approach to improve sheep breed workable and widely acceptable in this community? 1. Yes 2. No

11.14 How do you perceive the trend of your sheep productivity in the past 2- 3 years?

1. decreasing 2. Increasing 3. remains the same 4. I can't compare

---

11.14 Body size of new born sheep in your flock after breeding program:

1. showed improvement 2. Showed no change 3. Decreased in body size 4. I didn't notice

11.15 Number of twin born lambs in your sheep flock per year after the breeding program:

1. Increased 2. No change 3. Decreased 4. I didn't notice

11.16 Mothering ability of ewes in your flock after the breeding program:

1. showed improvement 2. showed no change 3. Deteriorated 4. I didn't notice

11.17 Do you see improvement in lambing interval between after and before the sheep breeding program was started among ewes in your sheep flock?

1.Yes 2. No 3. I don't know

11.17.1 If yes, do you believe that is due to the sheep breeding program based on best ram selection implemented over the last few years in this community?

1.Yes 2. No 3. Not sure

11.18 What would you say about income gained from sell of sheep and sheep products over two-three years?

1. Improved significantly 2. No change 3. Decreased

11.19 If your income from sheep keeping increased over the last two-three years, it is

1. completely due to improvement in the sheep breed
2. Partly due to improvement in the breed
3. Just due to increase in demand and price of sheep over years
4. Not easy to tell
5. Other reasons_____

11.20 Consumption of sheep meat in the household after the program:

1. Increased 2. Decreased 3. No change

11.20.1 If increased, why consumption has increased? _____

11.20.1 If decreased, why consumption has decreased? _____

11.21 Do you think CBBP remains important as compared to common farmers practice?
(1) Yes (2) No (3) I can't decide

11.22 Have you ever been trained on sheep husbandry and management? 1. Yes 2. No

11.22.1 If yes, by whom? 1. NARS 2. District extension 3. ICARDA/ILRI 4. (other) _____

11.23 Have you been trained on selection of best rams for breeding? 1. Yes 2. No

11.24 How frequent extension staffs/ researchers contact you?
(1) Always (2) most of the time (3) sometimes (4) not at all

11.25 How do you evaluate the extension service you get(very good, good, moderate, poor)?

11.26 Do you believe the breeding program could sustain without external support? 1. Yes 2.No

11.27 Do you believe members of the breeding program have gained adequate skill to select best rams? 1. Yes 2. No 3. I don't know

11.28 Would you continue to be a member of the breeding program if technical and financial support stops? 1. Yes 2. No

11.29 How do you evaluate the benefit you get from CBBP intervention?
1) Good 2) very good 3) Excellent 4) Others_____

11.30 How do you evaluate composition of women in your group?
1. low 2. Very low 3. moderate 4. high 5. very high 6. others (specify)_____

11.31 Do you have plan to organize & upgrade in to cooperatives?
1. Yes 2. No

11.31.1 If yes how?_____

11.31.2 If no why?_____

11.32 What are internal constraints you face? (mention)----------
---

11.33 What are external constraints you face? (mention) ----------
---

11.34 What do you recommend to alleviate these constraints? (mention)----------
---

11.35 What is your future perspective with regard to CBBP intervention and what do you recommend for its sustainability_____

12. Perception of farmers (for non CBBP - participants)

12.1 Are you aware of farmers participating in CBBP in your area?
1. yes 2. No
12.2 Do you think farmers that participate in CBBP are benefiting from the intervention?
Yes 2. No
12.2.1 If your answer is 'yes' in what regards_____
12.3 Do you think sheep in CBBP are better in performance than yours?
1. yes 2. no
12.3.1 If your answer is 'yes' could you please specify_____
12.3.2 If you answer is 'no' could you please specify _____
12.4 Do you think you benefited indirectly from CBBP? 1. yes 2. no
12.4.1 If your answer is 'yes' how_____
12.5 Do you want to be member of such intervention? 1. yes 2. No
12.5.1 If your answer is 'yes' could you please specify the reasons_____
12.5.2 If you answer is 'no' could you please specify the reasons _____
12.6 What are the opportunities of CBBP?
12.7 What constraints do you observe in CBBP?

Thank You for your time!!!

