EVALUATION OF AWASSI-MENZ SHEEP CROSSBREEDING PROGRAMS AT DEBRE-BIRHAN AND AMED GUYA SHEEP MULTIPLICATION AND BREED IMPROVEMENT CENTERS

MSc THESIS

BY

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The thesis entitled "EVALUATION OF AWASSI-MENZ SHEEP CROSSBREEDING PROGRAMS AT DEBRE BIRHAN AND AMED GUYA SHEEP MULTIPLICATION AND BREED IMPROVEMENT CENTRES" will be approved by School of Animal and Range Sciences for partial fulfillment of the Degree of Master of Science in Animal and Range Sciences (Specialization: Animal Breeding and Genetics).

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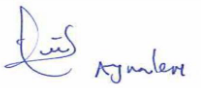
Aynalem Haile (PhD)		30/11/ 2021
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DEDICATION

I dedicated this Thesis manuscript to my parent's (Muchie Jemberie and Yezbalem Adugna), my wife Yezebie Belachew and to my sons Rufael and Kaleab Diress.

STATEMENT OF THE AUTHOR

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LIST OF ABBREVIATIONS (ACRONYMS

AFL	Age at First Lambing
AGSMBIC	Amed Guya Sheep Multiplication and Breed improvement Center
ANRSBOARD	Amhara National Regional State Bureau of Agriculture and Rural Development
BED	Breed Evaluation and Dissemination
BHS	Black Head Somalis
BOA	Bureau of Agriculture
BWT	Birth Weight
CADU	Chilalo Agricultural Development Unit
CSA	Central Statistics Agency
DAD-IS	Domestic Animal Diversity Information System
DBARC	Debre Birhan Agricultural Research Center
DBSMBIC	Debre Birhan Sheep Multiplication and Breed improvement Center
FAO	Food and Agriculture Organization
GLM	General Linear Model
HHs	House Holds
LI	Lambing Interval
LS	Litter Size
PPR	Peste des Petits Ruminants
SMBIC	Sheep Multiplication and Breed Improvement Center
WWT	Weaning Weight

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Evaluation of Awassi-Menz Sheep Crossbreeding Programs at Debre-Birhan and Amed Guya Sheep Multiplication and Breed Improvement Centers

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ABSTRACT

The study was conducted at Debre Birhan and Amed Guya sheep multiplication and breed improvement centers with the objective of evaluation performance of Awassi-Menz sheep crossbreeding program in the ranches. To achieve this, survey was conducted on crossbred program beneficiaries and data from the two ranches was used. Data collection conducted via questionnaire survey from respondents, focus group discussions and secondary data from ranches. A total of 104 beneficiary farmers were purposively selected and 9,840 lambs for Birth weight (5,991 at Debre Birhan and 3,849 at Amed Guya), 8,299 lambs for weaning weight (4,833 at Debre Birhan and 3,466 at Amed Guya), 4,462 ewes for lambing interval (2,995 at Debre Birhan and 1,467 at Amed Guya) and 368 ewes for age at first lambing (285 at Debre Birhan and 83 at Amed Guya) were used for analysis. The effects of different fixed factors like blood level of lambs and ewes, lamb sex, parity of dam, season of birth, year of birth, and birth type on survival rate, productive and reproductive performance were analyzed. The acceptance of crossbred lambs by the farmers, the preference of respondents on different traits and the purpose of using crossbred Awassi-Menz sheep were evaluated from Menz Gera Mider and Baso districts. The main smallholder sheep producers' traits of interest were growth rate, body size, and color in the order of their importance. The overall average ram dissemination performances of the ranches per year were 92.76±14.29 rams. The overall birth and weaning weight of Awassi -Menz crossbred sheep in the present study was 3.65±0.009 and 16.17±0.038 kg respectively. In the present study lamb blood level (50%, 75%, 87.5% and 93.75%) parity, lamb sex and lamb birth year had very highly significant ($p<0.0001$) effect on birth weight and weaning weight of lambs at both centers. The overall age at first lambing and lambing interval of Awassi-Menz sheep in the present study was 425±6.92 and 436.44±2.41 days. The effect of birth year were significant ($p<0.0001$) on age at first lambing and lambing interval of sheep at both centers. The overall survival rate from birth to 30 days, 90 days, 180 days, 270 days and yearling age were reported to be 90.6%, 86.2%, 84.6%, 84.5% and 84.5%, respectively. It can be concluded that the higher blood level of Awassi crossbred sheep had higher body weight than the lower blood level of Awassi crossbred sheep. The lower blood level of Awassi crossbreed sheep lambs (50%) had higher survival rate than lambs with higher blood level (75% and 87.5%) Awassi-Menz crossbred lambs. Blood level effects influenced survival rates in the study and needs to be considered whenever there is a need to improve the performances of Awassi crossbred sheep breeds both at Debre Birhan and Amed Guya centers

Key words: Awassi Menz crossbred sheep, productive and reproductive performance, survival rate, fixed factors

1. INTRODUCTION

Small ruminant production is an important agricultural activity and has a substantial contribution to smallholder farmers in generating income and securing food in developing countries (Kosgey *et al*., 2006). The total sheep population in Ethiopia has estimated to be about of 40 million (CSA, 2019/20). Tropical developing countries typically rely on non-specialized multipurpose breeds and extensive production systems and control over breeding animals is often poor. Existing breeds are adapted to the existing environmental situation which is characterized by feed scarcity and disease challenge (Baker *et al*., 2002; Haile *et al*., 2002; Gizaw *et al*., 2008a).

Indigenous sheep breeds have great potential to contributing more to the livelihoods of the people in low-input, smallholder crop livestock and pastoral production systems (Kosgey and Okeyo, 2007). They are considered as a living bank against the various environmental calamities (crop failure, drought, and flooding) and have socio-cultural values for diverse traditional communities (Edea *et al.,* 2010). Mostly indigenous sheep in Ethiopia have a multipurpose role for smallholder farmers as a source of income, meat, milk, manure and wool. In the pastoral system of Ethiopia, sheep are commonly used for milk as well as for meat and skin (Getachew *et al*., 2010). However, there is a belief that local breeds are less productive and unlikely to continue sustaining the fast growing demand for food that is created by rapid human population growth, urbanization and income growth.

Crossbreeding is considered as one of the options and it is a potentially attractive breed improvement method due to its quick benefits as the result of breed complementarity and heterosis effects (Leymaster, 2002; Hayes et al., 2009).

Among several improvement strategies that have been proposed one of them is the use of exotic germplasm on indigenous breeds of the country (Getachew *et al*., 2016). However, this strategy has not yielded the desired results among the sheep. This may be ascribed to the traditional management of the sheep and that the top down approach which was popular till a few decades back. The major drawback of the top down approach was that the stakeholders were rarely consulted by the scientific communities and that the adaptability of the crossbreds themselves was generally poor (Wollny *et al*., 2002). This is because the management and nutritional need of the crossbreds were seldom fulfilled and the genotype by environment effect was in most of the cased negative (Gizaw *et al*, 2007). However, as the top down approach did not yield appreciable results the bottom up approach (community led) were initiated which proved to be much better as the stake holders were involved across the different decision making processes (Zewdu *et al.*,2006).

Community-based breeding program under the bottom up approach have emerged as a viable option to harvest the genetic potential of the native breeds, this is a time consuming process but if carried out properly can lead to sustainable gains in the long run (Wurzinger *et al*., 2011).

Therefore, over the period of time it is expected that the selected sheep can help sustain themselves under the meager feed resources besides will have a better adaptability and sustainability to the prevailing agro climate (Wollny, 2003).

Moreover, such selection methods also take into account the traditional knowledge of the farmers who are known the potential of their sheep under the climate where they are raised (Sölkner-Rollefson, 2003). Traditional knowledge also takes into account the various factors which the sheep may exhibit very early in their lives and are generally correlated with higher production and reproductive capability when mature (Zewdu *et al*., 2012).

Therefore, keeping all the above into consideration and in absence of long term and sustainable breeding policies especially for the small holder farmers (who are majority in the country) International Centre for Agricultural Research in the Dry Areas (ICARDA), the International Livestock Research Institute (ILRI) jointly with the Austrian University of Natural Resource and Applied Sciences (BOKU) and National Agricultural Research Systems in Ethiopia is designing a community-based sheep breeding strategy.

Crossbreeding of local sheep with the exotic Awassi genotype is the adopted strategy for increased meat and coarse wool production in the central highlands of Ethiopia. Previous investigations showed the superiority of crossbred sheep in body weight measurements, carcass and annual coarse fleece yield (Sisay et al., 1988). Measurements of few component traits mainly on experimental stations are less useful in estimating the relative performance of the genotypes involved.

Menz sheep genetic improvement program was initiated in 1967 by crossing local Menz sheep with exotic wool sheep breeds to improve mutton and wool production. Initially the crossbreeding program was started by introduced 50 Corriedale, six Hampshire, and six Romney exotic rams (DBHBMC, 2007). However, the exotic breeds were later stopped because they were not accepted by farmers as the breed did not meet phenotypic preferences like face cover with hair, absence of horn in males, thin tail, fatty nature of wool making it difficult to spin in traditional way and the suspected poor skin quality (Gizaw and Getachew, 2009).

The Awassi-Menz sheep cross breeding program involved introducing of pure Awassi rams, production of Awassi–Menz crossbred rams in multiplication centers, distribution of 6-month-old rams to village farmers and improving meat and wool production of local sheep (Gizaw and Getachew, 2009). Since 1980, 45 pure Awassi ram lambs and ewes were imported. At the end of 2004, 67 breeding rams at Debre Birhan and 13 at Amed Guya multiplication centers were managed to maintain pure breed flock. These multiplication centers followed to produce crossbred rams with the desired blood levels through crossing of Awassi rams and Menz ewes (Gizaw and Getachew, 2009).

Currently, Awassi breed in the highland is being used for crossbreeding by farmers to improve the performance of local sheep breeds. Moreover, previous studies on the program have not or little, if any, addressed on-farm and on-station productive and reproductive performance evaluation of Awassi crossbred sheep.

Therefore, to design sustainable breeding program and to select optimal level of Awassi-Menz sheep breeds to the local environment, reproductive and productive performance evaluation of the existing breed and their crosses is the pro founding factor.

The present study, was, therefore looked at performance of the sheep multiplication and breed improvement centers to evaluate the flock size and their composition, status of crossbreeding program, reproductive and productive performances and adaptation of different blood levels of Awassi and Menz sheep breeds with the following objectives:

1.1. Objective

1.1.1 General objective

- The general objective of the current study is to evaluate performance of Awassi-Menz sheep crossbreeding program in the ranches.

1.1.2 Specific objectives

- To evaluate productive and reproductive performances of Awassi, Menz, and different blood levels of Awassi-Menz crossbreds in crossbreeding program at Debre Birhan and Amed Guya ranches.
- To evaluate survival rate of different blood levels of Awassi-Menz crossbreds in crossbreeding program at Debre Birhan and Amed Guya ranches.

2. LITERATURE REVIEW

2.1. Sheep Breeds of Ethiopia

Ethiopia has a large sheep population in Africa, which is estimated at 39.89 million sheep (*CSA, 2019/20)*; Ethiopia is believed to be one of the major gateways for domestic sheep migration from Asia to Africa (Edea, 2008). The existence of this diversity is largely due to its geographical location near the historical entry point of many livestock populations from Asia, its diverse topographic and climatic conditions; the huge livestock population's size and wide range in production systems (Assefa, 2010).

Different sheep are widely distributed across different agro ecological zones of the country. Generally, based on phenotypic attribute there are six recognized indigenous sheep breed groups, 9 breed types and 14 traditional populations in the country. These breed groups are (Short-fat-tailed, Washera, Thin-tailed, Long-fat tailed, Bonga and Fat-rumped). Under these breed groups there are 9 breed types (Simien, short fat tailed, Afar and BHS, Gumuz, Horro and Arsi, Bonga and Washera) (FAO, 2007; Solomon, 2007).

Further, Gizaw (2008) grouped each sheep breeds into 14 traditional populations (Simien, Sekota, Farta, Tikur, Wollo, Menz, Gumuz, Washera, Horro, Adilo, Arsi, Bonga, Afar and Black head Somali) (Table1). Each sheep population are characterized by different tail types (7 are fatty and short tail type, 4 are fatty and long tail type, 2 are fat rump and Gumuz are thin and long tail type (Table1).

Table 1: Classification summary of Ethiopian sheep breeds and breed groups

Breed group	Breed	Population	Tail type/shape	Fiber type
Short fat tailed	Simien	Simien	Fatty and short	Fleece
	short fat tailed	Sekota, Farta, Tikur, Wello, Menz	Fatty and short	Fleece
Washera	Washera	Washera	Fatty and short	Hair
Thin-tailed	Gumuz	Gumuz	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 rumped	Afar and BHS	Afar and BHS	Fat rump /fat tail Fat rump/fat tiny	Hair Hair

Source: (Gizaw, 2008); BHS, Black Head Somali

2.2. Genetic Diversity of Ethiopian Sheep Breeds

Sheep are found in different ecological zones of the country and they adopt subalpine, arid lowland, sub-humid lowland, dry highland and wet highlands. The major and common sheep production system in Ethiopia is based on indigenous breeds. However, Awassi crossbreds, Dorper crossbred and indigenous Menz crossbreds also existing in the different part of the country (Tibbo, 2006*;* Mekuriaw *et al.*, 2013). Within a long period of time, indigenous sheep breeds have become adapted to various stress condition such as heat, cold, humidity, water scarcity, seasonal fluctuations in feed availability in terms of quality and quantity, and various diseases.

Ethiopia has a large genetic resource of sheep, but these genetic resources have been lost and many more are threatened due to uncontrolled crossbreeding and replacement with exotic breeds (Tibbo, 2006*;* Gizaw *et al.*, 2013).

2.3 Genetic improvement practices of sheep in Ethiopia

The first introduction of exotic sheep breeds into Ethiopia traced back to 1944 where Merino sheep was introduced from Italy by an American aid organization and were maintained at Entoto (located near Addis Ababa) sheep breeding station (DBSBMC, 2007). Romney, Corriedale, Hampshire, and Rambouillet were introduced from Kenya in 1967 and were kept at the government farm Debre Berhan Sheep Breeding and Multiplication Center (DBSBMC). In 1980, Awassi sheep were introduced from Israel and kept at DBSBMC and Amed Guya Sheep Breeding and Multiplication Center (AGSBMC). There were also continuous importations of purebred Awassi sheep totaling 45 (ram and ewe lambs). The two government farms have been engaged in multiplication and distribution of crossbred rams to farmers at a subsidized price. Ram dissemination was prevented between the years 2001 and 2009 following the confirmed Maedi-Visna disease in crossbreds and associated sheep flocks (DBHBMC, 2007).

In 2011, about 170 pure Awassi sheep were imported from Israel to recommence crossbreeding in the farms. Dorper sheep were introduced into the Jijiga area (Somali Region) in the late 1980s. On-station performance of crossbred was very good however there was no on-farm evaluation during that time (Awgichew and Gipson, 2009). All sheep were looted from the ranch during the political instability in 1991 (Awgichew and Gipson, 2009).

A total of 120 Dorper sheep (ewes and rams) were imported again from the Republic of South Africa in 2007 (Awgichew and Gipson, 2009). Regional research institutions also showed interest in Dorper sheep and additional ~250 sheep were imported in 2011, aiming to establish new nucleus flocks.

Introduction of different exotic sheep breeds like Romney, Corriedale, Hampshire, and Rambouillet was to crossbreed them with local sheep breeds aiming to supply wool for the Debre Berhan blanket factory which is established in 1967. From the year 1969 to 1974, a total of 99 crossbred ewe lambs and ram lambs were distributed to farmers. The breeds performed well in growth under station and farmer situation except Romney breed (DBHBMC, 2007). However, these breeds were not fully accepted by farmers due to their physical characteristics (face covered with hair, absence of horn in males and thin tail), fatty nature of wool making it difficult to spin in the traditional way, and the suspected poor skin quality.

DBSBMC and AMSBMC distributed more than 4000 crossbred rams of different breeds (Awassi, Corriedale, and Hampshire) to smallholder farmers at subsidized prices between the year 1974 and 2001 (DBHBMC, 2007). Hampshire and Corriedale breeds were initially used while these breeds were gradually replaced by Awassi following the introduction of Awassi in 1980. Awassi breed has been well accepted by Ethiopian farmers due to its similar physical appearance to that of local breeds. In the first four years of Awassi ram distribution, individual smallholder farmers were targeted.

