SOME GENETIC AND NON-GENETIC FACTORS INFLUENCING FERTILITY OF DIFFERENT SHEEP BREEDS IN HIGHLAND OF NORTH-SHEWA, ETHIOPIA

SHENKUTE GOSHME

ADVISOR: SANDIP BANERJEE (PhD)

CO-ADVISOR: MOURAD REKIK (PhD)

CO-ADVISOR: AYNALEM HAILE (PhD)

A Thesis Submitted to the School of Animal and Range Sciences

HAWASSA UNIVERSITY

Collage of Agriculture

In partial Fulfillment of the Requirements for the Degree of Master of Science in Animal and Range Sciences

(Specialization; Animal Breeding and Genetics)

HAWASSA, ETHIOPIA

March, 2018

GRADUATE STUDIES
HAWASSA UNIVERSITY
EXAMINERS' APPROVAL SHEET-1
(Submission Sheet-2)

6. We, the undersigned, members of the Board of Examiners of the final open defense by **Shenkute Goshme Debay** have read and evaluated her thesis entitled **Some Genetic and Non-Genetic Factors Influencing Fertility of Different Sheep Breeds in Highland of North-Shewa, Ethiopia.** and examined the candidate. This is therefore to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree of **Master of Science**.

Dr.Mestawat Taye Name of the Chairperson	Signature	11/03/2018 Date
Dr Sandip Banerje Name of Major Advisor	Signature	11 March'2018 Date
Prof.Abera Melesse Name of Internal Examiner	Signature	11/03/2018 Date
Dr .Wondimeneh Esatu Name of External Examiner	Signature	11/03/2018 Date

Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the school of Graduate Studies (SGS) through the School Graduate Committee (SGC) of the candidate's School.

Stamp of SGS **Date** _______

Remark

- Use this form to submit the thesis with minor correction suggested by the examining board
- 6 copies

SCHOOL OF GRADUATE STUDIES
HAWASSA UNIVERSITY
EXAMINERS' APPROVAL SHEET-2
(Submission Sheet-3)

7. As members of the Board of Examiners of the final Masters open defense, we certify that we have read and evaluated the thesis prepared by **Some Genetic and Non-Genetic Factors Influencing Fertility of Different Sheep Breeds in Highland of North-Shewa, Ethiopia.** and recommend that it be accepted as fulfilling the thesis requirement for the degree of Master of Science in **Animal and Range Sciences** with specialization in **Animal Breeding & Genetics.**

Dr.Mestawat Taye		11/03/2018
Name of the Chairperson	Signature	Date
Dr Sandip Banerje		11 March 2018
Name of Major Advisor	Signature	Date
Dr Mourad Rekik	For	11/03/2018
Name of Co-Advisor	Signature	Date
Prof.Abera Melesse		11/3/2018
Name of Internal Examiner	Signature	Date
Dr .Wondimeneh Esatu		11/03/2018
Name of External Examiner	Signature	Date

Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the candidate's department.
Thesis approved by

Dr.Mestawet Taye		
School Head	Signature	Date

Certification of the final Thesis

I hereby certify that all the corrections and recommendation suggested by the Board of Examiners are incorporated into the final Thesis entitled **Some Genetic and Non-Genetic Factors Influencing Fertility of Different Sheep Breeds in Highland of North-Shewa, Ethiopia.** by **Shenkute Goshme Debay**

Name of the Designate	Signature	Date

Dedication

I dedicate this thesis manuscript to my father Mr. Goshme Debay and my mother Mrs. Shibre Desta for nursing me with affection and love and for their dedicated partnership in the success of my life.

Acknowledgements

"Let the one who boasts, boast in the God"

I would like to express my sincere appreciation and heartfelt thanks to my research advisors, Dr. Sandip Banerjee, Dr. Mourad Rekik and Dr. Aynalem Haile for their valuable comment, professional guidance and dedication throughout the study period. I express my deepest and heartfelt gratitude to my major advisor, Dr. Sandip Banerjee for utmost cooperation, concrete suggestions, valuable criticism and assistance. I express my deepest and heartfelt appreciation to my intimate friend Dr. Tesfaye Getachew for his invaluable technical assistance throughout the study period. I acknowledge the encouragement and support received from Dr Mestawet Taye. I also acknowledge the assistance received from Head and staff members from the School of Animal and Range Sciences, Hawassa University.

A special, thanks goes to the staff of livestock department of Debre Birhan agricultural research center for their ultimate help to facilitating research animals and laboratory equipment's. I express my gratefulness and heartfelt thanks to my partner ErdachewYitagesu (DVM), Mr. Derb Aydefiruhim, Mr. Asfaw Bisrat, Mr. Ayele Abebe, Mr. Tadios, Mr. Derbew bekele , Chekole Demissie (DVM), Mr. Amine Mustafa, Mr. Shambel Befufekad, Mr. Aschalew Abebe for their assistance during laboratory works and encouragements and drivers, Ato. Fekade Cherkoss, Feleke Asgelit, Manush Fantaye and Tekiliye Fisha for their commitments to assist me during the weekends. I would like to duly acknowledged Mr. Abiy Legesse, Center director Debre Birhan Agricultural Research, for his encouragements and hospitality during the study. I express my heartfelt thanks to Debre Birhan agricultural research and ICARDA (International Center for Agricultural Research in the Dry Areas) for granting me the study leave.

Statement of author

I declare that this thesis is my original work and that all sources of material that are used for this thesis have been duly acknowledged. This thesis is submitted in partial fulfillment of the requirements for MSc degree at Hawassa University and is deposited at the University, Debre Birhan Agricultural research center and ICARDA (International Center for Agricultural Research in the Dry Areas) libraries to be made available to borrowers under the rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the awards of any academic degree, diploma and certificate.

Name……………………………………… Signature …………………………

Place: Collage of Agricultural, Hawassa University, Hawassa.

Date of Submission……………………………………

List of Abbreviation

AXM	Awassi cross with Menz
ASBMC	Amedguya Sheep Breeding and Multiplication Center
DBSBMC	Debre Birhan Sheep Breeding and Multiplication Center
DBARC	Debre Birhan Agricultural research Center
BW	Body weight
BC	Body Condition
SC	Scrotal Circumference
LIB	Libido
COL	Color
VOL	Volume
CON	Concentration
CON	Concentration
MOT	Motility
LD	Live/dead
AB	Abnormal spermatozoa
EBV	Estimated Breeding Value
GLM	General linear Model
REML	Restricted maximum likelihood
RID	Ram Identification
DB	Debre Birhan
LSM	Least Square Means
SE	Standard Error

Table of contents

Contents **page**

List of tables

Tables **page**

List of figures

Figures **page**

List of table in the Appendices

Tables

SOME GENETIC AND NON-GENETIC FACTORS INFLUENCING FERTILITY OF DIFFERENT SHEEP BREEDS IN HIGHLAND OF NORTH-SHEWA, ETHIOPIA

BY, SHENKUTE GOSHME

ADVISORS: SANDIP BANERJEE (PhD), MOURAD REKIK (PhD) and AYNALEM HAILE (PhD)