Appendix Table 2. Data collection sheet for body weight under community based breeding program

PAs	Birth Date	Ewe ID	Ewe age	Parity	Ram ID	Lamb ID	Breeding program (BF and PSR)	Birth Year	Birth Season	Sex	Gen	BT	BW	TMW	SMW	YW

Appendix Table 3. Data collection sheet for reproductive performances under community based breeding program

PAs	Date of birth	Birth year	Ewe ID	Season of Previous birth	Season of actual birth	Ewe age	Parity	Birth type	lambing interval	Progeny (Female) ID	Progeny date of birth	Progeny Age at first lambing

Appendix Table 4. The GLM Procedure for body weight comparison between base flock and Progeny of selected rams after selective breeding

Dependent Variable: birth weight

R-Square	Coeff Var	Root MSE	bw Mean
0.121139	10.87733	0.226546	2.082734

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Selective breeding	1	1.73963983	1.73963983	33.90	<.0001
Site	1	5.55100840	5.55100840	108.16	<.0001
Selective breeding*PAs	1	0.16788276	0.16788276	3.27	0.0707

Dependent Variable: three months weight

R-Square	Coeff Var	Root MSE	tm Mean
0.021241	19.22020	1.397264	7.269768

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Selective breeding	1	53.29405901	53.29405901	27.30	<.0001
Site	1	1.17242725	1.17242725	0.60	0.4385
Selective breeding*PAs	1	4.53588348	4.53588348	2.32	0.1277

Dependent Variable: six months weight

R-Square	Coeff Var	Root MSE	sm Mean
0.047929	16.72872	1.584827	9.473691

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Selective breeding	1	36.75053529	36.75053529	14.63	0.0001
Site	1	23.60257952	23.60257952	9.40	0.0023
Selective breeding*site	1	0.00000571	0.00000571	0.00	0.9988

Dependent Variable: yearling weight

R-Square	Coeff Var	Root MSE	nm Mean
0.053275	12.52804	1.428369	11.40138

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Selective breeding	1	1.20630795	1.20630795	0.59	0.4422
Site	1	18.88034062	18.88034062	9.25	0.0024
Selective breeding*site	1	7.31854802	7.31854802	3.59	0.0586

Appendix Table 5. The GLM Procedure for fixed factors on body weight performances of Highland sheep under CBBP rearing

Dependent Variable: birth weight

R-Square	Coeff Var	Root MSE	bw Mean
0.072551	10.27008	0.220584	2.147835

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Birth year	2	0.13460467	0.06730234	1.38	0.2518
Season	2	0.62438078	0.31219039	6.42	0.0018
Sex	1	0.00512126	0.00512126	0.11	0.7458
Generation	1	0.12115296	0.12115296	2.49	0.1152
Birth type	1	0.00044305	0.00044305	0.01	0.9240

Dependent Variable: three months weight

R-Square	Coeff Var	Root MSE	tm Mean
0.319922	16.01357	1.122617	7.010412

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Birth year	2	47.25971478	23.62985739	18.75	<.0001
Season	2	7.00225141	3.50112570	2.78	0.0632
Sex	1	2.71247454	2.71247454	2.15	0.1430
Generation	1	9.10979712	9.10979712	7.23	0.0074

Birth type	1	0.71988991	0.71988991	0.57
0.4501				

Dependent Variable: six months weight

R-Square	Coeff Var	Root MSE	sm Mean
0.211880	15.32618	1.393448	9.091946

Source	DF	Type III SS	Mean Square	F Value
Pr > F				
Birth Year	1	0.57557070	0.57557070	0.30
0.5870				
Season	2	42.40135324	21.20067662	10.92
<.0001				
Sex	1	0.61215065	0.61215065	0.32
0.5753				
Birth type	1	5.06313068	5.06313068	2.61
0.1086				

Dependent Variable: yearling weight

R-Square	Coeff Var	Root MSE	nm Mean
0.087990	11.85308	1.333910	11.25369

Source	DF	Type III SS	Mean Square	F Value
Pr > F				
Birth year	1	0.46245839	0.46245839	0.26
0.6110				
Season	2	9.33385741	4.66692871	2.62
0.0761				
Sex	1	0.11119188	0.11119188	0.06
0.8030				
Birth type	1	4.15486522	4.15486522	2.34
0.1287				

Appendix Table 6. Pearson correlation of birth, weaning, six months and yearly weight of Highland sheep under CBBP

	BW	3MW	6MW	YW
BW	1.00000	0.34985	0.31154	0.10081
WW	0.34985	1.00000	0.49660	0.36174
SMW	0.31154	0.49660	1.00000	0.66599
YM	0.10081	0.36174	0.66599	1.00000

Appendix Table 7. Average annual rain fall distribution of Atsbi Wenberta district

year	Avg. Annual rain fall (mm)
2006	633
2007	972.8
2008	332.2
2009	484.
2010	724.4
2011	660.6
2012	529.3
2013	678.7
2014	677.4
2015	315.3

Appendix Table 8. Average annual temperature of Atsbi Wenberta district

year	Avg. Temperature (^{O}C)
2006	14.45
2007	14.5
2008	14.6
2009	14.4
2010	14.0
2011	14.7
2012	15.0
2013	14.8
2014	14.6
2015	14.7