The target has been on disseminating rams with 75% Awassi inheritance to farmers for crossbreeding with their local ewes aimed at replacing the local sheep breed through repeated backcrosses (DBSBMC, 2007).

2.4. On-Station Evaluation of Indigenous Sheep

Ethiopia has large number of sheep genetic diversity (DAGRIS 2004). Sheep breeds are found in all agro ecological zones of Ethiopia and are mostly kept under smallholder subsistence production system where input supplies are low. On-station experiment provides controlled environments for a more accurate evaluation of performance, measuring several traits that would be difficult under village conditions, and comparative evaluation of more than one breed under similar conditions (Gizaw *et al.*, 2013). Understanding the production environment of indigenous sheep would enable a better comparative understanding of the adaptive fitness and performance of the breed (Helen *et al.*, 2015).

Study from the on-station performance evaluation of indigenous sheep breeds and crossbreds in the Central Highlands of Ethiopia by (Tibbo, 2006) confirmed that Horro lambs were heavier than Menz lambs at birth (2.40 vs. 2.06 kg), at weaning (9.48 vs. 8.64 kg) and at yearling (19.0 vs. 17.1 kg) and had faster pre weaning (78.0 vs. 72.6 g per day) and post-weaning (31.0 vs. 29.1 g per day) growth rates.

Another author (Abegaz 2002), however, showed that the yearling weight of most indigenous breeds is between 20 and 25 kg although some breeds (e.g., Horro) can weigh up to 34 kg under on-station management.

He confirmed that the average lamb body weight of Black head Somali sheep on station at birth, weaning and yearling were 2.6±0.02; 11.0±0.11 and 23.8±0.16 kg respectively.

The other author (Yibrah 2008) shows the Horro lambs weighed 2.6, 12.1 and 23.8 kg at birth, weaning and 12 months of age. Reproductive performance study conducted at Debre Birhan Agricultural Research center showed that Menz ewes are superior to crossbreds in age at first lambing and lambing intervals. Pure Menz ewes gave 1.02 litters within 279 days of lambing intervals and their first birth earlier in 598 days than 681 days of crossbreds (DBARC, 2006).

Table 2: Productive and reproductive performance of Ethiopian indigenous sheep breed under on-station

Breed	Mgt type	BWT (kg)	WWT (kg)	YWT (kg)	Reference
Menz	On-station	2.06	8.64	17.1	Tibbo 2006
	On-station	2.07	9.03	15.5	Solomon 2002
Horro	On-station	2.4	9.48	19	Tibbo 2006
	On-station	2.6	12	24	Yibrah 2008
	On-station	2.27	12.6	23.7	Solomon 2002
BHS	On-station	2.60	11.4	23.7	Abegaz 2002
Afar	On-station	2.70	11.5	24.5	Yibrah 2008
		AFL (month)	LI (month)	Litter size	
Menz	On-station	598 days	279 days	1.02	DBARC 2006

Mgt = management type, BWT = birth weight, WWT = weaning weight, YWT = yearling weight, BHS = Blackhead Somali, AFL = age at first lambing, LI = lambing interval

2.5 Awassi crossbreeding programs

The follow up to wool improvement project was the introduction of the Awassi sheep breed from the Middle East. The Awassi crossbreeding program was initiated in 1980 using Menz sheep as Dams. The component of the research program is mandated to Debre Birhan and Sirinka research centers, and the development wing is run by Debre Birhan and Amed Guya sheep breeding and multiplication center under Amhara Bureau of Agriculture. While the program has a clear cross breeding scheme for the multiplication of crossbred rams in the multiplication areas. Extensive and indiscriminate distribution of crossbred rams across the country for the last three decades yielded virtually no impact on the sheep industry (Gizaw and Tesfaye 2008).

There are also problems in the production of crossbred rams. These are the number of crossbred rams produced over the years have been far below than the demand. This is mainly because of the lengthy crossing and back crossing in order to produce 75% Awassi blood rams. The crossbred ram dissemination strategy may have to shift to distribution of 50% Awassi crossbred rams. There have also been repeated outbreaks of viral diseases (Maedi-Visna) that caused the elimination of pure breed Awassi and crossbreds, followed by restocking. Furthermore, the failure to maintain pure breed Awassi flock has necessitated repeated importation of pure stock. The recently imported large pure Awassi flock needs to be maintained properly to avoid further importations. This requires, among other things, planned breeding of the nucleus flock to avoid inbreeding and improved health management.

2.6 Performance Evaluation of Awassi Crossbred Sheep

The importance of sheep production as a source of meat in Ethiopia has been increasing from time to time. This sheep production has experienced changes regarding the use of introduced exotic breeds, to increase the growth rate of lambs. Thus, there is a great demand for Awassi sheep to improve the growth performance of lambs, which is an important trait that determines the overall productivity of the flock.

Crossbreeding of indigenous sheep breeds with improved exotic or local breeds is a usually fast means of genetic improvement. The purpose of crossbreeding is to combine high yielding capacity of the exotic breed with the adaptation attributes of the indigenous breed, but not all crossbreds equally combine both. The Awassi breed, which has phenotypic similarity to the local Menz sheep was imported in 1980, 1984 and 1994 from Israel, and crossed with the indigenous Menz (Rummel *et al.*, 2005). These crosses of Awassi-Menz have been well accepted by farmers of Ethiopian highlands, subsequently, producing of crosses has been boosted up by establishing of ranch and research centre for improvement of the indigenous Menz sheep (Tibbo, 2006). Awassi x Menz (75% Awassi) crossbred rams are distributed to smallholders for breeding purposes aimed at upgrading of village flocks to same blood level. The research center also produced Awassi-Menz crosses and used them for on-station research.

According to Hassen *et al*. (2002), the performance of 37.5% Awassi x 62.5% Menz was no better than the indigenous Menz sheep in a low-input system under smallholder management in the cool highlands of Ethiopia.

He suggests that the superiority of 37.5% Awassi x 62.5% Menz in birth weight was not maintained at weaning due to inability of the indigenous Dam breed to support or provide milk to higher growth rate in the lamb. However, several authors (Lemma *et al.*, 2014; Hassen *et al.*, 2004; Tibbo 2006) investigated that birth weight; growth; carcass and wool were increased as exotic blood level increased.

Several studies from the on-station evaluation of growth performance of crossbreds using exotic (Awassi) sires in different areas of Ethiopia confirmed that the crossbreds are superior to their local counterparts (Tibbo, 2006*;* Tsegay *et al.*, 2013*;* Lakew *et al.*, 2014*;* Tilahun *et al.*, 2014). Evaluation of the effect of two genotypes (local Menz, 50% Awassi 50% Menz and 75% Awassi 25% Menz) and two levels of feed supplementation (supplemented and non-supplemented) and 2 treatments against internal parasite (treated and non-treated) on the overall productivity of sheep was carried out at DBARC for 10 months (Tibbo *et al.*, 2004).

At the beginning of the experiment (yearling age), the 75% Awassi × Menz were superior in live body weight than the indigenous Menz sheep (23.5 vs. 16.6 kg). At the end of the 10 months experimental period, also crossbreds performed better in live body weight, carcass weight, and fleece yield and had higher marginal profit. However, overall marginal profit including skin price showed that the indigenous Menz sheep were more profitable than the crossbreds due to the higher skin price compared to the crossbreds at that time. However, the authors explained that crossbreds already reached market weight of Menz sheep at the beginning of this experiment indicating that keeping those crossbred sheep for longer time can be costly compared to local genotypes.

Reproductive performance of local and their crosses with Awassi (25 to ~50%) and Corriedale based on the data from the three villages, Serity (Chacha), Negasi-Amba (Menz) and Chiro (Wollo) were studied (Getachew *et al*., 2013). In this study crossbreds showed poor performance for age at first lambing (553.2), lambing interval (286.3), and number of lambs born per ewe per year (1.62) than local breeds with a value of 472.7 days, 247.6 days and 1.74 in all locations.

Table 3: Productive and reproductive performance of Awassi and local crosses under on-station

Breed group	BWT (kg)	WWT(kg)	AFL (days)	LI (days)	Reference
50% Awassi	3.0	17.6	669	252	Getachew *et al*., 2013
75% Awassi	3.8	21.5	553.2	286.3	Gizaw &Getachew, 2009
Local	2.4	15.6	472.7	247.6	Getachew *et al*., 2013

BWT = birth weight, WWT = weaning weight, AFL = age at first lambing, LI = lambing interval

2.7. Reproductive Performance and Lamb Survival of Awassi-Menz Crossbred

Mating of related individuals was unavoidable due to small flock size, leading to inbreeding depression. The inbreeding rates per generation derived from the number of breeding males and females were 6.1% at Debre Berhan and 32.5% at Amed Guya (BoA and ARARI, 2001). Based on the data at DBSBMC collected from 25 Awassi rams and 92 different mattings between the year 2009 and 2013, number of ewes lambed per ewe mating was on average 37% with a range of 10 to 77.5%.

(Demeke *et al.*, 1995) carried out a study at Sheno Agricultural Research Center to evaluate the effect of breeds (pure Menz, Menz × Awassi) and feed supplement (grazing and grazing + 300 g concentrate supplement day 1) on reproductive performances. The authors reported that age at first lambing and the proportion of ewes lambed was not influenced by genotype and supplementary feeding, whereas body weight at conception was influenced by both factors and the interaction of the two. Crossbreds respond more to supplementary feed than pure Menz breed. Awassi × Menz crossbred lambs were heavier at birth compared to pure Menz lambs. The overall effect of supplementation was not significant on lamb birth weight. However, breed by feeding analysis showed lambs from supplemented pure Menz and Awassi crosses ewes were heavier at birth than their counterpart lambs born from the non-supplemented ewes.

Olsson and Beyene (1990) reported a comparable performance of crossbreds in litter weight and lamb survival whereas in total weaning weight of lambs per ewe lambed were increased with increasing level of exotic genes up to 50%.

2.8. Benefits and Adoption of Sheep Crossbreeding

Awassi x Menz crossbreeding program were evaluated on three crossbreeding villages in Angolelana Tera, Menz Gera and Legambo districts (Teferra *et al.*, 2014). A total of 208 farmers, 71 starters (got initial breeding ram from research center), 63 co-farmers (start crossbreeding by buying crossbreds from the starters) and 74 non-users (they do not have crossbred sheep in their flocks) were considered in the study. Low input smallholder farmers participating in the pilot village crossbreeding program were able to improve their income and livelihood.

In all locations, crossbreds were superior in market price compared to their corresponding locals at similar age and under similar management. For example, the price (in Ethiopian Birr) of crossbred vs. local ram lambs was 319 vs. 171, 362 vs. 177, and 497 vs. 180 in Angolelana Tera, Menz Gera and Legambo, respectively (Teferra *et al.*, 2014).

The positive impact of crossbreeding on their livelihood was mentioned by almost all farmers in the three locations. Increased proportion of crossbreds over time showed the acceptance of crossbreeding (Gizaw *et al.,* 2014; Teferra *et al.,* 2014). Proportion of crossbred sheep in the project participant farmers flocks in Angolelana Tera, Menz Gera, and Legambo districts was 63.6, 42.1, and 64%, respectively. The proportion of crossbreds in flocks of co-farmers was also comparable, with proportions of 47.8, 35.6%, and 54.7 % in respective villages.

2.9. Awassi crossbred Ram Production and Dissemination

Still now introduction and maintaining of exotic breeds, as well as multiplication and dissemination of crossbreds are totally dependent on government farms. Efficient multiplication and dissemination of appropriate genotypes is one of the major components in a breed improvement program. Sheep in government farms suffered from inbreeding due to small numbers of exotic animals and diseases (*e.g.,* Maedi-Visna) associated with confinement. Low fertility with natural mating in the farms and lack of infrastructure and logistics (*e.g.,* shortage of mating pens) limited the number of available Awassi crossbred rams for dissemination from the government farms.

3. MATERIALS AND METHODS

3.1. Description of the study area

The study was conducted at Debre-Birhan and Amed Guya Sheep Multiplication and Breed Improvement Centers in North Shewa zone which are the center of multiplication and distribution of Awassi sheep crossbreeding programs. The sheep flocks were a mix of Awassi, Menz, and crosses (50%, 75%, 87.5% and 93.75%) blood level lambs.

Debre Birhan sheep multiplication and breed improvement center is located in the Baso District around Debre-Birhan town at 120 km North of Addis Ababa at a latitude between 9º 3' 26'' to 9º 64'92''N and 39º 14' 32'' to 39º 27' 37''E longitude. The study ranch is found in the central highland of the country at an altitude above 2,770 m.a.s.l. The annual rainfall of the study area ranges from 950-1,200mm. The mean annual minimum and maximum temperatures are 1.5 and 23.3^{0}C, respectively. The area experiences a bimodal rainfall pattern with a short rainy season occurring from January to March and long rainy season starting at the end of June and extending to early November.

Amed Guya sheep multiplication and breed improvement center; is the other study area, which is situated in the Mehal Meda town of Menz Gera Mider, North Shewa zone of the Amhara region. It has a geographical coordinate of 10^0 18' North, 39^0 40' East with an altitude of 3,132 m.a.s.l. It is located 180 km north of Debre-Birhan town and 361 km northeast of Addis Ababa. The average temperature and the average annual rainfall of the study area are 12.2 ^{0}C and 1149 mm, respectively.

Amed Guya sheep multiplication and breed improvement center experiences a bimodal rainfall patterns with a short rainy season which occurs in winter from January to March and long rainy season in summer starting at the end of June and extends to early November.

3.2. Sampling Technique

Debre-Birhan and Amed Guya sheep multiplication and breed improvement centers were purposively selected due to the existence of Awassi and Menz sheep crossbreeding programs. The studies in the two selected ranches were carried on the Awassi – Menz crossbred sheep. A total of 9840 crossbred sheep of which 5,991 in DSMBIC and 3,849 in AGSMBIC from 2004 E.C to 2013 E.C have been found in the centers and 104 crossbreeding programs beneficiaries from Baso and Menz Gera Mider districts who introduced Awassi crossbreds from the centers were considered. A total of 62 beneficiaries who have gotten crossbred rams from Debre Birhan and 42 from Amed Guya were selected and considered in the study.

3.3. Data collection

3.3.1. Data collection from beneficiary respondents

Primery data from beneficiary respondents were collected by semi structured questionnaire. These included the current household characters (sex, age, education level, household size, and livestock possession), the acceptance of crossbred lambs by the farmers, the preference of respondents on different traits and the purpose of using crossbred Awassi-Menz sheep. Data for this research consisted of 104 beneficiary respondents at Baso and Menz Gera Mider districts.

3.3.2. Data collection from sheep multiplication and breed improvement centers

Data from ranches were collecte by group discussion and secondary sources. Group discussions were held with ranch leaders, ranch experts and sheep keepers of the multiplication centers. Discussions were focused on the improved Awassi – Menz sheep population, breeding objectives, breeding strategies, status of breeding program and major constraints of the program. Focal group discussions were held using a prepared checklist. Data for this research consisted of 9,840 records of birth weight and survival rate (5,991 at Debre Birhan and 3849 at Amed guya), 8,299 lambs for weaning weight (4,833 at Debre Birhan and 3,466 at Amed Guya), 4,462 ewes for lambing interval (2,995 at Debre Birhan and 1,467 at Amed Guya) and 368 ewes for age at first lambing (285 at Debre Birhan and 83 at Amed Guya) over ten years period (2004 to 2013) at Debre Birhan and Amed Guya sheep multiplication and breed improvement centers.

The major challenges and constraints that face the breeding program, policy directions for the program, sire distribution strategies, mating system (flock mating, hand mating, pen mating) and the suitability of the ranch's environment for sheep were also evaluated. The total number of sires and that have entered the breeding station so far, where they came from, why they came, the year they entered, how the sires were distributed to the farmer after their arrival, the blood levels of sires during distribution, current sheep population in the area, flock structure (pure Awassi and Awassi-Menz crosses), management of flocks like feeding system or practice (intensive, semi-intensive and extensive), health of the animals (providing of strategic deworming, regular case to case follow-up and spraying barns), availability of feed throughout the year and types of barn (open, semi open and bound sheep housing) were evaluated.