Abstract

The study was conducted at Debre Birhan Agricultural Research Center, with the aim to study some genetic and non-genetic factors influencing fertility of rams. Semen quantity and quality related traits were evaluated for 18 rams; 6 each of Menz, Dorper and Awassi x Menz (AxM). The fertility study encompassed those of 155 rams mated to 14357 ewes over several years, seasons, locations, parities and genotypes. Data were obtained from Amedguya Sheep Breeding and Multiplication center (ASBMC), Debre Birhan Sheep Breeding and Multiplication center (DBSBMC) and Debre Birhan Agricultural Research Center (DBARC).The data on the fertility of the rams and genetic and non-genetic factors influencing the same were analyzed using non-parametric tests. While, the effects of genetic and non-genetic factors (body weight, body condition, scrotal circumference, libido and season) and their effect on some semen parameters viz. volume, color, mass motility concentration, live spermatozoa and abnormal spermatozoa, were analyzed using GLM of SAS (9.0). Animal model were used for the estimation of genetic parameters and sire ranking based on their breeding value estimates using WOMBAT®. The overall least square means for body weight (BW), body condition (BC), scrotal circumference (SC), libido, color, semen volume, semen concentration, semen mass motility, percentage of live sperm cell and percentage of abnormal spermatids were 58.9±0.5, 4.01±0.06, 30.4±0.13, 3.7±0.06, 2±0.034, 0.92±0.04, $3.34x10^9$ ±0.13, 3.4±0.08, 83.87±0.26 and 9.41±0.36 for AxM rams, the corresponding values for Dorper rams were 74.4±0.58, 4.48±0.07, 32.3±0.15, 3.3±0.07, 2.1±0.036, 1.14±0.04, $4.1x10^9$ ±0.14, 3.18±, 83.6±0.27 and 10.04±0.38 and 41.7±0.49, 3.65±0.06, 28.8±0.13, 3.2±0.05, 2.3±0.03, 0.7±0.04, $2.44x10^9$±0.13, 3.17±0.08, 84.65±0.25 and 6.78±0.35 for Menz rams respectively. All semen quality traits were influenced by genotypes and season, while mass motility of semen was similar across the genotypes. The correlation between volume and concentration of semen was 0.69, 0.86 and 0.78 for AxM, Menz and Dorper respectively. The fertility traits of Awassi, AxM, Menz and Dorper rams were 45.44 53.36, 84.85 and 70.62% respectively. Fertility traits among the Menz rams was not influenced by season contrary to the same for the Awassi, AxM and Dorper rams. Heritability estimates for fertility of Awassi, Menz and Dorper rams were 0.1, 0.41 and 0.46 respectively, which was grossly overestimated for the latter two breeds. This can be ascribed to small sample size of the flock. It can be concluded that, Awassi rams and A x M had lower fertility across seasons and location studied. These indicated that further investigation would be needed to identify the cause of low fertility across the genotypes and identifying candidate gene/s responsible for fertility traits and the levels of inbreeding need to be assessed.

Key words: Awassi, Dorper, Menz, Awassi cross Menz, ram fertility, seasons, semen quality traits and heritability.

1. Introduction

Small ruminant specially, sheep are important for the subsistence, economic and social livelihood of small holder farmers in the developing countries and those residing in highlands of Ethiopia are no exception (Solomon *et* al., 2013; Mueller *et al.,* 2017).Traditionally the sheep were/are selected for their adaptive traits which compromised with their productive, reproductive functions and existing environment (Solomon *et al.*, 2008; Kosgey and Okayo, 2007). The overall improvement of the livestock is best sustained through within breed selection (Kosgey and Okeyo, 2007; Solomon *et al.,* 2009, 2011; Philipson *et al.*, 2011). However, the genetic improvement through within breed selection are a slow and tedious process and the other method of improvement can be through crossing them with some improved breeds (Solomon and Tesfaye , 2009; Tesfaye et *al*., 2013, 2016).

Crossbreeding by using fast growing temperate sire lines has been suggested as rapid ways of breed improvement and such programs have been initiated in the past in many parts of the tropics and Ethiopia being no exception. These projects were initiated to improve the production and reproduction traits among the indigenous genotypes. However over the years several attempts of crossbreeding have not met with their appropriated goals as the introduced breeds were not adapted to the prevailing agro climate/s (Philipsson et al., 2011). The performance of the crossbreds at the farmers end are much below what was obtained on station studies , the traits which are adversely influenced were those associated with fertility (Tesfaye *et al.,* 2013). In Ethiopia several exotic sheep breeds have been introduced over decades and Debre Birhan Agricultural Research Station had been established as the focal station for sheep research. Awassi breed was among the sheep breeds which were introduced from Israel in the year 1980, 1984 and 1994. They were introduced with an aim to improve the body weight of the Menz sheep (Rummel *et al*., 2005). Studies by Tesfaye *et al.*, (2016) have indicated that the fertility among the Awassi rams reared in Ethiopia was lower than those reported from many Middle Eastern countries (Galal *et al*., 2008). Findings of a study by Solomon et al., (2007) indicated that there are around 14 breeds of sheep in Ethiopia, with within breed variations for most of the economical traits. The nicking ability of the Menz and Wollo ewes with those of Awassi rams have being studied (Solomon and Tesfaye, 20009; Tesfaye *et al.,* 2013, 2016). Menz and Wollo ewes are small sized besides that they are poorly prolific (Solomon &Tesfaye, 2009; Tesfaye *et al*., 2013).

The aim of selecting the Menz sheep was to access the within breed variations for improving their body weight (Solomon et al., 2008, 2009). The selection of the rams was based on their fitness which in turn is influenced by inbreeding, fertility and survival related traits among the closed nucleus flock (Solomon *et al.*, 2013). The major challenges in the process of selection include identification of the genetically superior breeding stock (rams and ewes) and estimating the response to selection based on their breeding values of the trait of importance (Solomon *et al.,* 2011). However, the underlying bottlenecks of the same are the difficulties associated with recording of the performance and reproduction related parameters of the animals themselves or their ancestors or progenies (Tesfaye *et al*., 2013). Besides the pedigree of these animals, which in most of the cases are not formally maintained by the reared or sometimes are remembered through recall methods thereby compromising on the quality of the data (Solomon *et al*., 2014). Studies by Petrovic e*t al.*, (2012) have indicated that the fertility related traits are lowly heritable and hence can be improved only through improving their management. Thus, in order to improve the weight of the Menz sheep raised in the Central highlands of Ethiopia it was decided to upgrade them using Dorper (from South

Africa) and Awassi (from Israel). The introduced sheep breeds were reared at two government ranches, Debre Birhan Sheep Breeding and Multiplication Center (DBSBMC) and Amedguya Sheep Breeding and Multiplication Center. Presently nucleus stock of Awassi sheep are being maintained at these ranches with an aim to maintain the pure stock besides the crossbreeds are also being developed with Menz ewes as dam lines. The performances of these crossbreds are evaluated vis-a-vis those of the Menz sheep for traits such as yearling weight, survival and fertility (Solomon and Tesfaye, 2009; Tesfaye *et al.,* 2016). However, it has been recorded in several studies that the fertility of the crossbred rams (Awassi♂ x Menz♀) are/were lower when compared to their Menz counter parts (Tesfaye *et al.*,2013,2016). However, it was also recorded that the lambs born from the crossbreds Awassi ♂x Wolo ♀had better nicking abilities and had heavier body weights vis-a-vis those of the dam lines (Tesfaye *et al.*, 2013, 2016)

On farm and on station performances have indicated that the F_1 (Awassi ♂x Menz♀) was much below the expectations with respect to their fertility traits which varied across the studied locations (Tesfaye *et al*., 2013). The values for the fertility traits for the Awassi rams were significantly lower than those reported from the Middle Eastern countries (Mohammed et al., 2006; Galal *et al.,* 2008). Overall conception rate of the ewes are fallout of several hormonal attributes of both the sexes. Among the functions associated with the conception of the ewes are those associated with the semen related traits of the rams themselves besides several genetic and non-genetic factors (Foote, 1964; Duguma *et al.,* 2002; Al-Samarrae, 2009; Tejaswi *et al.,* 2016). Among the same are the various semen components viz. mass motility or individual motility of the sperms, acrosome integrity, the size of head, mid piece, length of the trail and other morphological functions associated with the same (Salhab *et al.*,2003, Ababneh *et al.,* 2017) .The overall component of the semen and their fertilizing capacity is influenced by several genetic and non-genetic factors the latter being more important as the fertility traits are lowly heritable (Salhab *et al.*, 2003; Mohammed, 2006; Casao 2010; Babiker, 2010). Studies by Yavarifard *et al.,* (2015) have indicated that the fertility is also influenced by inbreeding among the flock, where the inbred rams have low fertility when compared to their non-inbred counterparts. Findings by Shamir *et al.*, (2010) have indicated that inbreeding among Awassi sheep of the Ein Harod flock resulted in day blindness reared in Israel. Evaluating the performance of the traits particularly those related to fertility of different indigenous and exotic breeds of rams at each stage is impudent. Reproductive performance is one of the factors which determine the efficiency of the production among the sheep flock/s in the cool highlands of north Shewa, Ethiopia. In the region mentioned ahead sheep production is important as a means of livelihood and thus selection of rams' breeds on the reproduction trait and pedigree record is essential in sheep breeding program.