Productive performance evaluated were lamb birth weight and weaning weight. Reproductive traits evaluated were type age at first lambing and lambing interval. Survival traits like survival of lamb from birth to thirty days, to ninety days, to 180 days, to 270 and to yearling ages was evaluated at both sheep multiplication centers.

From the centers data, the following traits were collected as follows:

Litter size (LS): - Number of lambs had born per ewe per lambing.

Birth weight of lamb (BWL): the birth weight of newborn lamb recordedwithin days after birth.

Litter size at weaning: number of lambs reached weaning age per ewe.

Litter weight at weaning: weight of lambs reached weaning per ewe.

Age at first lambing (AFL): the age when the ewe gives first lamb in her life.

Lambing interval (LI): the interval between one lambing to succeeding lambing in days.

3.4. Ranking analysis

Ranking analysis was used to analyse data from beneficiary respondents. Smallholder sheep producers' trait preferences of live animals for their breeding objectives such as body conformation, hair type, color type, drought tolerance, disease tolerance, marketing value, horn type, growth rate, temperament, prolificacy rate, meat character, tail type, body size, age at first lambing, lambing rate and weaning rate analyzed using index method ranking analysis (Musa *et al*., 2006).

Purpose of keeping sheep, traits for breeding objectives and breeding rams' selection criteria analyzed using index method of ranking analyses from beneficiary respondents. Ranking index is important to manage multiple trait selection.

Index = sum of (4 X value of ranks 1 + 3 X values for 2 + 2 X values for 3 + 1 X values for rank 4) given for an individual attribute /response divided by the sum of (4 X value of ranks 1 + 3 X values for 2 + 2 X values for 3 + 1 X values for rank 4) for overall attribute (Belete, 2013; Hulunim, 2014; Yaekob*et al*., 2015).

3.5. Data Management and Analysis

All the collected data obtained from ranch records and survey were checked for any types of errors occurred. All collected data were entered and managed into Microsoft excel 2016. Data on productive performance, reproductive performance and survival rate in days at different ages were analyzed using GLM procedures of SAS (2002). The fixed effect like lamb sex, parity of ewe, season of lambing, year of lambing and lamb birth type were considered and the response variables were age at first lambing (AFL), lambing interval (LI), birth weight (BWT), weaning weight (WWT) and survival from birth to different ages. Survival trait was determined by whether a lamb survives to the end of each period and by using different age classes of cross bred sheep at ranches (survival to thirty days, to ninety days, to one hundred eighty days, to two hundred seventy days and to yearling).

The statistical models are:

Model 1: Analysis of productive performance

$Y_{ijklmno} = \mu + b_i + d_j + f_k + s_l + t_m + x_n + y_o + e_{ijklmno}$

Where,

$Y_{ijklmno}$ = the observation on productive performance

μ = overall mean

b_i = effect of ith genotype (i=1-6, 1= 50% Awassi, 2=75% Awassi3=87.5% Awassi,)

(4= 93.75% Awassi, 5= Menz, 6= pure Awassi)

d_j = effect of jth season of lamb (j=1-2, 1=Born in wet season (May to October),

(2= Born in the dry season (November to April),

f_k = effect of kth sex of lamb (k = 1 or 2, 1 = male, 2 = female)

s_l = effect of lth year of lambing (l = 1 to 10, from 2004 to 2013E.C).

t_m = fixed effect of lamb birth type (m=1,2 1= single, 2=twine)

x_n = fixed effect of ewe parity (n=1,2,3,4,5)

y_o = effect of location (o= Debre Birhan, Amed Guya)

$e_{ijklmno}$ = random error term associated with each observation.

Model 2: Analysis of reproductive performance

$Y_{ijklmno} = \mu + a_i + b_j + d_k + f_l + s_m + t_n + x_o + e_{ijklmno}$

Where,

$Y_{ijklmno}$ = the observation on reproductive traits

μ = overall mean

a_i = fixed effect of lamb birth year (i = 1 to 10 , from 2004 to 2013E.C).

b_j = fixed effect of ewe parity (j=1,2,3,4,5,)

d_k = fixed effect of birth season (k=1-2, 1=Born in wet season (May to October),

(2= Born in the dry season (November to April)

f_l = fixed effect of lamb birth type (l=1,2 1= single, 2=twine)

s_m = effect of mth sex of lamb(m = 1 or 2, 1 = male, 2 = female)

t_n = effect of mth genotype (n=1-6, 1= 50% Awassi, 2=75% Awassi),

(3=87.5% Awassi, 4= Menz, 5=pure Awassi)

X_o = effect of location (o= Debre Birhan, Amed Guya)

$e_{ijklmno}$ = random error term associated with each observation.

Model 3: For analysis of variances of survival rate in days

$Y_{ijklmno} = \mu + a_i + b_j + c_k + d_l + f_m + x_n + y_o + e_{ijklmn}$

Where,

$Y_{ijklmno}$ = the observation of survival to different ages

μ = overall mean

a_i = fixed effect of lamb sex (i= male, female)

b_j = fixed effect of ewe parity (j=1,2,3,4,)

c_k = fixed effect of birth season (k=1-2, 1=Born in wet season (May to October),

(2= Born in the dry season (November to April)

d_l = fixed effect of lamb birth type (l=single, twin)

f_m = fixed effect of lamb birth year ((m = 1 to 10, from 2004 to 2013E.C).

x_n = effect of nth genotype (n=1-4, 1= 50% Awassi, 2=75% Awassi, 3=87.5% Awassi),

(4= 93.75% Awassi, 5= Menz, 6= pure Awassi)

y_o = effect of location (o= Debre Birhan, Amed Guya

$e_{ijklmno}$ = random error term associated with each observation.

4. RESULTS AND DISCUSSIONS

4.1 Household Characteristics

Household characteristics of the studied sample households in the two districts are presented in Table 4. The average proportion of male respondents in the sample households was 93.3%, while it was 95.1% and 90.5% at Baso and Menz Gera Mider Woredas, respectively**.** As reported by the respondents, males participated more at the field work with the grazing of their livestock and play a dominant role in livestock production practices compared to females who spend most of their time at home. The result in this study with respect to the proportion of the female headed households was lower than 13.5 and 12.5% reported by Amare *et al*. (2019) in Setit and Kafta Humera areas. The proportion of sheep keepers aged between 41-50 years was higher in the study area accounting for 46.15%.it shows that sheep keepers are in medium age and have good experiances for managed the flicks. This agrees with Mekete (2018) who reports that 46% of sheep keepers were aged 41-50 years at Debre Birhan areas.

Interviewed households in the study area have different educational backgrounds. The largest proportion (37.5%) of household heads had attended primary school (grade 1-8) while 6.7% of household have attended high school (grade 9-12). Their exposure to study increases their awareness and insight for accepting and applying crossbreeding program. All of them have Awassi crossbred rams and used for improve their local sheep particularly than the other respondents. In contrast to this report, larger percentage value of primary (44%) in the Damote Gale area and secondary (62.5%) in the Damot Sore area were reported for Dorper sheep breed crosses in Wolaita zone Ermias (2014).

Table 4: Sex, educational level, age group and marital status of HHs head

Household heads characteristics	Baso		Menz Gera		Overall	
	N	%	N	%	N	%
Total respondents	62	100	42	100	104	100
Sex: Male	59	95.1	38	90.5	97	93.3
Female	3	4.8	4	9.5	7	6.7
Education level						
Illiterate	13	20.9	7	16.6	20	19.2
Read and write	22	35	16	38	38	36.5
Primary (Grade 1-8)	22	35	17	40	39	37.5
Secondary (Grade 9-12)	5	8.6	2	4.76	7	6.7
Age Group (year)						
<30	1	1.6	2	4.7	3	2.88
30-40	19	30	10	23	29	27.8
41-50	31	50	17	40	48	46.15
>50	11	17	13	30	24	23.07
Marital status						
Married	56	90.3	39	92.8	95	91.34
Unmarried	6	9.7	3	7.2	9	8.65

N= Number of Respondents

4.2. Livestock holding and composition

The major livestock species kept were sheep with the average holding size of 13.51±0.69 at Baso and 15.80±1.1 at Menz Gera Mider. This is higher than the previous study by Ermias Belete (2014) who reported 7.57±2.3 in Alicho Worero area and 6.1±1.2 reported by Derib (2009) in Alaba, Southern Ethiopia. The present result shows the areas were suited for sheep production.

According to the respondents, the crossbreeding activity of sheep increased from time to time, but has different problems that faced the program (disease, feed and labor shortage). Mostly Awassi crossbred rams those have 75% and more blood levels at the study districts are affected more influenced by these problems but lower blood level lambs from 25% to 50% were resist the problems. Numerically local sheep were the dominant livestock species followed by crossbred sheep at Baso and crossbred cattle at Menz Gera Mider.

The overall average number of crossbred sheep per household was 4.74±0.15, (4.61±0.20 and 4.92±0.23 at Baso and Menz Gera Mider, respectively) (Table 5). Respondents in both districts had no significant *(P>0.05)* in number of crossbred sheep (Table 5). But there was significantly *(P<0.05)* higher number of goat and local chicken in Baso than Menz Gera Mider, and higher number of horse and crossbred chicken in Menz Gera Mider than Baso.

Table 5: Average livestock holding per HHs in the study area

Livestock species	Baso (N=62)	Menz Gera Mider(N=42)	Overall (N=104)	P-value
	Mean±SE	Mean±SE	Mean±SE	
Local species				
Sheep	13.51±0.69	15.80±1.1	14.44±0.61	0.06
Cattle	3.87±0.31	3.64±0.23	3.77±0.20	0.59
Goat	4.14±0.27	3.33±0.26	3.81±0.19	0.044
Chicken	4.69±0.24	3.90±0.23	4.37±0.17	0.027
Donkey	2.06±0.11	2.35±0.14	2.18±0.09	0.12
Mule	0.016±0.016	0.047±0.03	0.028±0.016	0.35
Horse	1.29±0.11	1.95±0.28	1.55±0.13	0.018
Cross species				
Sheep	4.61±0.20	4.92±0.23	4.74±0.15	0.32
Cattle	4.56±0.19	5.09±0.36	4.77±0.36	0.19
Chicken	4.12±0.31	5.19±0.27	4.55±0.22	0.02

SE= standard Error, N= Number of Respondents

4.3. Sheep Flock Structure

Flock composition is an indicator of the production objectives and breeding practices (Solomon Gizaw *et al*., 2014). In the present study at the study districts, breeding ewes had higher proportion among the flock with the overall average number of 7.88±0.48 in the flock followed by the lambs 5.15±0.25 and breeding rams 4.05±0.21. In the present study, relatively large proportion of breeding ewes per flock was observed with the previous result 5.45 reported by Michael (2013) at East Gojjam. The ratio of breeding rams to breeding ewes was about 1:2 which indicates rams are properly mat ewes for fast genetic improvement of sheep in the area. The present study is higher than the 1:4 reported by Hussien (2018) for Legambo and Tenta districts in South Wollo zone and 1:7 for Gumuz sheep reported by Solomon (2007).

Table 6: Average flock size and structures per HHs at the study area

Sheep type/Breed	Baso (N=62) Mean±SE	Menz Gera Mider (N=42) Mean±SE	Overall mean (N=104)	P-value
Ewe	8.46±0.59	7.02±0.45	7.88±0.40	0.08
Ram	3.88±0.19	4.30±0.20	4.05±0.14	0.14
Ram lamb	2.62±0.08	2.57±0.09	2.60±0.06	0.65
Ewe lamb	2.87±0.12	2.59±0.25	2.75±0.12	0.28
Lamb	4.75±0.18	5.73±0.33	5.15±0.18	0.007
Ram: Ewe	1:2			

N= Number of Households

Menz sheep, Awassi-Menz crossbred and pure Awassi sheep are reared at Debre Birhan and Amed Guya sheep multiplication and breed improvement centers with the objective of improving the productivity of the indigenous sheep (figure 1 showes pure Awassi ewes(A),pure Awassi rams(B), 50% Awassi ewes(C) and 75% Awassi(D).

Large flock size usually had extensive sheep breeding practices and generated large number of lambs (Gizaw *et al*., 2010a). The sheep multiplication and breed improvement centers introduced the best Menz sheep breeds from farmers and imported pure Awassi rams for crossbreeding. Based on the current study, sheep flock increased after the introduction of Awassi rams.

In Debre Birhan center, Awassi crossbreds formed the largest proportion (67.36%) followed by local Menz (24.5%) and pure Awassi sheep breed (8.18%). However, different results were obtained in Amed Guya sheep multiplication and breed improvement center where local Menz were dominant (58.46), followed by Awassi cross (39.6%) and pure Awassi breed (1.94) (Table 7). In the present study, relatively larger proportion of breeding ewes per flock (54.1% at Debre Birhan and 71.3% at Amed Guya) was observed. The male to female ratio is 1:19 at Debre Birhan and 1:26 at Amed Guya center. Male to fimale ratio is fair and at recommended level at both centers. In Debre Birhan ranch a total of 94 and at Amed Guya 28 pure Awassi sheep breeds are found. At Debre Birhan, the ranch is trying to replace and breeding pure Awassi breeds by born Awassi and grow here but at Amed Guya the replacement practices of pure Awassi breeds was lower than Debre Birhan center.

According to Taye *et al*. (2011), the larger proportion of breeding ewes would be implied that production of a larger number of lambs, which in turn might increase the intensity of selection, and saleable lambs.

Table 7: Flock size and structures of sheep at the two ranches

	Debre Birhan		Amed Guya		Overall	
Sheep type /breed	N	%	N	%	N	%
Total sheep	1149	100	1447	100	2596	100
Cross breed	774	67.36	573	39.6	1347	51.88
Pure Awassi	94	8.18	28	1.94	122	4.7
Local Menz	281	24.5	846	58.46	1127	43.41
Cross: Ewe	370	32.2	270	18.65	640	24.65
Ram	6	0.52	3	0.21	9	0.34
Ram lamb	12	1.04	22	1.52	34	1.30
Ewe lamb	237	20.63	72	4.97	309	11.90
Lamb	149	12.96	206	14.23	355	13.67
Local: Ewe	252	21.93	762	52.66	1014	39.06
Ram	NA	NA	3	0.21	3	0.11
Ram lamb	NA	NA	46	3.17	46	1.77
Ewe lamb	NA	NA	35	2.41	35	1.34
Lamb	29	2.52	NA	NA	29	1.11
Pure Awassi: Ewe	22	1.91	13	0.89	35	1.34
Ram	16	1.4	13	0.89	29	1.11
Ram lamb	18	1.56	1	0.07	19	0.73
Ewe lamb	13	1.13	NA	NA	13	0.5
Lamb	25	2.17	1	0.07	26	1.00

A. Pure Awassi ewes B. Pure Awassi rams

C. 50% Awassi ewes D. 75% Awassi

Figure1. Type of sheep genotypes at the two ranches

4.4. Crossbreeding Program and performance of ranches

Crossbreeding is a practice that is widely used as a rapid method to improve productive and reproductive performance by mating of two or more pure breeds. The program was considered sustainable genetic improvement of sheep. Sustainability of crossbreeding program highly depends on the choice of appropriate breeding scheme (Leroy *et al*., 2015).

The current program was involved importation of pure Awassi rams, production of Awassi-Menz crossbreds and distribution of six-month-old rams to villagers and improves flock structures by upgrading blood level up to 75% Awassi crosses. First, 50% crossbreds are produced by mating Menz ewes and pure Awassi rams and then males were distributed to villages after they weighted 20 kg and females were back crossed to pure Awassi and then produced 75% Awassi crossbred and distributed males to villages.

From September 1/2004 E.C to January 30/2013 E.C, 9,840 Awassi-Menz crossbred lambs were born in both SMBICs. In the Debre Birhan sheep multiplication and breed improvement center higher crossbred lambs (5,991) were born than Amed Guya sheep multiplication and breed improvement center (3,849). Lower lambing performance of crossbreeding program with the number of 33 lambs at Debre Birhanand 100 lambs at Amed Guya was recorded in 2013E.C (Table 8). During 2004 E.C, in Amed Guya sheep multiplication and breed improvement centercrossbreeding program was closed due an outbreak of a respiratory disease (Maedi-Visna).

Table 8: Awassi -Menz crossbred lambs born over the years at the two ranches

	Newborn lambs									
	Debre Birhan					Amed Guya				
Year	50%	75%	87.5%	93.75%	**Total**	50%	75%	87.5%	93.75%	**Total**
2004	520	111	NA	NA	631	NA	NA	NA	NA	NA
2005	720	229	3	NA	952	137	17	3	NA	157
2006	169	305	9	NA	483	626	9	2	NA	637
2007	387	708	24	NA	1119	689	56	11	NA	756
2008	102	839	65	1	1007	630	56	16	NA	702
2009	48	191	14	1	254	638	66	9	NA	713
2010	84	550	17	NA	651	244	53	40	NA	337
2011	18	422	190	9	639	51	122	37	NA	210
2012	NA	143	75	4	222	105	56	76	NA	237
2013	NA	7	25	1	33	100	NA	NA	NA	100
Total	**2048**	**3505**	**422**	**16**	**5991**	**3220**	**435**	**194**	**NA**	**3849**

NA= Not Applicable,

Efficient multiplication and dissemination of appropriate genotypes is one of the major components in a breed improvement program. Debre Birhan and Amed Guya multiplication centers followed to produce crossbred rams with the desired blood levels through crossing of Awassi rams and Menz ewes (Gizaw and Getachew, 2009).

The crossbred rams were managed at each sheep multiplication and breed improvement centers for four to six months of age and up to attaining 20 kg weight. Before disseminating the rams, the ranches report or announce to regional bureau. After the ranches gate feedback from bureau, they disseminate these rams to selected zones, districts and farmers.

The overall average dissemination performances of the ranches per year were 92.76±14.29 rams, while it was 96.44±16.71 and 88.13±24.92 rams for Debre Birhan and Amed Guya respectively per year (Table 9). This is higher than 4,208 crossbred rams disseminated from Debre Birhan sheep multiplication center during the period of 1970 to 2000 (DBSBMC, 2006) and 355 crossbreds rams disseminated from Amed Guya sheep multiplication center during the period of 1996 to 1999 (BoA, 2000).The ranches disseminated Awassi crossbred rams based on plans made by govornments according to the experience of districts and farmers. They disseminated 75% and more blood levels of rams for districts and farmers who have practiced crossbreeding program for a long period but for beginner districts and farmers they disseminate 50% Awassi crossbred rams.

Table 9: performance of sheep multiplication and breed improvement centers in disseminated Awassi-Menz crossbred sheep

	Disseminated Rams		
Source of variation	N	LSM± SE	P-value
Overall mean	4824	92.76±14.29	
Location		**NS**	**0.217**
Debre Birhan	2797	96.44±16.71	
Amed Guya	2027	88.13±24.92	

N= Number of Rams, NA= Not Applicable, NS= Not Significant

The highest number of Awassi crossbred rams was disseminated in 2008 from both centers. During 2008, a total of 392 and 484 breeding rams were distributed from Debre Birhan and Amed Guya centers, respectively. On the other hand, the lowest number of breeding rams of 77 and 102 rams was distributed in 2013 from Debre Birhan and Amed Guya centers, respectively.

Debre Birhan sheep multiplication and breed improvement center disseminated 2,797 Awassi crossbred rams to eight districts of North Shewa zone, nine districts of North Wello and eight districts of South Wello over the last ten years. Accordingly, Amed Guya sheep multiplication and breed improvement center disseminated a total of 2,027 Awassi crossbred rams to ten districts of North Shewa zone, eight districts of North Wello, 14 districts of South Wello and Debre Birhan Agricultural Research Center in the past eight years (2006 to 2013 E.C). During 2004 and 2005 E.C, in Amed Guya sheep multiplication and breed improvement center dissemination of Awassi crossbred ram was halted due to an outbreak of a respiratory disease (Maedi-Visna) (Table 10).

Table 10: Performance of ranches in dissemination of Awassi-Menz crossbred rams over the year

	Location									
	Debre Birhan					**Amed Guya**				
Year	50%	75%	87.5%	93.75%	**Total**	50%	75%	87.5%	93.75%	**Total**
2004	200	51	NA	NA	**251**	NA	NA	NA	NA	NA
2005	258	92	NA	NA	**350**	NA	NA	NA	NA	NA
2006	218	152	NA	NA	**370**	182	4	NA	NA	**186**
2007	202	185	NA	NA	**387**	361	11	NA	NA	**372**
2008	149	234	9	NA	**392**	432	46	6	NA	**484**
2009	18	263	18	1	**300**	287	101	7	NA	**395**
2010	38	214	57	3	**312**	156	54	1	NA	**211**
2011	26	101	27	2	**156**	64	29	13	NA	**106**
2012	7	133	62	NA	**202**	31	98	39	3	**171**
2013	NA	43	31	3	**77**	34	43	25	NA	**102**
Total	**1116**	**1468**	**204**	**9**	**2797**	**1547**	**386**	**91**	**3**	**2027**

NA= Not Applicable

4.5. Breeding practices

Breeding was generally controlled in both sheep multiplication and breed improvement centers. Pure Menz breed ewes are mated with pure Awassi rams to produce 50% crossbreds. A breeding ram is assigned to a group of ewes of 25 to 30 for 51 days in 3 cycles. The ewes those are not matting in the first cycle have a chance to mat in 2^{nd} or 3^{rd} cycles. One cycle have 17 days.

At mating, ewes were herded together with their respective sire groups during the daytime and depart for the nighttime to be housed together. Both ranches try to avoid dry season lambing and indiscriminate mating. The mating season is started at May and also from June to Augest during wet season.

4.6. Benefit of ranches from Awassi ram introduction

In the present study, the benefit of ranches from Awassi ram introduction is to improve the genetic of local sheep by crossing local with pure Awassi, disseminating of crossbred rams to the districts, to get revenue for districts from disseminated rams. Since the arrival of the pure Awassi sheep breed, large numbers of sheep have been bred and many activities have been done to improve the local sheep breed. The ranches produced and distribute 50% to 75% Awassi-blood crossbred sheep to different Zones, districts and farmeres cooperatives and organized youth groups at affordable prices. The ranches also increased the revenue of district areas from sale of distributed rams. From 2004 to 2013 E.C, 2797 rams from Debre Birhan and 2027 rams from Amed Guya center distributed.

As reported by the respondents, after the introduction of Awassi crossbred rams they are getting the best benefits by breeding their local sheep breeds. The benefits of the breeding program are to improve growth performance of lambs, to change the flock structure from local breeds to improved Awassi-Menz sheep by crossing them, they increase fleece production, they give birth to twins and they sell sheep at a good price. This is in the line of Taye *et al*., (2011) and Teferra *et al*. (2014) who reported that farmers are interested in adoption of sheep crossbreeding due to the fast growth of crossbreds compared to their local sheep breeds in the Awassi×Menz and Farta×Washera crossbreeding attempts in the highlands of the Amhara region. The phenotypic similarity of pure Awassi and their crosses sheep has increased the acceptance of the crossbred animals. As a result, the number of improved sheep has increased at the farmer level.

4.7. Management Practices of Sheep

Flocks in the two ranches the management is semi-intensive with grazing and supplement. The supplement feeds provided regularly and includes grass hay, chopped pasture and concentrate supplement based on their age, breed type and body weight. The health of all the flocks was regularly followed by a veterinarian. Providing strategic deworming, regular case by case follow-up and spraying barns and animals with acaricides to make them free from external parasites were some of the practices exercised.

The ranches provided special management for rams according to the breed type independently. The reason might be that pure Awassi rams need better management and are susceptible to harsh environment.

Types of management for rams were to confine in nucleus barns separately which is complemented with hay trough, water trough and provided concentrated feeds. Pure Awassi rams provided 0.9 to 1.0 kg concentrate feed and crossbred rams were provided with 0.4 kg per day. After the rams distributed to farmers they also provide suplimentary feeds like wheat bran to the distributed rams.This is in agreement with Lakew *et al.* (2014) studies about feeding of 0.4 kg concentrated feeds for Dorper crossbred rams.

Selected rams have been used for the breeding purpose, and at the end of the mating period rams are removed from the ewes' flock s and managed separately. To increase the sheep population, productive and reproductive performance, to improve local sheep breeds and to ensure the benefit of farmers by distributing better rams and to increase the overall activities in each ranches different management practices are taken.

4.7.1. Feeding management

The quantity and quality of feed resources availability for animals primarily depends upon the climatic and seasonal factors (Zewdu, 2008). Natural pasture from grazing land, hay and concentrated feeds were the major feed resources for sheep at all sheep multiplication and breed improvement centers (Figure 2, shows grazeland and figere 3, shows concenterate feed sources). Availability of feeds on grazing land was depends on the season of the year when the lands are covered with grass in wet season. Natural pasture is the major feed resource during the rainy season. All sheep were grazing at pastureland for eight hours a day (Figure 2). Feeding program is considered age of sheep, weight, condition, type of confinement, stage of production, pregnancy, lactation, quality and quantity of feed, health, status of sheep, season of year and weather.

Based on these factors, additional feeds such as hay and concentrate feeds were prepared and given. For local ewes, crossbred and pure Awassi 0.2 kg, 0.4 kg and 0.9 kg concentrated feeds was provided at both centers, respectively. They fed these feeds at their barns and at pastureland under shed places (trees).

Figure 2. Feeding practices of sheep on grazing land

Figure 3. Concentrate feed stock for sheep at Debre Birhan ranch

4.7.2. Health

Free from major diseases is regarded globally as pre-request for genetic improvement (Solomon, 2007). Improvement in the management is a necessity to reduce the loss associated with diseases and parasites. Health management, farm hygiene, proper nutrition, daily monitoring of sheep, daily cleaning of their barns, deworming, dipping for ticks and mites, isolating infected sheep, vaccination of all animals for different diseases, providing a variety of treatments, recording of diseases and reporting of these to regional bureau and research centers were done at both ranches.

4.7.3. Housing

Good housing system can determine good productivity by reducing stress, disease hazards and making management easier. The house is constructed on a well-drained area at both ranches. It is partitioned according to sheep breeds, sex and age of sheep and it creats easier to feed different classes of animals according to their needs, to follow a mating schedule, to control breeding and matind at a very early age, lactating animals can after their young better and pregnant animals can give birth under a more relaxed environment. It is well-ventilated to provide the desired amount of fresh air and to maintain temperature within desired limits. Adequate housing protects sheep from extreme temperature, rain, cold, wind, predator and theft. It further provides opportunities for intensive feeding and controlled breeding of sheep. The sheep were confining in separate house. The ranches housed their sheep when the sun light is strong (11:00 am to 2:00 pm) and night. All barns were fenced and partitioned and is well-feed, well watered and well-drainage.

4.8. Productive performance of Awassi-Menz crossbred sheep

4.8.1. Birth weight

As indicated in the Table 11, the overall mean birth weight of Awassi-Menz crossbred lambs in the present study was 3.65±0.009 kg, with a mean of 3.78±0.033 kg at Debre Birhan and 3.45±0.013 kg at Amed Guya sheep multiplication and breed improvement centers. The difference between the two ranches was statistically significant (*P<0.0001*). The result of birth weight reported in the present study is higher than the 2.57 and 2.77 kg reported by Ayele *et al*. (2015) for Dorper×Afar and Dorper ×Menz 50% crosses, respectively at Debre Birhan agricultural research center. Similarly, the average birth weight result obtained in the present study was also higher than literature reports (Demeke *et al.*,1995; Gizaw et al., 2012) for Awassi × Menz 50% crosses and Corriedale × Menz 50% crosses at Sheno research center) and Awassi × Menz lambs at Debre Birhan research center . However, the present study was slightly lower than the birth weight of pure Awassi lambs 4.4 kg (Seid *et al.*, 2012) and the 3.8 kg reported by Sisay et al. (1988) for the 75% Awassi × Menz crosses under on-farm managemnt. This variation between the different reports might be due to breed difference, the blood level of sheep, management and environmental variation.

Location had significant effect (*P<0.0001*) on the lambs' birth weight. Lambs born in Debre Birhan ranch were heavier than lambs born in Amed Guya ranch with the mean birth weight of 3.78±0.033 vs 3.45±0.013 kg. This should be the management and genotype of sheep in the ranches.

At Debre Birhan more of the sheep breeds (65.8%) have 75% and more blood levels which weighed heavier while at Amed Guya ranch 50% blood level sheep were higher in proportion (83.6%) which weighed lower compared to higher blood level lamb breeds.

In the present study, blood levels of lambs, year of birth and birth season have significant effect (*P<0.0001*) on the birth weight of Awassi-Menz crossbred lambs at the sheep multiplication and breed improvement centers as indicated in Table11.

At Amed Guya sheep multiplication and breed improvement centers, 87.5%, 75% and 50% blood level of Awassi crossbred lambs were heavier at birth than 87.5%, 75% and 50% of Awassi cross lambs at Debre Birhan center (*P<0.0001*) with the average birth weight of 4.56 vs 4.4, 4.18 vs 4.1 and 3.29 vs 3.16 kg respectively. Similarly at the two centers, birth weight of higher blood level Awassi crossbred lambs was heavier than Awassi crossbred lambs those have lower blood level. This increased growth rate as exotic blood level increased was supported by Gizaw and Getachew (2009), The growth rate of lambs was increased as the exotic blood level increased; >50% Awassi were better in birth weight than that of local and 25-50% Awassi. Rams those had 50% blood level should selected for better groth rate and survival at the environment. Several authors (Lemma et al., 1989; Hassen *et al*., 2004; Tibbo 2006) also reported that birth weight increased as exotic blood level increased.

Lambs born in wet season had heavier birth weight compared to those born in dry season with the mean value of 3.8 vs 3.7 kg at Debre Birhan and 3.56 vs 3.28 kg at Amed Guya Sheep multiplication and breed improvement centers, respectively.

This is similar to the findings of Ayele *et al.* (2015) where lambs born in wet season had higher BWT than lambs born in dry season at DBARC. This also tells us the difference in pasture availability in terms of quality and quantity among the different season of the years.

Lambs with heavier birth weight (4.73±0.11 kg) and lighter birth weight (2.92±0.0.24) were born in 2013 and 2005 E.C at Debre Birhan, while at Amed Guya multiplication center the heavier (4.08±0.074 kg) and lighter (2.90±0.022 kg) birth weight of lambs were recorded in 2012 and 2004 E.C respectively compared to those born in other years.

Parity, birth type and sex of lambs had significant *(P<0.0001)* effect on the birth weight of the lambs at sheep multiplication and breed improvement centers (Table 11).

Parity had also significant effect *(P<0.0001)* on the lambs' birth weight at both SMBIC. The present study result shows the birth weight of lambs is better in the latter parities. In the present study, lambs born in 5^{th} parity were heavier than other parities. This is similar to the works reported by Gameda *et al.* (2002).

Single born lambs were significantly *(P<0.0001)* heavier at birth than twin born lambs (3.83±0.013 vs 3.33±0.37 kg) at Debir birhan and (3.47±0.014 vs 3.34±0.04 kg) at Amed Guya sheep multiplication and breed improvement center. Results in the present study are similar with the findings of Abegaz and Hedge (2011) reported for Gumuz sheep.

Similar results were reported by Momani Shaker et al. (2002, 2003) who reported that birth weight of Awassi lambs was 36.12% greater in singles compared with twins and is in agreement with Menz, Horro, Washera and Jordan bred lambs reported by Hassen (2004), Taye (2009), and Momani *et al.* (2010), respectively.

The reason of lower body weight of twin lambs is because of twin pregnant dams might have not sufficient nourishment for their lambs both at pre-natal and post-natal, stage of lamb growth, limited uterine space, and inadequate availability of nutrients during pregnancy and competition between the twins for limited quantity of milk available from the dam.

Male lambs were superior to females *($P<0.0001$)* in birth weight at both ranches with the average birth weight of 3.84 kg vs 3.73 kg at Debre Birhan and 3.5 vs 3.4 at Amed Guya sheep multiplication and breed improvement centers respectively. This result is similar with the findings of Ayele *et al.* (2015) who reported that lambs born from Dorper-Afar 50% and Dorper-50% Menz males were higher than females in birth weight at DBARC.