1.1 General objective

- To investigate the causes influencing the fertility of the different genotypes of rams' breeds.

1.1.1 Objectives

- To access the effects of season and genotypes on semen traits of rams from Dorper, Menz and Awassi x Menz crosses.
- To estimate some genetic parameters influencing the fertility traits of rams of the above mentioned genotypes.

2. Literature review

2.1. Effect of genotype on semen quality parameters

The overall fertility of rams are culmination of both genetic and non-genetic factors (Rege et al., 2000; Salhab *et al.*, 2003; Al-Samarrae, 2015; Olah *et al.*, 2013). The reproductive tracts of the rams as that of other mammals comprises of several anatomical structures which are penis, epididymis, testis, vas difference and other accessory glands. Differences in fertility have been reported between rams within a breed and among rams of same ages and across breeds. The differences in semen quantity and quality have also been reported to vary across breeds managed under similar conditions (Salhab *et al*., 2003;Al-Samarrae, 2009; Martinet et al., 2013; Casaco, 2010;Babiker, 2010). In line with the above fact the semen characteristics of Karradi rams are superior to their Arabi counterparts in terms of volume, mass motility, individual motility, concentration and viability of semen (Al-Samarrae 2009).

It has also been reported that differences in the semen quantity, quality and scrotal circumference vary across breeds and also among rams of same age within breeds (Mohammed *et al.,* 2006). According to Al-Samarrae, (2015) seminal characteristics of Karrabi rams were superior when compared to Arabi rams in aspect of ejaculation volume, mass motility, individual motility, sperm concentration and viability. Another report showed that differences were reported in quality and quantity of semen; Canadian rams had higher seminal volume semen per ejaculation when compared to those of the Finnish Landrace (Babiker, 2010).

Findings by Olah et al., (2013) indicated the influence of genetics on the semen of ram, in case of rams of Barbados black belly breed there was a significant correlation between the mass motility (of fresh ejaculate) and its density. Similar results also indicated that the motility percent of spermatozoa and the density of ejaculate were also significantly correlated. Furthermore, studies have also indicated that in several breeds, viz. Babolna tetra, Tsigai, Ile de France and prolific Merino rams there was a significant correlation between the percent motility of spermatozoa and the mass motility of the ejaculate (Olah et al., 2010). The higher the percent motility is the more vigorous the individual motility. Semen quality, like other phenotypic expressions, are influenced by both genetic and environmental factors and the interaction effect of between the two, however the contribution of the genetics is low as the traits are lowly heritable (Foote,1970;Yavarifard *et al.*,, 2015; Dariusz et al, 2013; Al-Samarrae, 2015; Martin et al., 2013). Traits such as cryptorchidism are inherited in many families of the rams, in the bilateral state no spermatozoa are produced, but normal seminal fluid can be ejaculated because of testosterone which can maintain the libido (Babiker, 2010; Al-Samrrae, 2015). However, under such condition the sperm output is approximately half of that of the normal, so sperm concentration (per ejaculation) is much lower than their normal counterparts (Babiker, 2010; Al-Samrrae, 2015). Studies by Amann, (1970) indicates that the size of the testis is highly heritable in chicken and there is a significant correlation between size of the testis and sperm output (Van Demark, 1956; Foote *et al.,* 1970; Kridli et al., 2007; David et al., 2015; Al-Samarrae, 2015; Mozo *et al.,* 2015; Oláh et al., 2013).

It has also been reported in a study by Kridli, (2006) that semen motility was lower and abnormal spermatozoa was higher among the Awassi rams when compared to the Romanov x Awassi and Charolaise x Awassi crossbreds. Findings by Land, (1983); Foote, (1964);

Milosevic & Stojkovic, (2012); Rodríguez-Martínez, (2013) indicated that testicular size among the rams correspond with the ovulation of the ewes within a particular breed. The overall average concentration of spermatozoa of Awassi rams from Syria was recorded to be 4.0 x10^9 sperm /ml (Salhab *et al.*, , 2003) which was much lower than 4.9 x 10^9 sperm/ml in unimproved Awassi and 4.8x10^9 sperm/ml improved Awassi rams (Ibrahim, 1997) reared in the United Arab Emirates. These values were much higher than those of 2.8 x 10^9 sperm/ml recorded among the Lebanese Awassi rams (AbiSaab and Sleiman, 1987) and 2.2 x 10^9 sperm/ml to Iraqi Awassi rams (Asofi et *al*., 1997).

The concentration of spermatozoa among the Awassi rams was higher than those recorded among the various other Iraqi breeds (Asof *et al.*, 1997; Salhab, 2003; Al-Samarrae, 2015). It has also been reported that the spermatozoa concentration enhanced till a certain age thereafter the concentration decreases (Salhab *et al.*, 2003). However, in another study it was reported that the concentration of the spermatozoa was not influenced by either the breed or the age of rams (Mandiki et al., 1998).

According to Johansson, (1960) many types of abnormal sperm have been described and some types are inherited viz. abnormality of the head, acrosomal integrity and secondary abnormalities of the tail. Abnormal distribution of the chromosomes may also be present in the spermatozoa which can be recognized as giant sperm with variability in DNA content; these are observed to be higher among the spermatozoa from infertile bulls (Leutchenberger, 1960). These abnormal variations in sperm morphometric values are lowly to moderately heritable (Wolf, 2010; Duguma et al., 2002; Yavarifard et al., 2015).

The genetic parameters and the development of molecular biological techniques have led many scientists to use candidate gene studies to predict sperm quality traits in bulls (Yang *et al.,* 2011; Sang *et al.,* 2011).

2.2. Non-genetic factors affecting semen quality parameters

There are several non-genetic factors influencing the semen quantity and quality of rams, some of the factors include the differences associated with variations in levels of nutrition, age of the animals, body weight and body condition of the rams. Age of the rams correlated significantly with the scrotal circumference and also semen characteristics (Malejane et al., 2014). A ram with large symmetrical testes, free of any defect, is likely to produce good quality and have high seminal volume (Salhab et al., 2003; Mohammed et al., 2006; Kridli et al., 2007) . It has also been reported that there exists within breed differences among the rams can be associated with age and method of semen collection techniques like, artificial vagina and electro ejaculator the rams and also among flocks raised at different locations (Salhab et al., 2003; Hassan et al., 2009; Malejena *et al.,*2014)

Rams with poor body condition score and different semen collection techniques usually have low semen volume /ejaculation and concentration (Mohammed, 2006; Afolayan et al., 2014; Oláh *et al.,* 2013; David e*t al.,* 2015). The differences in the body weight are usually correlated with concentration of sperms, volume of ejaculation and semen characters/appearance and mass motility are influenced. Other non-genetic factors that can influence the quality of sperms are feeding, housing, diseases and climatic variations. This may be ascribed to climatic influences influencing the secretion of testosterone, these can at times totally cease the production of spermatozoa or the concentration is lowered drastically (Tabbaa.et al., 2006; Maksimović et al., 2016).