Table 11: Least Squares Means ± SE of birth weight of crossbred lambs by location at the two ranches

	Location						
Source of	Debre Birhan Center			Amed Guya center			
variation	N	LSM± SE	P-value	N	LSM± SE	P-value	Overall mean
Overall mean	5991	3.78 ±0.033	**<0.0001**	3849	3.45±0.013	**<0.0001**	3.65±0.009***
CV (%)	5991	20.7		3849	19.75		20.68
Lamb blood level		***	**<0.0001**		***	**<0.0001**	***
50%	2048	3.29±0.011^{c}		3220	3.16±0.018^{c}		3.23±0.01^{c}
75%	3505	4.18±0.015^{b}		435	4.1±0.015^{b}		4.11±0.01^{b}
87.5%	422	4.56±0.04^{a}		194	4.25±0.04^{a}		4.35±0.04^{a}
93.75%	16	4.58±0.22^{ab}			NA		NA
Lamb birth year		***	**<0.0001**		***	**<0.0001**	***
2004	631	3.3±0.029^{e}			NA		NA
2005	952	2.92±0.0.24^{d}		157	2.8±0.06^{g}		2.90±0.022^{f}
2006	483	3.79±0.039^{c}		637	3.16±0.022^{f}		3.43±0.023^{e}
2007	1119	3.72±0.028^{c}		756	3.29±0.025^{e}		3.55±0.020^{d}
2008	1007	4.11±0.029^{b}		702	3.52±0.03^{d}		3.87±0.022^{b}
2009	254	4.25±0.06^{ab}		713	3.44±0.032^{d}		3.65±0.031^{c}
2010	651	4.33±0.04^{a}		337	3.71±0.044^{c}		4.12±0.032^{a}
2011	639	4.21±0.038^{ab}		210	3.96±0.062^{ab}		4.15±0.033^{a}
2012	222	4.15±0.06^{ab}		237	4.08±0.074^{a}		4.11±0.049^{a}
2013	33	4.56±0.14^{a}		100	3.75±0.061^{bc}		3.95±0.065^{b}

Cont's…..

	Location						
Source of		Debre Birhan			Amed Guya		
variation	N	LSM± SE	P-value	N	LSM± SE	P-value	Overallmean
Birth Season		***	**<0.0001**		***	**<0.0001**	***
Dry season	2596	3.7±0.018		1556	3.28±0.02		3.56±0.014
Wet season	3395	3.8±0.018		2293	3.56±0.017		3.72±0.013
Birth type		***	**<0.0001**		***	**<0.0001**	***
Single	5418	3.83±0.013		3307	3.47±0.014		3.69±0.010
Twin	573	3.31±0.37		542	3.34±0.04		3.32±0.027
Lamb sex		***	**<0.0001**		***	**<0.0001**	***
Female	3141	3.73±0.018		2019	3.4±0.017		3.60±0.013
Male	2850	3.84±0.019		1830	3.5±0.02		3.71±0.014
Parity		***	**<0.0001**		***	**<0.0001**	***
1st parity	2427	3.44 ± 0.019^{d}		2030	3.46 ± 0.019^{d}		3.45 ± 0.013^{e}
2nd parity	1681	3.71 ± 0.024^{c}		1124	3.37 ± 0.023^{c}		3.59 ± 0.017^{d}
3rd parity	1015	4.09 ± 0.029^{b}		496	3.48 ± 0.03^{bc}		3.89 ± 0.023^{c}
4th parity	536	4.41 ± 0.04^{a}		157	3.68 ± 0.065^{ab}		4.26 ± 0.036^{b}
5th parity	332	4.58 ± 0.51^{a}		42	3.93 ± 0.19^{a}		4.28 ± 0.054^{a}

Means with different superscript letters within the same column and class are statistically different at indicated level; NS: Not significant (p>0.05); *=p<0.05, **=P<0.01, ***=P<0001, NA=Not Applicable

4.8.2. Weaning weight

The overall mean weaning weight of pure Awassi and local Menz crossbred lambs was 16.17±0.038 kg, with 15.82±0.049 and 16.66 ±0.061 kg at Debre Birhan and Amed Guya sheep multiplication and breed improvement centers, respectively. Weaning weight obtained for Awassi Menz crossbred in the present study is higher than the 9.45 and 12.34 kg, respectively reported by Ayele *et al*. (2015) for Dorper × Afar 50% and Dorper × Menz 50% lambs. However, the weaning weight of Awassi Menz crossbred lambs obtained in the current study was lower than the 21.5 and 17.6 kg reported by Sisay *et al*. (1989) for 75% Awassi × Menz and 50% Awassi × Menz under on farm condition . The variation might be due to the variation in management. In contrast to this, the present study had higher weaning weight than 25% Awassi × Menz (10.35±0.21kg) and 37.5 % Awassi × Menz (10.22±0.21 kg) on station performance evaluation (Demeke, 2013). This is because of the higher blood level of Awassi sheep and adaptability to the local environment. The weaning weight of lambs increased as the exotic blood level increased.

Location had significant effect *(P<0.0001)* on the lambs weaning weight (Table 12). Lambs born in Amed Guya ranch were heavier than lambs born in Debre Birhan centers with the mean weaning weight of 16.66±0.061vs 15.82±0.049 kg. This might be due to the blood level of the sheep and better adaptation to the local environments. Birth weight lambs born at Debre Birhan center had heavier birth weight but at weaning age they were not increased like that of lower blood level lambs.

At Debre Birhan center more of the sheep breeds have 75% and more exotic blood levels which required higher amounts of feeds to attain their weaning weight on the local environment than other sheep breeds. However, at Amed Guya ranch 50% blood level sheep formed higher proportions which are adapted and attained better weaning weight at the local environment compared to Debre Birhan centers.

Lamb blood level, birth year of lambs and birth season had significant effect *(P<0.0001)* on weaning weight of Awassi-Menz crossbred sheep at both sheep multiplication and breed improvement centers (Table 12).

Awassi crossbred lambs with 87.5% blood level were significantly heavier *(P<0.0001)* than 93.75%, 75% and 50% Awassi crossbred lambs at Debre Birhan. Similarly, at Amed Guya, 87.5% blood level of Awassi-Menz crossbred lambs were heaviest in weaning weight than 75% and 50% blood level lambs. The weaning weight of 50%, 75% and 87.5% blood level lambs at Amed Guya center had heavier weaning weight than 50%, 75% and 87.5% blood level lambs at Debre Birhan center with the mean value of 15.88 vs 14.27, 20.04 vs 16.58 and 22.18 vs 17.34 kg respectively.

Lambs born during 2011 at Amed Guya and in 2008 at Debre Birhan had heavier weaning weight *(P<0.0001)* than those lambs born in other years. The heavier overall weaning weights (17.82 kg) of lambs were recorded in 2011 and the lowest (13.94 kg) were in 2005 E. C. During 2011 E.C, 19.05 kg of weaning weight were recorded at Amed Guya and 17.41 kg weaning weight at Debre Birhan breed improvement centers.

The present study was higher than that reported by Ayele *et al.* (2015) who reported 12.46. 13.15, 12.07 and 13.34 kg for Dorper × Afar 50% and Dorper × Menz 50% in the year of 2011, 2012, 2013 and 2014 respectively at DBARC. The variation might be due to the difference in management practices and fluctuation of environment that had occurred in the years.

Birth season had significant *(P<0.0001)* effect on the weaning weight of lambs at Amed Guya however did not have significant effect *(P>0.05)* at Debre Birhan center. Lambs born during the wet season had higher weaning weight than those lambs born in the dry season with the mean value of 16.95±0.07 kg vs 16.21±0.10 kg respectively at Amed Guya multiplication centers which could probably be due to green feed availability in the wet season. Planning mating in the wet season had a great significant contribution in achieving better weaning weight.

In the current study the weaning weight of lambs born in wet and dry season in AGSMBIC was 16.95 and 16.21 kg respectively. This result is higher than Dorper × Afar 50% and Dorper × Menz 50% reported by Ayele *et al.* (2015) who reported 14.70, 12.34, 9.78 and 14.19 kg in main rainy season, cold dry season, dry season and short rainy season respectively at DBAGRC. This could be attributed to the type and accessibility of green feed in each season.

Parity, lamb sex and lamb birth type had significant effect *(P<0.0001)* on the weaning weight of lambs at both sheep multiplication and breed improvement centers (Table 12).

Lambs in the 5th parity at Amed Guya (18.69 kg) and Debre Birhan (17.73 kg) had higher weaning weight than those lambs in other parities. The lambs born at first parity were lighter than other parities at both sheep multiplication and breed improvement centers which is similar to the observations of Ayele *et al.* (2015) who reported that lambs born in the first parity were lighter.

Male lambs had heavier weaning weight than female lambs *(P<0.0001)* in both SMBIC with the mean value of 15.98 kg at Debre Birhan and 16.84 kg at Amed Guya SMBIC. The result is similar with Dorper × Afar 50% and Dorper × Menz 50% reported by Ayele *et al.* (2015) who reported 12.8kg for males and 12.64 kg for females at DBAGRC.

Single born lambs had heavier weaning weight than twin lambs 15.87 kg vs 15.24 kg at Debre Birhan and 17.46 kg vs 16.54 kg at Amed Guya centers. Result in the present study is similar with Dorper × Afar 50% and Dorper × Menz 50% reported by Ayele *etal.* (2015) who reported single birth type lambs were heavier than twin birth type lambs.

Table 12: Least Squares Means ± SE of weaning weight of crossbred lambs by location at the two ranches

	Location						
Source of	Debre Birhan			Amed Guya			Overall mean
variation	N	LSM± SE	P-value	N	LSM± SE	P-value	
Overall mean	4833	15.82±0.049	**<0.0001**	3466	16.66±0.061	**<0.0001**	16.17±0.038***
CV (%)		19.29			17.45		19.14
Lamb blood level		***	**<0.0001**		***	**<0.0001**	***
50%	1680	14.27±0.06^{c}		2900	15.88±0.05^{c}		15.29±0.041^{c}
75%	2842	16.58±0.06^{b}		400	20.04±0.21^{b}		17.00±0.067^{b}
87.5%	298	17.34±0.23^{a}		166	22.18±0.39^{a}		19.07±0.229^{a}
93.75%	13	16.38±1.28^{abc}			NA		NA
Lamb birth year		***	**<0.0001**		***	**<0.0001**	***
2004	540	14.79±0.10^{d}			NA		NA
2005	747	13.42±0.074^{e}		152	16.5±0.29^{c}		13.94±0.088^{e}
2006	408	15.08±0.132^{d}		573	15.17±0.10^{e}		15.14±0.084^{d}
2007	931	15.75±0.09^{c}		682	16.56±0.15^{c}		16.09±0.083^{c}
2008	801	17.41±0.121^{a}		636	18.08±0.13^{b}		17.70±0.091^{a}
2009	199	15.14±0.23^{cd}		627	15.98±0.11^{d}		15.78±0.104^{c}
2010	499	17.15±0.19^{ab}		317	16.55±0.2^{c}		16.92±0.141^{b}
2011	520	17.37±0.17^{ab}		190	19.05±0.31^{a}		17.82±0.155^{a}
2012	160	16.50±0.31^{bc}		190	16.98±0.34^{c}		16.76±0.236^{b}
2013	28	15.96±0.41^{bcd}		99	16.76±0.18^{c}		16.59±0.172^{b}

Cont's…...

	Location						
	Debre Birhan			Amed Guya			
Source of variation	N	LSM± SE	P-value	N	LSM± SE	P-value	Over all mean
Birth Season		**NS**			***	**<0.0001**	*******
Dryseason	2003	15.98±0.077		1350	16.21±0.10		16.07±0.063
Wetseason	2830	15.71±0.064		2116	16.95±0.07		16.24±0.049
Birth type		***	**<0.0001**		***	**<0.0001**	**
Single	4431	15.87±0.05		2999	17.43±0.19		16.32±0.13
Twin	402	15.22±0.17		467	16.54±0.06		16.14±0.04
Lamb sex		***	**<0.0001**		***	**<0.0001**	***
Female	2530	15.68±0.066		1790	16.50±0.08		16.02±0.053
Male	2303	15.98±0.07		1676	16.84±0.08		16.34±0.056
Parity		***	**<0.0001**		***	**<0.0001**	***
1st parity	1876	15.18 ± 0.071^{e}		1836	16.75 ± 0.08^{c}		15.96 ± 0.056^{c}
2nd parity	1389	15.72 ± 0.090^{d}		996	16.21 ± 0.10^{d}		15.93 ± 0.069^{c}
3rd parity	861	16.36 ± 0.122^{c}		453	16.84 ± 0.17^{bcd}		16.53 ± 0.100^{b}
4th parity	444	16.65 ± 0.16^{bc}		143	17.55 ± 0.33^{abc}		16.86 ± 0.149^{b}
5th parity	263	17.73 ± 0.26^{a}		39	18.69 ± 0.87^{a}		18.03 ± 0.529^{a}

Means with different superscript letters within the same column and class are statistically different at indicated level; NS: Not significant (p>0.05); *=p<0.05, **=P<0.01, ***=P<0001, NA=Not Applicable

4.9. Reproductive performance of Awassi Menz crossbred Sheep

4.9.1. Age at First Lambing (AFL)

Age at first lambing (AFL) is the age at which the ewe lamb is giving its first lamb. It is an important reproduction trait as greater population turn over and faster genetic progress can be obtained when sheep produce their first offspring at an earlier rather than later age. Early maturing females are known to possess a comparatively long and fruitful reproductive life.

As indicated in the Table 13, the overall age at first lambing was 425.37±6.92 days, while it was 426.18±8.54 days at DBSMBIC and 422.63±9.06 days at AGSMBIC.This is due to their blood level variation of ewes at the centers. This result was shorter than the 669 days reported by Gizaw and Getachew (2009) for Awassi crossbred sheep flocks managed under on-farm condition in Serity (Chacha), Negasi-Amba (Menz) and Chiro (Wollo). The present findings on age at first lambing of the Awassi crossbred sheep ewes is longer than than 410±6.7 days of Farta sheep (Mekuriaw,2011), the 365 days reported for pure Dorper sheep (Fourie *et al.,* 2009; and *Budaie et al.,* 2013) and the 410±72 days reported for Gumuz sheep (Abegaz, 2007). In this study, crossbreds showed poor performance for age at first lambing. This is in agreement that under village management condition, age at first lambing of local sheep was shorter than that of Awassi crossbred with a value of 228 and 252 days (Gizaw and Getachew 2009).

Location however had no significant effect *(P>0.05)* on age at first lambing of ewes at both sheep multiplication and breed improvement centers.

Dam genotype had significant effect *(P<0.0001)* on age at firs lambing at Debre Birhan SMBIC. Awassi crossbred ewes of 75% blood level were faster than other crossbred ewes (50%) at DBSMBIC to attain the age at first lambing with 376.5±9.7 Vs 460±12.1 days. However, at Amed Guya sheep multiplication and breed improvement center, dam genotype had no significant effect *(P>0.05)* on age at first lambing of ewes (Table 13). But the likely reasons for the difference between the centers are the hetrosis vigour of the breeds. It is decreasing from generation to generation.

In the present study, birth type had no significant *(P>0.05)* effect on age at first lambing at both sheep multiplication and breed improvement centers.

Season of birth had significant *(P<0.05)* effect on age at first lambing at Debre Birhan SMBIC but have no significant effect *(P>0.05)* at Amed Guya SMBIC.The likely reseaon for difference between the centers is tha at Amed Guya the environment is more highland than Debre Birhan center. Ewes lambed during the dry season had shorter days to attain age at first lambing compared to those ewes lambed during the wet season with the mean value 392.2±12.2 Vs 459.3±11.3 days, respectively at DBSMBIC. This significant effect of ewe's season of birth on age at first lambing is similar with the reports of Awemu *et al.* (2000). This might be in the late dry season they took advantage of the rains following immediately after birth, grew faster and came to the reproductive status at an earlier age.

Year of birth had significant *(P<0.0001)* effect on age at first lambing of ewes at both SMBICs. In the present study, ewes lambed during the year of 2006 (319.3±5.9 days) at Debre Birhan and in 2008 (357.7±5.2 days) at Amed Guya SMBICs lambed ewes at earlier age than ewes lambed in other years.

The longest age at first lambing of ewes were recorded in the year of 2009 (609.9±26 days) at Debre Birhan and in 2011 (542±2.3 days) at Amed Guya SMBICs. The variation between years and ranches reflects sheep blood level reared in the ranches and occurrence of disease outbreak in the SMBICs in different years. During 2006 at Debre Birhan and 2008 at Amed Guya center a sudden death of sheep at the beginning and end period of rain season was recorded. This result was better than on station (470±8.44) and on farm (457±4.76 days) reports of age at first lambing performance of Washera sheep (Shigdaf *et a*l., 2013) in 2007 and 2008. This might be due to fluctuation of feed availability; the amount and distribution of rain fall between years and management practice of sheep in each year.

Table 13: Least Squares Means ± SE of AFL of the crossbred sheep by location at the two ranches

	Location						
Source of		Debre Birhan			Amed Guya		
variation	N	LSM± SE	P-value	N	LSM± SE	P-value	Overall mean
Overall mean	285	426.18±8.54	**>0.05**	83	422.63±9.06	**>0.05**	425.37±6.92(NS)
CV%	285	24.71		83	14.24		26.46
Dam		***	**<0.0001**		**NS**	**0.51**	**NS**
Genotype							
Local (100%)		NA		65	418.7±9.5		418.73±9.51
50% Awassi	167	460.1±12.1		18	436.6±24.12		457.87±11.24
75% Awassi	116	376.5±9.7			NA		NA
87.5% Awassi	2				NA		NA
Birth year		***	**<0.0001**		***	**<0.0001**	***
2004	23	391.7 ± 18.1^{cd}			NA		NA
2005	84	544.9 ± 17.7^{ab}		26	358.8 ± 6.5^{c}		500.94 ± 15.57^{a}
2006	89	319.3 ± 5.9^{e}		30	458.7 ± 13.3^{a}		354.47 ± 7.87^{b}
2007	15	500.6 ± 15.5^{b}		3	441 ± 36.6^{abc}		490.66 ± 14.89^{a}
2008		NA		7	357.7 ± 5.2^{b}		NA
2009	11	609.9 ± 26^{a}		9	435.4 ± 26^{ab}		531.40 ± 26.86^{a}
2010	63	381.5 ± 9.2^{d}		4	517.5 ± 63^{a}		389.68 ± 10.12^{b}
2011		NA		4	542 ± 2.3^{a}		NA
2012		NA			NA		NA
2013		NA			NA		NA
Birth season		*	**0.049**		**NS**	**0.067**	*
Dry season	141	392.2±12.2		32	402.8±11.15		394.22±10.16
Wet season	144	459.3±11.3		51	435±12.7		453.02±9.01
Birth type		**NS**	0.35		**NS**	**0.22**	**NS**
Single	273	426.1±8.7		69	425.6±10		426.06±7.29
Twin	12	426.5±36.7		14	407.5±20.6		416.30±19.91

Means with different superscript letters within the same column and class are statistically different at indicated level; NS: Not significant (p>0.05); *=p<0.05, **=P<0.01, ***=P<0001, NA=Not Applicable

4.9.2. Lambing Interval (LI)

Lambing interval is the difference between successive lambing from the same ewes. The shorter lambing interval gives better opportunity to increase lifetime productivity of ewes by increasing the number of lamb crop. The overall mean lambing interval of ewes found in this study was 436.44±2.41 days, while it was 448.9±3.18 and 410.8±3.6 days at Debre Birhan and Amed Guya sheep multiplication and improvement centers, respectively (Table 14). The result of the current study was longer than the lambing interval of 306 days for Dorper crossbred *(*Lakew *et al.,* 2014) and 240 days for pure Dorper (Budaie *et al.,* 2013) while it was in line with Gizaw and Getachew (2009) study who reported that Awassi crossbred sheep had longer lambing interval than local sheep.

Location had significant effect *(P<0.0001)* on lambing interval of ewes (Table 14). Ewes lambed at Amed Guya sheep multiplication and breed improvement center had shorter lambing intervals than ewes lambed at Debre Birhan with the mean value 410.8 days vs 448.9 days. This might be due to the genotype of ewes. At Amed Guya ranch the sheep flock structures were more of local and that adopted the environment compared to Debre Birhan ranch. Crossbred ewes were the dominant breeds at Debre Birhan ranch and have long lambing interval than local sheep breeds. This result is in agreement with Lakew et al. (2014), Gizaw and Getachew (2009) who reported that Awassi crossbred sheep attained longer lambing interval than the local sheep breeds.

Dam genotype had significant effect *(P<0.01)* on lambing interval of sheep at DBSMBIC. However, it did not have significant effect *(P>0.05)* at AGSMBIC.

The lambing interval of local Menz sheep of 424.6±3.8 days for the flock at DBSMBIC was shorter than those of 50% and 75% of Awassi crossbreds with 457.5±4.2 and 470.9±14.1 days respectively at DBSMBIC. This result is in agreement with Lakew *et al*. (2014), Gizaw and Getachew (2009) who reported that Awassi crossbred sheep attained longer lambing interval than the local sheep breeds.

Birth season had significant *(P<0.0001)* effect on the lambing interval of ewes at both SMBIC. Ewes lambed during the dry season at Debre Birhan and Amed Guya with 434.3±4.5 days, 392.6±5.17 days respectively had shorter lambing interval than those ewes lambed in wet season at Debre Birhan and Amed Guya SMBICs with 461.76±4.2 and 423.4±4.8 days respectively. This might be ewes gave birth during the dry season were able to get more additional feeds and have advantages of the rains following immediately lambing and lambs were isolated from their dam at earlier age.

Year of birth had significant *(P<0.0001)* effect on lambing interval of ewes at both SMBICs (Table 14). The ewes lambed during 2004 (309.9±13.9 days) at Debre Birhan and in 2003 (275.3±59.5 days) at Amed Guya had shorter lambing interval than those ewes lambed in other years. Year to year variation in lambing interval are associated with management and seasonal changes.

Birth type and lamb sex had significant *(P<0.01)* effect on the lambing interval of ewes at DBSMBIC but had no significant effect *(P>0.05)* at AGSMBIC (Table 14). Ewes from single births took shorter than ewes from twin (446.9±3.4 days Vs 484.6 ±13) to come into reproductive status.

This result is similar with the finding of Belay B. and Haile A. (2009) who reported that ewes that gave birth to twins to have longer lambing interval than single bearing ewes. This might be ewe's lambed twin would take longer time for their body to recover.

Ewes lambed male have shorter lambing interval than those lambed female (439.3±4.3 Vs 457.2±4.5 days respectively) at Debre Birhan sheep multiplication and breed improvement centers.

Parity had also significant ($p<0.05$) effect on lambing interval at both SMBICs. Ewes had shortest lambing interval on their first parity, 400.5±23 and 337±35.7 days at Debr Birhan and Amed Guya center respectively. However at second and above parity ewes lambed with longest interval. This is disagrees with the finding of Shigdaf *et al.* (2013) who reported on Washera sheep that earlier parity ewes had the longest lambing interval than ewes with later parities.

Table 14: Least Square Means ± SE of lambing interval of crossbred sheep by location at the two ranches

	Location						
Source of	Debre Birhan			Amed Guya			
variation	N	LSM± SE	P-value	N	LSM± SE	P-value	Over all mean
Overall mean	2,995	448.9±3.18	**<0.0001**	1467	410.8±3.6	**<0.0001**	436.44±2.41***
CV%	2,995	29.68		1467	30.34		31.23
Dam		**	**0.0007**		**NS**	**0.1369**	***
Genotype							
Local	815	424.6±3.8[a]		1352	413.2±3.7		417.50±3.144[a]
50% Awassi	2045	457.5±4.2[b]		73	388.4±15.2		454.82±3.75[bc]
75% Awassi	133	470.9±16.4[b]		42	372.4±17		447.30±11.907[b]
87.5% Awassi	2				NA		NA
Birth year		***	**<0.0001**		***	**<0.0001**	***
2004	34	309.9±13.9[f]			NA		NA
2005	308	364.9±5.9[ef]		2			364.34±5.907[c]
2006	290	405.9±8.1[d]		129	300.4±4.7[g]		373.47±6.302[c]
2007	520	401.7±5.8[d]		457	365.9±4.6[def]		384.98±3.867[c]
2008	648	364.2±3.3[def]		325	437.9±8[cf]		388.82±3.641[c]
2009	191	466.1±11.1[b]		298	475.3±9[abf]		471.78±7.117[b]
2010	601	643.3±6.6[a]		169	451±9.9[bcf]		601.15±6.325[a]
2011	244	477.9±12.5[bc]		43	489.6±23.5[abc]		479.72±10.898[b]
2012	135	403.8±9.6[de]		40	343.3±11.5[eg]		389.97±8.108[c]
2013	24	514.7±24.9[be]		4	275.3±59.9[fg]		480.32±27.873[b]
Birth Season		***	**<0.0001**		***	**<0.0001**	**NS**
Dry season	1392	434.3±4.5		602	392.6±5.1		421.77±3.54
Wet season	1603	461.7±4.2		865	423.4±4.8		448.28±3.28

Cont's…

Source of variation	Location						
	Debre Birhan			Amed Guya			
	N	LSM± SE	P-value	N	LSM± SE	P-value	Over all mean
Birth type		**	**0.0059**		**NS**	**0.94**	**NS**
Single	2837	446.9±3.4		1360	410.1±3.7		435.02±2.49
Twin	158	484.6±13.2		107	420.1±13.6		458.73±9.82±
Lamb sex		**	**0.0043**		**NS**	**0.97**	**NS**
Female	1619	457.2±4.3		789	409.8±4.9		441.68±3.35
Male	1376	439.3±4.5		678	411.8±5.2		430.28±3.48
Parity		*	**0.012**		*	**0.04**	***
1st parity	53	400.5 ± 23^{b}		17	337 ± 35.7^{ab}		385.12 ± 19.66^{a}
2nd parity	1336	434.9 ± 4.2^{ab}		893	409.5 ± 4.5^{a}		424.80 ± 3.16^{a}
3rd parity	815	463.8 ± 6.3^{a}		397	419.2 ± 7.1^{a}		449.21 ± 4.91^{b}
4th parity	478	457.1 ± 8^{ab}		129	409.8 ± 12.1^{a}		447.07 ± 6.90^{b}
5th parity	313	470.25 ± 10.5^{ab}		31	382.29 ± 26.7^{b}		451.60 ± 16.29^{b}

Means with different superscript letters within the same column and class are statistically different at indicated level; NS: Not significant (p>0.05); *=p<0.05, **=P<0.01, ***=P<0001, NA=Not Applicable

4.10. Survival rate of Awassi – Menz Crossbred sheep

Adaptive fitness is characterized by survival, health and reproductive traits (Mirkena *et al.*, 2010). Awassi sheep crosses were adapted in highland and midland areas. Table 15 presents the survival rate of Awassi-Menz crossbred sheep under Debre Birhan and Amed Guya SMBICs. The overall survival rate from birth to 30 days, 90 days, 180 days, 270 days and yearling age were 90.6%, 86.2%, 84.6%, 84.5% and 84.5%, respectively, while it was 88%, 83.1%, 80%, 80% and 80% at Debre Birhan and 93%, 90.5%, 89%, 89% and 89% at Amed Guya center, respectively. Survival rate was better in Amed Guya than Debre Birhan center. This is because of at the blood level of lambs at each center. At Amed Guya more of lambs had 50% blood level but at Debre Birhan 75% and more blood level lambs are dominant. 50% , 75% and 87.5% blood level of lambs at Amed Guya center had higher survival rate than lambs 50%, 75% and 87.5% lambs born at Debre Birhan center with the average value of 90.1 % vs 82% , 90% vs 81% and 85.5% vs 71.3 respectively.The higher the blood level shows the lower survival rate.

Lamb blood level and birth year interaction had significant *(P<0.0001)* effect on survival rate of Awassi-Menz crossbred lambs at Amed Guya and Debre Birhan SMBICs (Table 15 and 16).

The results on survivability between different blood levels of lambs revealed that, 50% Awassi crossbred lambs had highest survival rate (90.1%) at Amed Guya and (82%) at Debre Birhan centers compared to other Awassi –Menz crosses from birth to old age.

Lambs born in 2013 adapted highly (90.1%) at Amed Guya centers compared to other years, while at Debre Birhan the highest survival rate of Awassi-Menz crossbred lambs were recorded in 2004 (81.8%) compared to other years. The lowest adaptability rates of lambs were recorded in 2012 at Amed Guya (88.5%) and in 2013 at Debre Birhan (73.7%) which was associated with outbreak of disease and environmental fluctuations that had occurred by then. In the same scenario, Gemeda *et al.* (2002), Yibrah (2008) and Berhanu and Aynalem (2009) reported that the survival rate difference between years may be a reflection of differences in feed availability caused by differences in irregularity of rainfall and other climatic factors.

Birth season had significant effect *(P<0.01)* on survival rate of Awassi-Menz crossbred sheep at Amed Guya but had no significant *(P>0.05)* effect at Debre Birhan multiplication center. Lambs born in wet season had higher survival rate *(P<0.01)* compared to lambs born in dry season at Amed Guya (89.9% Vs 89.7%). This result disagrees with a report by Mukasa-Mugerwa *et al*. (2000) that lambs born in the dry season had better survival than lambs born in the wet season. The current study also disagrees with the report by Berhanu and Aynalem (2009) that lambs born during the wet season had the lowest survival rate than those born during dry season under farm management. However, this result is in agreement with the report by other scholars that lambs born during the wet season had better survival than lambs born in dry season (Kassahun, 2000; Solomon, 2002; Berhan and Van Arendonk, 2006; *Mengistie et al., 2011*). This is due to the availability of green feeds at the location.

Birth type and parity interaction had significant *(P<0.0001)* effect on survival rate of Awassi-Menz crossbred sheep at both sheep multiplication and breed improvement centers, while lamb sex had no significant *(P>0.05)* effect at the two centers (Table 15 and 16).

Single born lambs had higher survival rate than twin lambs at Debre Birhan 80.7% vs 80% and 89.9% vs 89.3 % at Amed Guya. The risk of death with twin born lambs at Debre Birhan and Amed Guya sheep was higher than single born lambs from birth to different age classes. According to Abdelqader *et al.* (2017), lambs born twin were under very high risk to die from hypothermia, starvation, gastrointestinal infections and respiratory infections. Lower birth weight, larger surface area to lose body heat, smaller reserves of body fat and competition with its litter mate for colostrum and milk are the other possible causes of lower survival of twins (Hatcher *et al.*, 2009, 2010). This suggests that including litter size as a breeding goal trait increases the number of lambs born over time while decreasing their chances of survival rate.

Lambs born in the 2^{nd} and 3^{rd} parity at Amed Guya had highest survival rate than lambs born in other parities. However, at Debre Birhan lambs born in the 5^{th} parity adapted more compared to other lambs born in other parities up to 365 days of age.

Table 15 : Least Square Means ± SE of survival (%) of crossbred sheep at Amed Guya ranch

Source of variation		Survival rate from birth to				
	N	**30 days**	**90 days**	**180 days**	**270 days**	**365 days**
Overall	9840	0.906±0.0003	0.862±0.0004	0.846±0.0005	0.845±0.0005	0.845±0.0005
Location		***	***	***	***	***
Debre Birhan	5991	0.88±0.0002	0.831±0.0003	0.80±0.0003	0.80±0.0003	0.80±0.0003
Amed Guya	3849	0.93±0.0002	0.905±0.0001	0.89±0.0001	0.89±0.0001	0.89±0.0001
Lamb birth year		***	***	***	***	***
2004		NA	NA	NA	NA	NA
2005	157	0.93±0.0007[a]	0.907±0.0005[a]	0.90±0.0004[a]	0.90±0.0004[a]	0.90±0.0004[a]
2006	637	0.941 ±0 .0001[a]	0.909±0.0001[a]	0.90±0.0001[a]	0.90±0.0001[a]	0.90±0.0001[a]
2007	756	0.939 ±0 .0003[a]	0.907±0.0002[a]	0.90±0.0002[a]	0.90±0.0002[a]	0.90±0.0002[a]
2008	702	0.938 ±0.0004[a]	0.907±0.0003[a]	0.899±0.0002[a]	0.899±0.0002[a]	0.899±0.0002[a]
2009	713	0.939 ±0.0003[a]	0.908±0.0002[a]	0.90±0.0001[a]	0.90±0.0001[a]	0.90±0.0001[a]
2010	337	0.931 ±0 .0013[b]	0.901±0.0009[b]	0.895±0.0008[b]	0.895±0.0008[b]	0.895±0.0008[b]
2011	210	0.923 ±0.0018[c]	0.895±0.0013[c]	0.893±0.0012[c]	0.893±0.0012[c]	0.893±0.0012[c]
2012	237	0.913 ±0.0024[d]	0.889±0.0017[d]	0.885±0.0015[d]	0.885±0.0015[d]	0.885±0.0015[d]
2013	100	0.941 ±0[a]	0.909±0[a]	0.901±0[a]	0.901±0[a]	0.901±0[a]
Lamb blood level		***	***	***	***	***
50%	3220	0.94±0[a]	0.909±0[a]	0.901±0[a]	0.901±0[a]	0.901±0[a]
75%	435	0.93±0[b]	0.90±0[b]	0.90±0[b]	0.90±0[b]	0.90±0[b]
87.5%	194	0.86±0[c]	0.855±0[c]	0.855±0[c]	0.855±0[c]	0.855±0[c]
93.75%		NA	NA	NA	NA	NA
Birth Season		**	**	**	**	**
Dry	1556	0.935±0.0004	0.905±0.0003	0.897±0.0003	0.897±0.0003	0.897±0.0003
Wet	2293	0.937±0.0003	0.906±0.0002	0.899±0.0001	0.899±0.0001	0.899±0.0001

Cont's….