The age of Lacaune rams, Manech tête Rousse rams also influence the concentration of the sperms , number of spermatozoa, its volume and motility for volume and motility (Salhab et al.,2003; Zohara et al., 2012David et al., 2007). Frequencies of ejaculation/collection too have its own influence on the quality and quantity of the semen. Semen if collected frequently or even after prolonged duration adversly influence the quality of the semen (Mohammed et al., 2006; Martin et al.,2013; Mozo et al., 2015; Maksimović et al., 2016). Differences in semen volume and sperm concentration across ejaculations have also been reported by several authors (Salhab et al., 2003; Al-Samarrae, 2009; Malejane et al., 2014; Mohammed, 2006; Babiker, 2010). Studies by Mohammed, (2006) indicated that higher proportion of viable cells was obtained in the second ejaculation after an abstinence of 3 days.

Effect of season on the libido of the rams too have been recorded among the Awassi rams, it was reported that Awassi rams have higher libido during autumn while it was comparably lower during the springs (Karl et al., 2006; Kridli et al., 2007; Ababneh et al, 2017). According to Casao et al.,(2010) seasonality is less marked in rams when compared to the ewes, changes in testicular volume, hormonal profile , sexual behavior and semen quality too have been reported to vary across seasons. Seasonal variation in testicular morphology among different ram breeds subjected to different feeding levels indicated that nutritional factors contributed to the difference in the variation (Salhab, 2003; Maljane et al., 2014 ; Ababneh et al., 2017; Mozo et al ., 2015; Oláh et al., 2013; Maksimović et al., 2016).

Findings of a study by Salhab, (2003) indicated that the volume of ejaculation and concentration of spermatozoa enhanced with age of the rams increased but no differences were observed in progressive motility of spermatozoa with age increased. The average volume of the ejaculation of growing Awassi rams in Jordan was similar to those from Lebanon (AbiSaab and Sleiman, 1987). However, the volume of ejaculate was higher among the rams reared in Lebanon when compared to those reared at Iraq (Asofi et al., 1997) and also that from native rams from United Arab Emirates (Ibrahim, 1997; Al- Samarrae, 2009). The differences in the volume of ejaculate might be attributed to differences in breed, the method of collecting the ejaculate and the interval between two successive ejaculates besides the age of the rams itself (Mohammed et al., 2006).

The motility of spermatozoa collected from Awassi rams, (based on progressive forward motility) was reported to be independent of both age and season (Salhab, 2003; Kridli et al., 2006; Tabbaa et al., 2006; Ababneh et al., 2017). Studies have also concluded that the consistency of their semen, libido of the Awassi rams was a seasonal (Kridli et al., 2007). This can be further ascertained through uniformity in semen characters and morphology which was irrespective of seasonal variations (Salhab, 2003). Furthermore, studies by Salhab, (2003) indicated that the motility of the sperms was similar among the Awassi rams reared in Syria and Iraq while it was lower among the Awassi rams raised in Lebanon (AbiSaab and Sleiman, 1987). However, the observations are contrary to the findings of Dachenx et al., (1981) and Mandiki et al., (1998) who reported that the motility of the spermatozoa differed across breeds and also differed across seasons.

The rate of motility (of the sperms) peaked during the breeding season and declined thereafter in non-breeding season (Babiker, 2010; Zohara et al., 2014; Martin et al., 2013; Malejane et al., 2014; Oláh et al., 2013; David et al., 2015). It was also revealed that under tropical climate, adverse environment influences sperm motility, its concentration and numbers per ejaculation (Babiker, 2010). It was also reported in studies by Talebi et al., (2009) and Malejane et al., (2014) that among the Dorper rams differences in sperm motility varied across the collection techniques i.e artificial vagina and electro ejaculation, the differences were observed irrespective of the seasons.

Studies further revealed that higher volume of semen and higher motility was observed those collected using the artificial vagina technique (Moghaddam et al., 2012; Malejane et al., 2014. It was also reported that there were no seasonal differences in motility for semen collected using electro ejaculation and artificial vagina (Talebi et al., 2009; Malejane et al., 2014). It was also revealed in a study by Zohara et al., (2012) and Malejane et al., (2014) that there was seasonal variation in the quality of semen collected from both artificial vagina and electro ejaculation. However, no differences in quality of the semen obtained between the two collections method (Talebi et al., 2009; Malejane et al., 2014).

High motility of semen correlates with the quality semen, and acceptable fertilizing capability and good fertility (Evans and Maxwell, 1987; Salhab, 2003;Fosati et al., 2009; Moghaddam et al., 2012;Rodríguez-Martínez, 2013;Malejane et al., 2014).

Studies by Malejane et al., (2014) have also indicated that the concentration of semen obtained from Dorper rams varied across the collection techniques with higher concentration obtained among the rams whose semen were collected through artificial vagina vis-a-vis those collected using electro ejaculation, the observations are consistent across seasons and years. The effects of season influenced the concentration of the sperms with the highest values recorded during the spring (Matthews et al., 2003; Malejane et al., 2014). It was also indicated in studies that there was association between the collection year and season which also influenced the quality traits of the sperms (David et al., 2007).

2.3. Effect of genotype on ram fertility

Fertility of rams and ewes and the rate of conception are important for efficient sheep production. However, reproductive traits of the ewes are lowly heritable with low selection intensities; thus, improvement through selection is generally low (Duguma., 2002). In contrast to low heritability for the reproductive traits of among the ewe , the testicular traits in rams are moderately heritable (Mozo et al., 2015).

Genetic correlation has also been reported among the reproductive traits of ewes and rams (Mozo et al., 2015). In addition to this several authors (Duguma et al., 2002; Mozo et al., 2015) have indicated that males with larger testes produce higher volume of semen and consecutively higher numbers of sperms). In order to improve the fertility and genetic merit of the flock and to reduce the number of breeding rams, those with superior reproductive traits need to be identified besides standards of minimum scrotal circumference corresponding to a certain age can be ascertained breed wise. Testicular size as a correlation criteria for the selection of the ewes is influenced by the heritability of testicular size, and there is genetic correlation between testicular size and the reproductive traits of the females (Vleck, 2004; Rodríguez-Martínez, 2013; Nouman & Abrar, 2013; Al-Samarrae, 2015). According to Solomon et al., (2013) selective breeding is expected to reduce the fitness of the animal population although it also adversely affects the genetic diversity, particularly among the small closed populations. Reduction in fitness may be ascribed to higher selection intensity; these are higher among inbred population that of random mating population. Optimum genetic gains without increasing the rate of inbreeding can be achieved by adopting appropriate selection and mating designs (Solomon et al., 2013).

The low heritability and repeatability of the productive traits of the ewes indicate that selection based on a ewes own performance results in slow genetic improvement. Selection for the productivity traits of the ewes should be based on the information obtained from the female relatives of the ewes or on correlated traits which have high and genetic correlation vis-a-vis those of the productivity of the ewes (Foote, 1964; Rodríguez-Martínez, 2013;Dariusz et al., 2013; Nouman & Abrar, 2013).

According to Solomon et al., (2013) average estimated breeding value for yearling weight of Menz lambs increased over the years of selection and average estimated breeding values too. It was also influenced by the year of birth while the average inbreeding coefficient remained zero for the first few generations and below the acceptable level of 1% in later generations (Solomon et al., 2013). Studies by (Solomon et al., 2013) indicated that while calculating the rate of inbreeding (ΔF) (of Menz rams) per generations, accessed by regressing the rate of inbreeding on the number of generation number was 0.17%. These results show that optimum genetic progress (on growth) can be achieved with an acceptable increase in the rate of low level of inbreeding (<1%/ generation) (Solomon et al., 2013).

Reproductive performance of sheep is influenced by both genetic and non-genetic factors(Solomon & Tesfaye, 2009; Dugumaet al., 2002; Tesfaye et al., 2013). Assessment of the fertility levels among the Menz sheep was inconsistent over the selection period. However, the overall genetic trend was negative, with an average decline in estimated breeding value of 0.00026% per generation (Solomon et al., 2013). Correlations between coefficients of inbreeding and estimated breeding value associated with the fertility of the ewe was assessed to be (−0.023) while it was (0.074) towards the survival of the lambs (Solomon et al., 2013). Findings by Shenkute et at., (2014) also indicated that Dorper crossbreed lambs born from improved Menz ewes had better birth and weaning weight. . These observations are consistent across all the locations. However in Chiro, the performance of the Corriedale crossbreds was comparable with those of the native ewes (Tesfaye et al., 2013).