Source of Variation		Survival rate from birth to				
	N	**30 days**	**90 days**	**180 days**	**270 days**	**365 days**
Birth Type		***	***	***	***	***
Single	3307	0.938±0.0002	0.907±0.0001	0.899±0.0001	0.899±0.0001	0.899±0.0001
Twin	542	0.926±0.001	0.898±0.0008	0.893±0.0007	0.893±0.0007	0.893±0.0007
Lamb Sex		**NS**	**NS**	**NS**	**NS**	**NS**
Female	2019	0.937±0.0003	0.905±0.0002	0.898±0.0002	0.898±0.0002	0.898±0.0002
Male	1830	0.936±0.0003	0.905±0.0002	0.898±0.0002	0.898±0.0002	0.898±0.0002
Parity		***	***	***	***	***
1st parity	2029	0.935 ± 0.0004^{ab}	0.904 ± 0.0002^{ab}	0.898 ± 0.0002^{ab}	0.898 ± 0.0002^{ab}	0.898 ± 0.0002^{ab}
2nd parity	1124	0.938 ± 0.0003^{a}	0.907 ± 0.0002^{a}	0.899 ± 0.0002^{a}	0.899 ± 0.0002^{a}	0.899 ± 0.0002^{a}
3rd parity	498	0.938 ± 0.0006^{a}	0.907 ± 0.0004^{a}	0.899 ± 0.0003^{a}	0.899 ± 0.0003^{a}	0.899 ± 0.0003^{a}
4th parity	157	0.935 ± 0.001^{ab}	0.904 ± 0.0012^{ab}	0.897 ± 0.001^{abc}	0.897 ± 0.001^{abc}	0.897 ± 0.001^{abc}
5th parity	41	0.9273 ± 0.004^{b}	0.899 ± 0.0035^{b}	0.892 ± 0.003^{c}	0.892 ± 0.003^{c}	0.892 ± 0.003^{c}

Means with different superscript letters within the same column and class are statistically different at indicated level; NS: Not significant ($p>0.05$); *=$p<0.05$, **=$P<0.01$, ***=$P<0001$, NA=Not Applicable

Table 16 : Least Square Means ± SE of survival (%) of crossbred sheep at Debre Birhan ranch

Source of variation		Survival rate from birth to				
	N	**30 days**	**90 days**	**180 days**	**270 days**	**365 days**
Lamb blood level		***	***	***	***	***
50%	2048	0.899 ± 0^{b}	0.847 ± 0^{a}	0.822 ± 0^{a}	0.820 ± 0^{a}	0.820 ± 0^{a}
75%	3505	0.885 ± 0^{c}	0.833 ± 0^{b}	0.811 ± 0^{c}	0.810 ± 0^{c}	0.810 ± 0^{c}
87.5%	422	0.815 ± 0^{d}	0.741 ± 0^{d}	0.713 ± 0^{d}	0.713 ± 0^{d}	0.713 ± 0^{d}
93.75%	16	0.937 ± 0^{a}	0.812 ± 0^{c}	0.812 ± 0^{b}	0.812 ± 0^{b}	0.812 ± 0^{b}
Lamb birth year		***	***	***	***	***
2004	631	0.896 ± 0.0002^{a}	0.844 ± 0.0002^{a}	0.82 ± 0.0001^{a}	0.818 ± 0.0001^{a}	0.818 ± 0.0001^{a}
2005	952	0.895 ± 0.0002^{a}	0.843 ± 0.0002^{a}	0.818 ± 0.0002^{a}	0.817 ± 0.0002^{a}	0.817 ± 0.0002^{a}
2006	483	0.888 ± 0.0005^{b}	0.836 ± 0.0007^{b}	0.813 ± 0.0007^{b}	0.811 ± 0.0007^{b}	0.811 ± 0.0007^{b}
2007	1119	0.888 ± 0.0004^{bc}	0.835 ± 0.0004^{b}	0.812 ± 0.0005^{b}	0.811 ± 0.0004^{b}	0.811 ± 0.0004^{b}
2008	1007	0.882 ± 0.0005^{d}	0.83 ± 0.0007^{c}	0.807 ± 0.0007^{c}	0.806 ± 0.0007^{c}	0.806 ± 0.0007^{c}
2009	254	0.883 ± 0.0012^{d}	0.83 ± 0.0015^{c}	0.807 ± 0.0017^{c}	0.805 ± 0.0016^{c}	0.805 ± 0.0016^{c}
2010	651	0.884 ± 0.0005^{cd}	0.832 ± 0.0007^{bc}	0.809 ± 0.0007^{bc}	0.808 ± 0.0007^{bc}	0.808 ± 0.0007^{bc}
2011	639	0.866 ± 0.0013^{e}	0.807 ± 0.0017^{d}	0.783 ± 0.0019^{d}	0.782 ± 0.0019^{d}	0.782 ± 0.0019^{d}
2012	222	0.864 ± 0.0025^{e}	0.804 ± 0.0032^{d}	0.782 ± 0.0035^{d}	0.781 ± 0.0034^{d}	0.781 ± 0.0034^{d}
2013	33	0.835 ± 0.0064^{f}	0.763 ± 0.0074^{e}	0.737 ± 0.0081^{e}	0.737 ± 0.0081^{e}	0.737 ± 0.0081^{e}
Birth Season		NS	NS	NS	NS	NS
Dry	2596	0.884±0.0003	0.831±0.0005	0.808±0.0005	0.807±0.0005	0.807±0.0005
Wet	3395	0.885±0.0003	0.832±0.0004	0.808±0.0005	0.807±0.0004	0.807±0.0004

Cont's…

Source of Variation		Survival rate from birth to				
	N	**30 days**	**90 days**	**180 days**	**270 days**	**365 days**
Birth Type		***	***	***	***	***
Single	5418	0.885±0.0002	0.832±0.0003	0.809±0.0003	0.807±0.0003	0.807±0.0003
Twin	573	0.879±0.0012	0.824±0.0015	0.801±0.0016	0.80±0.0016	0.80±0.0016
Lamb Sex		**NS**	**NS**	**NS**	**NS**	**NS**
Female	3141	0.885±0.0003	0.832±0.0004	0.809±0.0004	0.807±0.0004	0.807±0.0004
Male	2850	0.884±0.0004	0.831±0.0005	0.807±0.0005	0.806±0.0005	0.806±0.0005
Parity		***	***	***	***	***
1st parity	2441	0.883±0.0005[b]	0.828±0.0006[b]	0.805±0.0007[b]	0.803±0.0007[b]	0.803±0.0007[b]
2nd parity	1682	0.886±0.0004[a]	0.833±0.0006[a]	0.809±0.0006[a]	0.808±0.0006[a]	0.808±0.0006[a]
3rd parity	1017	0.887±0.0004[a]	0.835±0.0005[a]	0.812±0.0005[a]	0.810±0.0005[a]	0.810±0.0005[a]
4th parity	528	0.886±0.0005[ab]	0.833±0.0007[a]	0.810±0.0007[a]	0.809±0.0007[a]	0.809±0.0007[a]
5th parity	323	0.886±0.0005[ab]	0.834±0.0007[a]	0.811±0.0007[a]	0.810±0.0007[a]	0.810±0.0007[a]

Means with different superscript letters within the same column and class are statistically different at indicated level; NS: Not significant (p>0.05); *=p<0.05, **=P<0.01, ***=P<0001, NA=Not Applicable

The survival rate of lambs was decreasing at increasing rate from birth to 90 days of age and decreasing at a decreasing rate from 180 to 365 days of age. This is because lamb survival up to 90 days of age is directly or indirectly associated with the condition of ewes change in environmental condition like utrine and out side environment. Thus, these should be due to improving management for lambs and ewes in order to reduce the loss of lambs. Gastrointestinal parasites, ectoparasites (lice, ticks,) pneumonia, sheep pox, ovine pasteurellosis, liver fluke, PPR, and Maedi-Visna were the major factors to cause lamb mortality at Amed Guya and Debre Birhan sheep multiplication and breed improvement centers.

4.11. Perception of Farmers on distributed crossbred rams

In both districts, farmers were interested on the distributed crossbred rams in the area. According to the current information from beneficiary farmers, they were interested and have good insight about the crossbred. The traits preferred and accepted by farmers were their good appearance, fast growth rate and the white coat color. The animals with their white fleece and fast body gain and reaching to market at six months of age has enabled them to generate more income at household level. As the exotic blood level increased the twining rate also increased which favored the crossbred among the farmers. Twining rate of Awassi crossbred in Menz area are accepted and encouraged than other breeds those give single lambs. In Baso, Awassi crossbreeding district, farmers started to produce genetic material and they are serving as sources of breeding rams.

The most important overall rams' attributes for selection were body size (index=0.149), followed by growth rate (index=0.147) and white coat color (index=0.139) (Table 17). All of the farmers (100%) at Baso and Menz Gera districts were selected growth rate and white color of rams. Body conformation, tail type, horn orientation and hair type were ranked in their order of importance and used for ram selection criteria (Table 17).

Table 17: Ranking of breeding rams' attributes by farmers

	Baso(N=62)					Menz Gera Mider(N=42)					Overall index
Study parameters	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index	(N=104)
Body size	44	18	0	0	0.155	25	17	0	0	0.138	0.149
Growth rate	40	18	4	0	0.149	26	16	0	0	0.139	0.147
Body conformation	30	8	0	0	0.10	22	9	0	0	0.105	0.101
Tail type	6	24	11	0	0.079	3	17	7	0	0.089	0.076
Horn orientation	5	17	0	0	0.047	2	19	0	0	0.059	0.05
Hair type	2	19	7	0	0.05	3	14	4	0	0.056	0.055
Color: White	38	22	0	0	0.147	23	15	0	0	0.125	0.139
Brown	27	23	1	2	0.12	13	24	3	0	0.12	0.13
Black Brown	0	0	34	6	0.05	0	0	16	9	0.037	0.045
Black	0	0	8	52	0.045	0	1	6	33	0.044	0.045
White within black	1	0	16	1	0.024	0	1	11	1	0.05	0.025
Black within white	1	10	5	0	0.03	1	8	4	0	0.033	0.031

R=Rank, N= Number of Respondents

Index = sum of (4 X value of ranks 1 + 3 X values for ranks 2 + 2 X values for ranks 3 + 1 X values for ranks 4) given for an individual attribute /response divided by the sum of (4 X value of ranks 1 + 3 X values for ranks 2 + 2 X values for ranks 3 + 1 X values for ranks 4) for overall attribute of breeding rams.

4.12. Management of crossbred rams at the study districts

Special management was provided for crossbred rams at both districts. About 92.85% and 93.54% of farmers provided special management to their crossbred rams in Menz Gera Mider and Baso districts, respectively (Table 18). This is because crossbred rams need better management to adapt to the local environment and are susceptible to harsh environment. Type of managements provided for crossbred rams included provision of supplementary feed such as hay, crop residues, wheat bran and weed. This is in agreement with the study of Tesfaye (2008) who reported that supplementary feed like hay, crop residues and weed was provided for breeding rams in Menz area.

Table 18: Management of crossbred rams

	Districts			
Management	Menz Gera Mider		Baso	
	N	%	N	%
Provide special management	39	92.85	58	93.54
Didn't provide special management	3	7.14	4	6.45

4.13. Potential traits of breeding objectives for crossbreds

According to the present study smallholder farmers have given body size, growth rate and color can be the main components of sheep breeding objectives in both study districts. Furthermore, lambing interval and survival of lambs should be considered in the breeding goals. Similarly Abiyu Shinkut *et al. (*2020) stated that growth rate and body size was the main components of breeding practices of local sheep in the North West highlands of Ethiopia.

The most important for breeding goal traits were body size (index=0.26), followed by growth rate (index=0.25) and coat color (index=0.24) (Table 19).

Table 19: Ranking of traits for breeding objectives

Study parameter	Baso (N=62)					Menz Gera Mider(N=42)					Overall index (N=104)
	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index	
Body size	56	6	0	0	0.27	39	3	0	0	0.28	0.26
Growth rate	52	10	0	0	0.25	33	9	0	0	0.26	0.25
Color	50	12	0	0	0.24	28	14	0	0	0.24	0.24
Survival of lambs	11	26	14	0	0.15	13	7	3	0	0.11	0.15
Lambing interval	2	17	11	0	0.08	0	14	7	7	0.10	0.09

R=Rank, N= Number of Respondents

Index = sum of (4 X value of ranks 1 + 3 X values for ranks 2 + 2 X values for ranks 3 + 1 X values for ranks 4) given for an individual attribute /response divided by the sum of (4 X value of ranks 1 + 3 X values for ranks 2 + 2 X values for ranks 3 + 1 X values for ranks 4) for overall attribute of breeding objectives.

4.14. Purpose of Keeping Awassi Crossbred Sheep

Knowing about the purpose for keeping animals is a prerequisite for deriving operational breeding goals (Tesfaye Getachew, 2008). The result from the current study indicates that the overall primary reason for keeping sheep was for generating income (index = 0.39) followed by meat (index = 0.25) and saving (index = 0.24) (Table 20). This indicates that sheep are considered as saving a pocket money being a live bank for their owners and serve as a means of ready cash income to meet immediate economic and socio-cultural needs of their owners.

Discussions with key informants and flock holders in two districts showed that farmers appreciate the capability of Awassi to produce lamb, as meat better than local sheep.

Table 20: Ranking of reported purposes of keeping sheep by the sample households in the study area

Purposes	Baso (N=62)					Menz Gera Mider(N=42)					Overall index (N=104)
	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index	
Source of Income	57	7	1	0	0.34	37	2	0	0	0.37	0.39
Meat	1	35	24	2	0.222	0	25	13	1	0.25	0.25
Savings	6	20	29	7	0.201	3	14	23		0.24	0.24
Wool/hair	0	0	0	1	0.001	0	0	0	0	0	0.00
Skin	0	0	5	28	0.186	0	0	3	18	0.059	0.06
Manure	0	0	0	7	0.009	0	0	2	4	0.019	0.01
Wealth status	0	1	1	18	0.031	0	0	1	14	0.039	0.04
Ceremonies	0	0	2	2	0.008	0	0	0	2	0.005	0.01

R=Rank, N= Number of Respondents

Index = sum of (4 X value of ranks 1 + 3 X values for ranks 2 + 2 X values for ranks 3 + 1 X values for ranks 4) given for an individual attribute /response divided by the sum of (4 X value of ranks 1 + 3 X values for ranks 2 + 2 X values for ranks 3 + 1 X values for ranks 4) for overall attributes of all purpose of keeping Awassi cross sheep in a production system.

The current breeding objectives in each sheep multiplication and breed improvement centers are to multiply different blood level of Awassi Menz crossbred rams and distribute young crossbred rams to different zones and districts of the region. The ranches developed breeding objectives for enhancing production, reproduction and survival rate of sheep in the areas.