The effects of location too differed both across years and also within breeds reared within particular locations. It was accessed that the ewes reared in South Wollo had better performance when compared to those reared at Menz and Chacha districts , lambing interval for Awassi x Wolo crossbred ewes reared in South Wollo (252 days) was comparable with those of the from Chacha and Menz (243 and 259 days), respectively. According to a study by (Solomon and Tesfaye, 2009; Sisay et al.,2012b;Tesfaye et al., 2013,2016) native breeds had higher age at first lambing, lambing interval and number of lambs born per ewe annually vis-a-vis those of Awassi x Local crossbred ewes across all the locations. However in South

Wollo, Corriedale crossbreds showed comparable performance with those of the reared south Wolo local ewes(Tesfaye et al., 2013).

2.4. Non-genetic factors influencing the fertility of the rams

Performances of crossbreds varied across the studied areas and were influenced by several factors including management. Crossbred (Awassi x Menz) lambs under station and farmers management outperformed their native (Menz and Wollo) contemporaries in North Shewa and Wollo highland areas of the Amhara region. The studies also indicated that Dorper x Menz crossbreds performed well under station management compared to Menz. However, it was concluded that the dissipation of the crossbreds should be correlated with their performance under farmers management (Sisay et al., 2012b; Tesfaye et al., 2013). The effect of the location too was significant as the, ewes in South Wollo outperformed those reared in Menz and Chacha districts. Lambing interval for Awassi x Local crossbred ewes from South Wollo was assessed to be 249.7±18 days was comparable with those of from Chacha and Menz which was 279.7±12.1 and 329.4±15.1 days, respectively (Tesfaye et al., 2013).

The research indicates also this performance could allow three lambing in two years which is a character of productive ewes in terms of lambing interval. This pointed out that in better environment and management Awassi x Wolo ewes could also perform comparable to south Wolo breeds in terms of reproductive performance. Better performance in South Wollo might be due to the combined effect of adaptability of the native breeds to the prevailing management (Solomon and Tesfaye, 2009; Tesfaye et al., 2013).

3. Material and methods

3.1 Description of the study area

The study was conducted at Debre Birhan Agricultural Research Center (DBARC) in the cool highland of central northern of Ethiopia which located at latitude of 9° 36'N and longitude 39° 38'E. The area is located at 120 km northeast from Addis Ababa with the altitude of 2780m above sea level and the mean annual rainfall of the area ranges from 781-1279mm and the minimum, maximum and mean range temperature were 7.3°c, 23.7°c and 2.21-28°c respectively and relative humidity 68% (center data). The climate characterized by bimodal rainfall consists of long rain season (June-September), short rain season (February-May) and dry season (October-January) (Fekadu, 2015).

The season division was according to Fekadu, (2015), Ethiopian highland has three different seasons dry (bega), short rain (belg) and long rain(kiremit). The monthly maximum, minimum temperature and average rainfall of the area during investigation was showed below.

Table1.Metreological data of Debre Birhan Agricultural research center

	2016				2017								
Factors	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep
Max(T)	20.7	19.1	18.2	18.4	19.9	20.4	21.7	22.6	21.8	23.7	21	20.1	19.7
Min(T)	9.4	9.58	9.4	8.3	7.3	8.1	9.5	10.6	9.8	9.1	8.1	8	8.6
Rainfall	28.5	15.6	4.4	0.0	0.0	18.7	31.5	8.5	51.9	35.1	214	292	58

Debre birhan agricultural research center (2017)

3.2 Animals and their management

3.2.1. Animals for semen parameter studies

For semen quality and quantity studies 18 rams of three genotypes included, Menz (n=6), Dorper (n=6) and Awassi x Menz (n=6) were used. Awassi breed was not included in semen quality and quantity study due to absence of breeding rams in the area. For each individual under study, a record sheet with full details of each parameter along with pedigree information was maintained. Ages of the rams were between 3.5 to 5 years (42-60 months) of age and their average body weight for Menz, Awassi x Menz and Dorper was 38.4, 52.5 and 65.9kg, respectively. Body condition score (scored on 1 to 5 basis; 1 for very poor and 5 very fat (Evans and Maxwell1987) of the rams was 3.25, 3.5, and 3.9 for Menz, Awassi and Awassi x Dorper, respectively. Before the actual semen collection date, scrotal circumference of rams were 28.5, 29.3 and 32 cm for Menz, Awassi and its cross and Dorper, respectively. Some ewes in estrus were used as dummies during semen collection time. During the course of this study there were some mortalities among the rams with 2 rams of Dorper genotypes were lost at various stages of the study.

All rams selected for semen quality evaluation were housed in the night at the study area and graze during the day with supplementation of commercial concentrate in the morning and at night. The house was provided with necessary arrangements for feeding, watering and were well ventilated. Feeding of hay as ad libitum and concentrate based on their body weight 400g, 500g and 600g for Menz Awassi and its cross and Dorper respectively (The concentrate feed had 19.9% crude protein, 79.3% total digestible nutrient. The feeding started before 56 days of the actual semen collection date. The pedigree animal data from research center and ranch were used for genetic parameter estimation. The rams have been trained on artificial vagina (AV) collection method. The artificial vagina was prepared from smooth rubber with conical shape meant for small ruminants.

3.2.2 Genetic and non-genetic factors associated with the fertility studies of the rams

A total of pedigreed 155 rams were used to access the genetic parameters associated with the fertility of the rams. Fertility of the rams in this case was defined as the percentage of ewes lambing among the total numbers of ewes in the flock. The fertility of the rams was assessed from the data collected from a total of 14357 ewes mated to the 155 rams. The data were obtained from Amedguya Sheep Breeding and Multiplication center (ASBMC), Debre Birhan Sheep Breeding and Multiplication center (DBSBMC) and DBARC. The data pertains to several years which varied across the genotypes while for Awassi rams the data pertained to records from 2001-2016 whereas for Menz and Dorper 2010-2016 and 2012-2016 respectively. Awassi, Dorper, Menz, Awassi x Menz and Dorper x Menz breeds were used for genetic parameter estimation. The structure of data used for genetic parameter estimation included pedigree data (animal identification number, sire, dam), fixed effects (year of birth, season of birth, sire breed, ewe breed and location) and a dependent variable (ram fertility). The feeding of animals was depending up on the availability of natural grazing land. Supplementary feed (commercial concentrate and hay) were required during dry and short rain seasons while they were not feeding their animal during long rain seasons. Feeding activities were based on the age, sex and weight of animals.

3.3 Sample and Data collection

The semen collection was undertaken for a period of twelve months encompassing all the seasons. About 393 ejaculations were collected from the rams. Annually the season was divided according to the methods suggested by Fekadu, (2015). The parameters to assess the quality of the semen were ejaculation volume, color of semen, mass motility of semen, concentration of spermatozoa, live spermatozoa, normal and abnormality of spermatozoa. Breeding soundness examination like inspection of genital organ (e.g. prepuce, sheath and scrotal circumference) was undertaken for all rams. Libido test was assessed based on (Evans and Maxwell, 1987) during semen collection and scored in 1 to 5 scales.