4.15. Situation of Introduced Crossbred Rams at Study District

Out of 104 HHs interviewed under the study, 92.3% mentioned that they were given crossbred breeding rams between the years 2005 and 2013. The introduced breeding rams were having 50%, 75% and 87.5% Awassi blood levels at proportions of 66.58%, 27.04% and 6.24% respectively (Table 21). Only 13.3% of these rams were still found in the hands of the HHs and the other 21.95% and 21.9% were either sold or died, respectively. Farmer's low awareness about the objectives of crossbreeding programs could be one reason among others (selling and culling) for higher losses of improved rams in the study area. Selling of improved breeding rams would affect the sheep improvement programs in this area.

Table 21: Situation of introduced crossbred breeding rams at the study area

Sheep breed	N	Alive (%)	Sold (%)	Died (%)
50% Awassi-Menz cross	64	15.6	28.09	22.89
75% Awassi-Menz cross	26	4.16	12.48	10.4
87.5% Awassi-Menz cross	6	NA	2.06	4.13
Overall	86	13.3	21.95	21.9

N= Number of Rams, NA= Not Applicable

4.16. Challenges and Constraints of Sheep Improvement in the Sheep Multiplication and Breed Improvement Centers

4.16.1. Feed Shortage

There was problem of feed shortage in both ranches, particularly during the dry season. Feed shortage as one of the challenges facing sheep production may arise due to prolonged drought resulting from a period of below average rainfall leading to feed and water shortage (Legesse *et al.,* 2008). Most nutritious vegetation is quickly eaten up and later animal will have eaten the rejected residual. During dry seasons, in both ranches the pasture grounds is covered with thick grass and sheep find it difficult to feed and not easily grazing it. This situation leads to reduction of feed quality, which in turn diminishes the nutrient intake of the sheep or fall below their maintenance (Tesfay, 2008). The survey result in the communities indicated that during dry season feed shortage was a problem and led to supplementation of feed to the animals.

4.16.2. Disease

Occurrence of disease was one of the major factors affecting productivity of sheep in both centers, which lowers there immune system making the animals vulnerable to disease infection. The frequently reported disease by veterinarians and animal's health service are those, which cause huge economic loss. In this study, Ectoparasites (lice, ticks,) and other disease including sheep pox, pneumonia, ovine pasturolosis, diarrhea, liver fluck, ppr (Peste des Petits Ruminants) and Maedi-Visna were the most frequently reported disease of sheep across both centers.

These diseases occurred seasonally but liver fluke and Maedi-Visna (respiratory disease) affected year round still at the centers. All sheep groups were affected by these disease and death of sheep were recorded. Disease and parasites infestation influences the improvement of sheep production, which in turn cause high mortality rate in both adult and young animals (Dhaba *et al.,* 2013).

Out of the 5991 sheep observed at Debre Birhan and 3849 sheep at Amed guya, 1155 and 361 were found dead giving the crude mortality of 19.27% and 9.37%, respectively at Debre Birhan and Amed Guya. Most of the mortality were due to sheep pox, ovine pasturolosis, liver fluck, Maedi-Visna, pneumonia and sudden death (Table 22).

Table 22: Mortality of sheep at the two ranches over the year

	Debre Birhan			**Amed Guya**		
Year	Number of sheep observed	Total number of sheep died	Mortality (%)	Number of sheep observed	Total number of sheep died	Mortality (%)
2004	631	115	18.22	**NA**	**NA**	**NA**
2005	952	174	18.27	157	15	9.5
2006	483	91	18.84	637	64	10.04
2007	1119	211	18.85	756	76	10.05
2008	1007	194	19.26	702	41	5.84
2009	254	49	19.29	713	71	9.95
2010	651	125	19.20	337	35	10.38
2011	639	139	21.75	210	22	10.47
2012	222	48	21.6	237	27	11.39
2013	33	9	27.27	100	10	10.0
Total	**5991**	**1155**	**19.27**	**3849**	**361**	**9.37**

NA= Not Applicable

4.16.3. Lack of transportation

There should be better transportation to facilitate overall operations under the sheep multiplication and breed improvement centers. However, this problem was serious at Amed Guya center. The center is located a long way from the district city and the road is old. They have one vehicle to pick up all the staff at once to get at ranches on time. Due to this problem, distribution of young rams, post distribution follow up, proper support and monitoring for zones, districts and farmers, timely arrived at the ranches and easy access to transport were not properly managed and performed. Still other responsible and supportive research institutions were not able to resolve these problems.

4.16.4. Lack of pure Awassi rams

The area where the centers are located is known to be home to a large number of Menz sheep. Therefore, in order to improve productivity of these local sheep breed, it is necessary to provide a pure Awassi ram properly and continuously. However, the performance of ranches to produce their own replacement of the parents for crossbreeding purpose was low. They are mainly depends on government to import pure Awassi rams and ewes to the ranches rather than replacement. Importing of pure Awassi rams and ewes were causes and affects ranches flock by disease (Maedi Visna), quarantine requirments and costs. Maedi-Visna caused high mortality and disposal of animals that tested positive. Exotic disease and bio security were challenges during importation of exotic germ plasma.

In the present study a total of 94 pure awassi sheep breeds at Debre Birhan and 28 pure Awassi sheep breeds at Amed Guya were found. From these pure breeds, 22 ewes, 16 rams, 18 ram lamb, 13 ewe lambs and 25 lambs are found at Debre Birhan and 13 ewes, 13 rams, 1 ram lamb and 1 lamb are found at Amed Guya centers. A total of 1014 local ewes for crossing which are 252 at Debre Birhan and 762 at Amed Guya are found. Due to these insufficient pure Awassi breeds the performance of genetic improvement was not effective at both ranches.

4.16.5. Lack of electricity

Lack of electricity was a common problem in Amed Guya sheep multiplication and breed improvement center. It leads to slow retrieval of data on the site, long term power outages, and widespread internet problems to refer and search supportive materials. Due to this problem still now, the ranch has not organized all data in soft copy.

5. SUMMARY AND CONCLUSION

Continuous evaluations of genetic progress of productive performance(birth waight and weaning waight), reproductive performance (age at first lambing and lambing interval) and survival rate of Awassi crossbred lambs from birth to different age classes are crucial to assess their performances and to optimize or to develop more efficient genetic improvement programs in the future. The present study was conducted to evaluate the productive and reproductive performance and survival rate of Awassi-Menz crossbred sheep. The study on evaluation of survival, productive and reproductive performance was based on the result in group discussion and secondary data from 9840 Awassi-Menz crossbred sheep from September 2004 to January 2013 at both ranches.

The overall birth weight and weaning weight of Awassi -Menz crossbred sheep was 3.65±0.009 and 16.17±0.038 kg respectively. The higher blood level crossbred lambs were heavier than lambs of lower blood level at both ranches. Location, lamb blood level, birth type, birth year of lambs, lamb sex and parity had significant *(P<0.0001)* effect on the birth weight and weaning weight of Awassi-Menz crossbred lambs at both centers.

The overall age at first lambing and lambing interval of ewes was 426.18±8.54 and 436.44±2.41 days respectively. Ewes lambed at Amed Guya center have shorter lambing interval than ewes lambed at Debre Birhan.

The overall survival rate from birth to 30 days, 90 days, 180 days, 270 days and yearling age were 90.6%, 86.2%, 84.6%, 84.5% and 84.5%, respectively.

Location, Lamb blood level, year of birth, birth type and parity had significant *(P<0.0001)* effect on the survival of Awassi-Menz crossbred lambs at both centers. However, sex of lambs had no significant *(P>0.05)* effect on survival of lambs at both centers. Lambs born at Amed Guya center survived the environment better compared to lambs born at Debre Birhan center from birth to different age classes.

The growth performance of Awassi-Menz crossbred sheep is an important character which determines the overall productivity of the flock and the economic return from sheep production with the objective of meat production. Pre-weaning growth performance traits such as birth weight and weaning weight rate have important implications on flock productivity, management systems and breeding policies.

The lower performances of Awassi- Menz crossbred sheep in some of traits like age at first lambing, lambing interval and survival and the better performance on productive traits; birth weight and weaning weight were observed.

Sheep keeping in the study districts are important for the livelihood of the farmers. Awassi crossbred rams are well accepted and preferred by the farmers for their fast growth, attractive coat color, easily adaptability and also disease resistance. Crossbred lambs distributed in the past and in present time but the follow up activities were not practiced successfully. There is information gap between the distribution ranches, districts and farmers.birth weight and weaning weights of lambs in the program showed successive performance, where as, age at first lambing, lambing interval and survival rate of lambs were give attention in the program.

6. RECOMMENDATIONS

From the current study, the following recommendations were forwarded.

- ✓ The centers had pure Awassi sheep breeds and these breeds should be a given priority to replace and multiply according to their blood level by considering survival rate.
- ✓ For successful age at first lambing, lambing interval and survival rate of sheep at both centers optimum blood levels from 50% to 75% should be considered.
- ✓ Crossbreeding performance at the centers has been declining recently and there is a need to coordinate the overall operation of the centers with a coordinated plan and direction.
- ✓ The centers need support from different institutions(research centers, regional bureau, ministry of agriculture and non-governmental organizations) with providing a variety of support and monitoring of the breeding center, training of professionals, provision of infrastructure and problem solving.
- ✓ General flock management and Care of sheep, such as, housing, feeding, watering, facilities, supplementation and health monitoring needs to be strengthened in the centers.
- ✓ According to the data collected from the beneficiary farmers, creating awareness, support and monitoring the status of crossbreeding program and performance of distributed rams from responsible professionals are low and should be strengthened.
- ✓ The traits that are required by farmers should be selected and addressed and scaling up for other no benefited areas.
- ✓ All the data from the multiplication centers should also be stored in a database.

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BIOGRAPHY

The author of this Thesis, Mr. Diress Muchie was born on March 29, 1980, in West Gojjam Zone of Amhara National Regional State, from his father Mr. Muchie Jemberie and mother Ms. Yezbalem Adugna. He attended his classes at Biray Primary School (grade 1-4), Quarit General Elementary School (grade 5-8), and Damot Senior Secondary School (grade 9 &10).

Then he joined Burie ATVET College and awarded a Diploma in Agriculture (Animal sciences) in 1998. After his graduation, he worked as Development Agent at rural kebele at Amhara Region West Gojjam Zone Quarit Woreda. After six years experiences, he joined Debre Tabor University College of Agriculture and awarded a BSc degree in Agriculture (Animal sciences) in 2008. Then he joined the School of Graduate Studies (SGS) of Hawassa University in 2011 to pursue his MSc study in animal breeding and Genetics in the School of Animal and Range Science.

8. APPENDIX

QUESTIONNAIRE FORMAT

The questionnaire is prepared for collecting different data on Awassi- Menz sheep cross breeding program at Debre berhan and Amed guya sheep multiplication and breed improvment centers.

Questionnaire code_____ Ranch name _____

A. General Information about the Ranches

Activities	Ranches	
	Debre Birhan	Amed Guya
Total land size		
Established year		
Region		
Zone		

1. Introduction of Improved Awassi Rams in the ranches

A. For how long has the ranch been using Awassi Rams? _____years.

Year	Debre Birhan Ranch		Amed Guya Ranch	
	Introduced Rams in to Ranch	Died Ram after introduction	Introduced Rams in to ranch	Died Ram after introduction
2004				
2005				
2006				
2007				
2008				
2009				
2010				
2011				
2012				
2013				

B. Current population of sheep in each ranch

S/N	Breed type	Debre Birhan Ranch			Amed Guya Ranch		
		Rams	Ewes	Lambs	Rams	Ewes	Lambs
1	Loca(Menz)						
2	Awassi cross						
3	Pure Awassi						

C. Flock structure of the Ranches

Age category	Debre Birhan Ranch				Amed Guya Ranch			
	Local	**Awassi cross**	**Pure Awassi**	**Total**	**local**	**Awassi cross**	**Pure Awassi**	**Total**
Male 6 months to 1yr								
Female 6 months to 1yr								
Male > 1 year								
Female> 1 year								
Male lambs < 6 months'								
female lambs < 6 months'								
Total								

D. Breeding Practice and Performance of Sheep

1. Type of Breeding/mating system with Awassi Ram?

1. Controlled 2. Uncontrolled

2. In which season does crossing with Awassi takes place mostly?

Dry season

Wet season

3. If so, what is the reason? _____

4 .Is there any special management for Awassi ram? 1. Yes 2. No

If yes, specify type of management _____

5. What are the general management activities of sheep in the ranches?

_____

6. Which physical appearances or traits of improved Awassi ram is appreciated by farmers/Sheepkeepers? **Tick & rank each**

Parameters	**Debre Birhan Ranch**		
	Tick	Rank	Justify
Size			
Appearance			
Color			
Temperament			

Parameters	**Amed Guya Ranch**		
	Tick	Rank	Justify
Size			
Color			
Appearance			
Temperament			

7. Which performance or traits of improved Awassi ram is appreciated by farmers/ sheep keepers?

Tick & rank each

Parameters	**Debre Birhan Ranch**		
	Tick	Rank	Justify
Disease tolerance			
Drought tolerance			
Feed adaptability			
Growth rate/fast growth			
Prolificacy			
Fertility/libido			

Parameters	**Amed Guya Ranch**		
Disease tolerance	Tick	Rank	Justify
Drought tolerance			
Feed adaptability			
Growth rate/fast growth			
Prolificacy			
Fertility/libido			

8. For what purpose, the ranch keeps Awassi sheep/ Its cross?

9. How is the ranches planning to increase sheep flock sizes and production in the future?

which breed will increase mostly? ----------

And what is the reason to select this breed**?** ----------

10. Number of Awassi cross multiplied and disseminated in each ranche

Year	Number of borne Awassi cross		Number of dissemination Awassi cross	
	Debre birhan ranch	Amed guya ranch	Debre birhan ranch	Amed guya ranch
2004				
2005				
2006				
2007				
2008				
2009				
2010				
2011				
2012				
2013				

E. Feed Resources of Sheep

1. What is the source of feed for sheep Flock? Fill the table

S/N	Type of feeds	
	Debre birhan ranch	Amed guya ranch
1st		
2nd		
3rd		
4th		
5th		
6th		

2. Is there is feed shortage in the ranch? 1. Yes 2. No

3. If yes, when? 1. Dry season 2. Wet season 3. Both

Justify

5. What are the common water sources for sheep?

E.Sheep Health Management

1. Is there any common diseases and parasites that affect health and production of sheep in the flock? 1. Yes 2. No

2. If yes, what are those common diseases and parasites that affect health and production of sheep?

S/N	Debre birhan ranch						Amed guya ranch					
	Disease name	Which sheep group it Affects				Seasons or months, it occurs/ Affects	Disease name	Which sheep group it Affects				Seasons or months, it occurs/ Affects
		Ram	Ewe	Lamb	All			Ram	Ewe	Lamb	All	
1												
2												
3												
4												

3. Has there been any death of Awassi crosses? 1. yes 2. No
4. If Yes, which sheep category mostly died? and how many?

Year and season	Lambs less than 3 months	Lambs more than 3 months	Rams	Ewes
2004				
2005				
2006				
2007				
2008				
2009				
2010				
2011				
2012				
2013				

F.Do the ewes face the following problems in the flock?

Parameters	Debre birhan ranch		Amed guya ranch	
	Abortion	Dystocia	Abortion	Dystocia
Yes/No				
In which parity, it occurs				
In which season, it is common				
What are the reasons				
If there is Dystocia, in which lamb sex mostly occur (M /F)				

Check List for Focal Group Discussion with ranch animal breeding professionals

Ranch _____

1. How was/is the breeding strategy of sheep in the ranches?

2. What are the breeding objectives and breeding practice of sheep currently?

3. Are there any social, religious and cultural complains concerning Awassi ram/sheep introduction, multiplication and dissemination?

4. What are the benefits/advantages of Awassi ram introduction in the ranches?

5. How is the level of farmers' preference of Awassi Ram?

6. How is the Adaptability and survivable rate of the Awassi Rams and its crosses?

7. Compare performance of sheep flock before and after the introduction of Awassi sheep?

8. What are the major challenges and constraints of sheep improvement in the area?

9. What are the policy directions and technical options on the future cross breeding program?

10. What is the performance of ranches in breeding animal multiplication and dissemination?

11. Do the ranches have the right type of awassi genotype?

12. How to implement the cross breeding program/ strategy?

13. What are the strategies to disseminate sires to the villages?

14. What are the effects of genotype by environment interaction on the performance of sheep?

15. How the ranches certify/approve sires for breeding?