- Excellent (5); when the ram introduce to the room it is spoiling for riding the staff is unable to hold it still.
- Very good (4); the ram mount immediately to the teaser ewe the staff able to control it.
- Good(3); the ram brought to the teaser sniffs around it and after 1-2 minutes it start mount it
- Poor(2); the ram sniffs around the teaser a few minutes and mounts it within 3-4 minutes and elapse the artificial vagina repeats mounting during which it ejaculates.
- Very poor(1); no interest to sniffs and mount

Initially, semen was collected from 18 rams, six (6) from each breed around the end of the study some rams was lost from different breeds one from Menz, one from Awassi and its cross and two from Dorper. During the course of the semen collection some rams passed out (1 ram each of Menz, Awassi and their crosses and 2 Dorper rams) and collection semen was continued with thus remaining 14 rams every fortnight for 12 months according to the above mentioned method. The color of semen was scored subjectively by looking and classified into, milky, watery, thin creamy, creamy and thick creamy (Evans and Maxwell, 1987). After looking the color of the semen was immediately stored at 35°C temperature in a water bath to evaluate the quality of the fresh semen included semen volume per ejaculation (Volume/ml), fresh sperm motility (score 0-5), sperm concentration and morphology.

Volume of ejaculate was directly measured in a graduated tube and its sperm cell concentration was measured using AccuRead IMV Technologies. SA, 232 Spectrophotometer (Evans and Maxwell, 1987). Sperm mass motility was estimated subjectively by using phase contrast microscope (Scope Technology Scope Photo 3.0.12.). To evaluate mass motility of semen using micropipette to take semen and put a drop of fresh semen on the slide and cover with cover slip and seen with the magnification of 10x on the objective lens. The mass motility is graded or leveled zero to five (0-5) score based on the intensity of wave motion as described by (Evans and Maxwell 1987). According to these methods:

0. Zero; all spermatozoa are immotile (motionless)
1. Very poor; very few spermatozoa are active about 10% (weak movement around),
2. poor (some movement of semen was visible about 20-40% of spermatozoa were live but poor motility),
3. Fair(small, slow moving wave 40-70% of sperm cells were active
4. Good (dense, vigorous wave movement 75-90% of sperm cells were active
5. Very good (cloudy, dense and rapidly moving waves more than 90% of spermatozoa were active.

The morphology of sperm was assessed using stained slides with Eosin Nigrosin strain The ratio of live and dead sperm cells and abnormality of the head, mid and tail had been evaluated using phase contrast microscope at the magnification of 100X. Percentage of live spermatozoa has been estimated after smearing of fresh semen. Using pipette and putting a drop of fresh semen was placed on a pre-warmed microscope slide (35%) and then stained with Eosin-Nigrosin staining methods and products (Rege et al., 2000).

A drop of Eosin, four drops of Nigrosin and a drop of semen are placed on a clean, grease free slide then mix the semen first with eosin and then immediately with Nigrosin stain. Again the mixture is taken on the edge of a slide and pulled across the top of another slide leaving a smear, thereafter it was air dried . 200 numbers of spermatozoa are counted under oil immersion at a magnification of 100X in different areas of smear and classify them as live spermatozoa, normal, head abnormal, mid piece abnormal and tail abnormal sperm(Rege et al.,2000)

.

$$\text{Head abnormal sperm percentage } = \frac{\text{total head abnormal counted}}{\text{total numbers counted}} x100$$

$$\text{Mid piece abnormal sperm percentage} = \frac{\text{total mid piece abnormal counted}}{\text{total numbers counted}} x100$$

$$\text{Tail abnormal sperm percentage} = \frac{\text{total tail abnormal counted}}{\text{total number count}} x100$$

3.4. Statistical analysis

The effect of genetic, non-genetic and their interaction with the sperm quantity and quality traits volume, concentration, motility and other parameters libido, body weight and body condition of the ram were analyzed by the general linear model and conception of ewes or ram fertility was analyzed by chi-square using SAS 9.0 program. Genetic parameters for fertility and estimated breeding value were estimated by restricted maximum likelihood (REML) procedure using WOMBAT (Meyer, 2006) program.

The single animal model used to estimate variance components was

$$Y_i = X_i b_i + Z_i a_i + W pe_i + e_i$$

Where Y_{i} = is a vector of observations,

b_i= is a vector of fixed effects for trait *i* (year, season location and ewe breed),

a_i= is a vector of random animal effects for trait *i*,

pe_i= is permanent environmental effects for trait *I* and non- additive genetic effect

e_i = is a vector of residual effects for trait *i*,

X, Z, W= incidence matrix of relating records to fixed, animal and permanent effect respectively.

Heritability and repeatability were estimated based on

$$h^2 = \frac{\sigma_a^2}{\sigma_a^2 + \sigma_{pe}^2 + \sigma_e^2}$$

$r = \frac{\sigma_a^2 + \sigma_{pe}^2}{\sigma_p^2}$

σ_a^2= additive genetic variance h^2= heritability

σ_p^2= phenotypic variance σ_{pe}^2 = permanent environmental variance

σ_e^2= residual variance = repeatability

The significance of fixed effects (non- genetic factors and genetic) was tested by least squares analysis of variance using general linear model (GLM) procedure of (SAS 9.0) program. This model works for all semen quality parameters like, volume of ejaculation mass motility, concentration of spermatozoa, live spermatozoa and abnormal spermatozoa.

The models are as follows;

$Y_{ijkm} = \mu + B_i + S_j + W_k + E_{ijkm}$

Y_{ijkm} = the dependent variable

μ= the overall mean

B_i= the fixed effect of i^{th}breed

S_j= the fixed effect of j^{th} season

W_k= the interaction effect of k^{th} breed and season

E_{ijkm}= the residual error

4. Results

4.1 Semen evaluation

4.1.1 Effect of genotype on semen quality parameters

Least square means for the effect of genotype on the volume, concentration morphologically abnormal, mass motility and live spermatozoa are presented in Table 2. There was difference in mass motility of the ejaculate, which varied across the genotypes but ejaculation volume and concentration of spermatozoa varied ($p<0.001$) across the genotypes. Percentage of live spermatozoa varied ($p<0.05$) across genotypes. Abnormality of semen was higher ($p<0.05$) in Awassi x Menz and Dorper when compared to than the Menz rams. of the results further indicated that abnormality of the sperm head and mid was higher ($p<0.05$) among the Awassi x Menz and Dorper rams vis-à-vis those of the Menz; whereas tail defects differed ($p<0.001$) among Menz rams and also differed ($p<0.05$) across Awassi x Menz and Dorper rams. According the site of morphologically abnormal spermatozoa can be classified into headless, tailless and coiled were clearly observed. Headless spermatozoa varied ($P<0.001$) across genotypes. The findings indicated that the numbers of headless spermatozoa was higher among the Dorperrams followed closely by the Awassi x Menz rams . Tailless and coiled abnormal spermatozoa were lower ($p<0.0001$) was lower among the Menz rams whereas it did not differ among the Awassi x Menz and Dorper rams.

Table 2: Semen quality parameters (LSM±SE) of different genotypes of rams

Parameters	Genotypes		
	Awassi x Menz(N=131)	Dorper(N=122)	Menz(N=139)
Color	2.0^{b}(0.034)	2.1^{b}(0.036)	2.3^{a}(0.033)
Volume (ml)	0.92^{ab}(0.04)	1.14^{a}(0.04)	0.7^{c}(0.04)
Concentration 10^{9}	3.34^{ab}(0.13)	4.1^{a}(0.14)	2.44^{b}(0.13)
Motility (0-5)	3.4(0.08)	3.18(0.09)	3.17(0.08)
Live sperm (%)	83.87^{b}(0.26)	83.6^{b}(0.27)	84.65^{a}(0.25)
Abnormality (%)	9.41^{a}(0.36)	10.04^{a}(0.38)	6.78^{b}(0.35)
Head	3.2^{a}(015)	3.42^{a}(0.16)	2.25^{b}(0.15)
Mid	3.08(0.18)	2.8(0.19)	2.5(0.18)
Tail	3. 12^{ab}(0.15)	3.8^{a}(0.16)	1.9^{b}(0.15)
Headless	2.29^{b}(0.18)	3.28^{a}(0.19)	1.27^{c}(0.18)
Tailless	6.4^{a}(0.26)	6.8^{a}(0.32)	4.5^{b}(0.3)
Coiled	4^{a}(0.26)	4.3^{a}(0.27)	2.6^{b}(0.26)

$^{a\ b\ c}$ Means with different letters for a trait across genotypes are different (p<0.05)

4.1.2 Effect of season on semen quality traits of different breeds

The effect of season in various ram semen characteristics of different genotypes are presented in Table 3. The results from the study indicate that the color of the semen of the Menz rams differed (P<0.05) across seasons with semen of lighter color recorded during the long and short rain seasons. The findings show that there was no difference across the genotypes when the volume of the semen was concerned. Abnormal spermatozoa's were higher (p<0.0001) among the Dorper, A x M and Menz rams during the long rainy season, while no differences across seasons were observed in volume and motility of semen in all breeds which were studied.

Table 3: Semen quality parameters (LSM±SE)of different breeds and different seasons

Variations	N	Parameters					
		Color	Volume	Motility	conception	Live	Abnormal
Dorper							
Dry	48	2.1(0.05)	1.18(0.07)	3.1(0.12)	4.3(0.2)	84.4^{a}(04)	8.5^{b}(0.7)
Long rain	32	2.2(0.06)	1.17(0.08)	3.5(0.15)	4.1(0.2)	82.2^{b}(0.5)	13^{a}(0.8)
Short rain	42	2.0(0.05)	0.98(0.07)	3.0(0.13)	3.7(0.2)	84^{ab}(0.4)	8.8^{b}(0.7)
Overall	122	2.1(0.04	1.11(0.04	3.18(0.09)	4.1(0.14)	83.6(0.27)	10.04(0.4
A x M							
Dry	46	2.0(0.1)	0.92(0.03)	3.3(0.14)	3.6(0.2)	85^{a}(0.4)	8.3^{b}(0.6)
Long rain	40	1.95(0.1)	0.94(0.04)	3.7(0.15)	3(0.2)	82^{b}(0.4)	11.4^{a}(0.7)
Short rain	45	2.02(0.1)	0.91(0.03)	3.2(0.14)	3.3(0.2)	84.5^{a}(0.4)	8.4^{b}(0.5)
Overall	131	2.0(0.03	0.9(0.04	3.4	3.3(0.13)	83.87(0.26	9.4(0.36)
Menz							
Dry	52	2.4^{a}(0.1)	0.68(0.09)	3.2(0.07)	2.9^{a}(0.2)	84.7(0.41)	6.2^{b}(0.5)
Long rain	40	2.1^{b}(0.7)	0.62(0.1)	3.1(0.08)	1.7^{b}(0.2)	84(0.46)	8.8^{a}(0.5)
Short rain	47	2.3^{b}(0.1)	0.64(0.09)	3.3(0.07)	2.6^{a}(0.2)	85.3(0.43)	5.2^{b}(0.5)
Overall	139	2.3(0.03)	0.65(0.04	3.17(0.08)	2.44(0.13)	84.6(0.25)	6.8(0.35)

$^{a\,b\,c}$ Means with different letters for a trait across seasons within breeds are different ($p<0.05$)

4.1.3. Association between genotypes and season on semen quality traits

The interaction effect of breeds and seasons on semen quality parameters are presented in table 4. The results indicate that the interaction of breed and season had significant influence on semen quality traits. The abnormal spermatozoa was highest among the Dorper, A x M and Menz rams during the long rainy season, while the color of the semen was lowest among the Menz rams during the rainy season with no differences across seasons among the rams of the other two genotypes. The numbers of live semen were highest among the rams of Dorper and A x M rams during the dry and short rainy season while the reverse was true for the abnormal spermatozoa which was lower in the long rainy season and across all the genotypes. The concentration of semen were highest in rainy season in Menz rams while no difference among Dorper and A x M rams in all seasons.

Table 4: Semen quality traits (LSM±SE) and its association between genotypes and seasons

Variations	N	Parameters					
		Color	Volume	Motility	concentration	Live	Abnormal
Dorper							
Dry	48	2.1^{b}(0.05)	1.18^{a}(0.07)	3.1(0.12)	4.3^{a}(0.2)	84.4(04)	8.5^{a}(0.7)
Long rain	32	2.2(0.06)	1.17^{a}(0.08)	3.5(0.15)	4.1^{a}(0.2)	82.2(0.5)	13^{a}(0.8)
Short rain	42	2.0^{b}(0.05)	0.98(0.07)	3.0(0.13)	3.7^{a}(0.2)	84(0.4)	8.8^{a}(0.7)
A x M							
Dry	46	2.0^{b}(0.1)	0.92^{b}(0.03)	3.3(0.14)	3.6^{a}(0.2)	85(0.4)	8.3^{a}(0.6)
Long rain	40	1.95(0.1)	0.94^{b}(0.04)	3.7(0.15)	3^{b}(0.2)	82(0.4)	11.4^{a}(0.7)
Short rain	45	2.02^{a}(0.1)	0.91(0.03)	3.2(0.14)	3.3^{ab}(0.2)	84.5(0.4)	8.4^{a}(0.5)
Menz							
Dry	52	2.4^{a}(0.1)	0.68^{c}(0.09)	3.2(0.07)	2.9^{b}0.2)	84.7(0.41	6.2^{b}(0.5)
Long rain	40	2.1(0.7)	0.62^{c}(0.1)	3.1(0.08)	1.7^{c}(0.2)	84(0.46)	8.8^{b}(0.5)
Short rain	47	2.3^{a}(0.06)	0.78(0.09)	3.3(0.07)	2.6^{b}(0.2)	85.3(0.43	5.2^{b}(0.5)

[a, b, c] Means with different letters for a trait between season and breeds are different ($p<0.05$)

4.1.4 Effect of seasons on breeding of rams

The effect of season on various breeding rams body weight, body condition, scrotal circumference and libido of different genotypes are presented in Table 5. Body weight and body condition of Dorper rams was higher during long rain seasons while AXM and Menz were no differences in body weight and body condition across all the seasons. There were no differences between AXM and Menz rams across all seasons on the parameters studied except libido on Menz rams which was higher during dry seasons.

The results further indicate that the libido was highest among the Dorper and A x M rams during the long rainy season, while the scrotal circumference of the semen was no differences across seasons among the rams of all genotypes.

Some morphology of semen

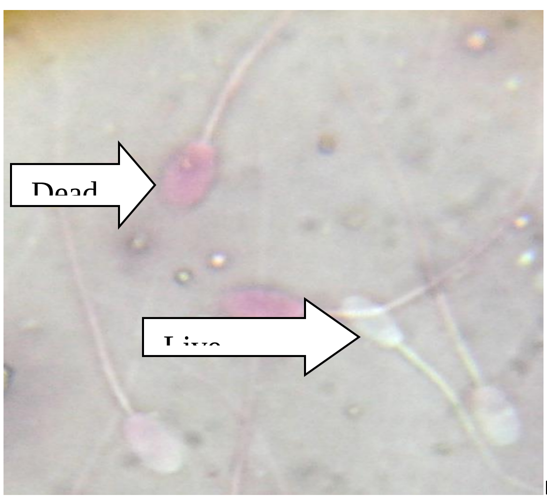

Figure.2. Abnormal and normal tail spermatozoa

Figure.1. Live/dead spermatozoa

Table 5: Effect of season on body weight, body condition, scrotal circumference and libido of different genotypes of Rams

Variations	N	Parameters			
		Body weight	Body condition	Scrotal circumference	Libido
Dorper					
Dry	48	71.57^{b}(0.9)	4.18^{b}(0.09)	32(0.27)	2.95^{b}(0.1)
Long rain	32	78.56^{a}(1.13)	4.94^{a}(0.12)	32.65(0.34)	3.7^{a}(0.12)
Short rain	42	75.9^{a}(0.99)	4.4^{b}(0.1)	32.47(0.29)	3.26^{ba}(0.1)
Overall	122	74.4(0.58)	4.5(0.07)	32.3(0.15)	3.30.07)
A XM					
Dry	46	58.4(0.9)	4.02(0.12)	30.06(0.2)	3.3^{b}(0.05)
Long rain	40	59.87(1)	4(0.13)	30.7(0.22)	4^{a}(0.05)
Short rain	45	58.36(0.9)	4(0.12)	30.5(0.2)	3.8^{a}(0.05)
Overall	131	58.9(0.5)	4.01(0.06)	30.4(0.13	3.7(0.06)
Menz					
Dry	52	41(0.59)	3.7(0.1)	28.7(0.18)	3.2^{a}(0.06)
Long rain	40	42.4(0.67)	3.4(0.12)	29.13(0.2)	3.1^{b}(0.06)
short rain	47	41(0.53)	3.78(0.1)	28.78(0.19)	3.3^{a}(0.06)
Overall	139	41.7(0.49)	3.65(0.06)	28.8(0.13)	3.2(0.05)

$^{a\ b\ c}$ Means with different letters for a trait across seasons within breeds are different ($p<0.05$)

4.1.5. Correlation between different ram semen quality traits

The correlations among various ram semen characteristics of AXM (above diagonal) and Menz (below diagonal) are presented in Table 6**.**The results of the study for the AXM rams indicate that the body condition (BC) of the rams is correlated ($P<0.0001$) with those of scrotum circumference (SC) and also libido (LIB). The study further indicates that the SC and LIB are correlated ($P<0.0001$) while it is also correlated ($P<0.05$) with the motility of the sperms. While LIB is also correlated ($P<0.05$) with the numbers of defective sperms, the volume of the sperms and its concentration too are correlated ($P<0.0001$). The study further indicates that the motility (MOT) are negatively correlated ($P<0.05$) with the numbers of defective sperms (DEF), the study further indicates that the numbers of live/dead sperms are negatively correlated ($P<0.0001$)with MOT .

The results pertaining to the correlation between the traits studied among the Menz rams show that the SC are correlated ($P<0.0001$) with LIB among the rams, similarly the LIB of the rams is correlated ($P<0.0001$) with the concentration of the semen. The results also show that the volume (VOL) of the semen and its concentration too are correlated ($P<0.0001$) besides the same the MOT values are also correlated ($P<0.0001$). The findings also show that the COL of the semen was correlated ($P<0.01$) with MOT of the semen.

Table 6: Correlations between semen characteristics of breeding rams Menz rams (below diagonal) and Awassi x Menz (above diagonal)

	BC	SC	LIB	VOL	COL	MOT	CON	LD	DEF
BC		0.3***	0.45***	-0.058	-0.16	-0.06	-0.08	0.04	0.002
SC	0.04		0.42***	-0.1	0.13	0.18*	0.05	0.05	-0.08
LIB	0.1	0.3***		-0.05	-0.04	-0.17	-0.18	-0.15	0.23*
VOL	-0.04	0.08	0.16		0.08	0.17	0.69***	-0.01	0.05
COL	0.13	-0.05	0.16	-0.01		0.17	0.16	0.16	-0.13
MOT	0.08	0.06	0.13	-0.04	0.3**		0.15	0.06	-0.22*
CON	-0.04	0.09	0.28**	0.86***	0.06	0.07		0.14	-0.07
LD	0.014	-0.015	0.01	-0.09	0.02	0.02	-0.02		-0.52***
DEF	-0.2	0.04	-0.07	0.09	-0.07	-0.19	-0.09	-0.15	

*=p<0.05, **=p<0.001 and ***=p<0.0001

SC = scrotal circumference BC= body condition VOL= volume of ejaculation semen

MOT= motility CON= concentration COL=color LIB= libido LD=live and dead DEF=defect

The results pertaining to the correlation between the semen traits of Dorper rams are presented in Table 7. The findings show that the BC of the rams is correlated (P<0.05) with the SC and defective sperms (DEF), the findings also show that BC is negatively correlated (P<0.05) with MOT. The findings show that the SC is negatively correlated (P<0.001) with VOL and CON of the semen while it was negatively correlated (P<0.05) with the LIB: While, LIB was correlated (P<0.05) with VOL of the semen. The VOL of semen is correlated (P<0.05) with MOT and CON (P<0.0001), while it is negatively correlated (P<0.05) with the COL. The findings also show that COL of the semen is correlated (P<0.05) with MOT of the semen.

The results show that the MOT of the semen was correlated (P<0.05) with the CON of the semen, while LD is correlated (P<0.0001) with the numbers of DEF.

Table 7: Correlation coefficient's between different semen traits of Dorper rams

	BC	SC	LIB	VOL	COL	MOT	CON	LD	DEF
BC		0.26^{*}	0.03	-0.09	0.05	-0.18^{*}	-0.17	-0.14	0.2^{*}
SC			-0.2^{*}	-0.33^{**}	0.09	-0.09	-0.3^{**}	-0.02	0.13
LIB				0.26^{*}	-0.08	0.11	0.14	-0.04	0.2
VOL					-022^{*}	0.18^{*}	0.78^{***}	0.01	-0.01
COL						0.23^{*}	-0.04	0.01	-0.06
MOT							0.22^{*}	0.04	-0.15
CON								-0.1	-0.03
LD									-0.4^{***}
DEF									

*p<0.05, **p<0.001 and ***p<0.0001

SC = scrotal circumference BC= body condition VOL= volume of ejaculation semen

MOT= motility CON= concentration COL=color LIB= libido LD=live and dead DEF=defect

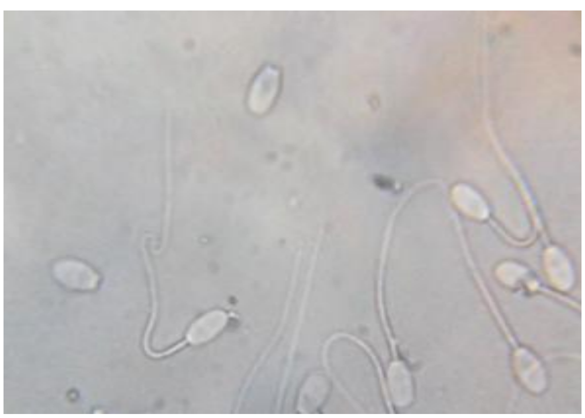

Figure3. Tailless spermatozoa

figure 4. Coiled tail and mid piece abnormal spermatozoa

4.2. Evaluations of fertility among the rams

4.2.1. Genetic variability of rams in conception of ewes

Means of different ram's genotype on conception of ewes and Awassi rams at Debre Birhan are presented in Table 8. There was difference (P< 0.05) in conception ewes was significantly (P<0.05) affected or influenced by genotype of rams and location. The results indicate that the conception of the Awassi rams were higher (P<0.05) at Debre Birhan (DB) when compared to those reared at Menz district (Menz).While, the fertility among the rams raised at DB , indicated that it was higher (P<0.05) among the Menz rams while it was the lowest among the Awassi rams.

Table 8: Mean values for conception of ewes mated to rams of different genotypes

Genotype	Number of ewes mated	Conception
Awassi	8320	45.44^{d}
Awassi (♂) x Menz (♀)	298	53.36^{c}
Menz	666	84.85^{a}
Dorper	616	70.62^{b}

$^{a, b, c, d}$ P<0.05 , values across genotypes are different

4.2.2. Seasonal variability of fertility among the Awassi rams reared across different locations

Means of Awassi ram's on conception of ewes in different location and season are presented in Table 9. It transpires from the study that there are differences across seasons (P<0.05) in the fertility of the Awassi rams reared in the two locations. The study shows that at Debre Birhan and Menz district the fertility was higher (P<0.05) in the long rainy season while it was lowest during the short rainy season, The results also indicate that the fertility was higher at Debre Birhan (during the long rainy season), while the reverse was true during the other two seasons.

Table 9: Fertility of Awassi rams reared at Debre Brhan and Menz districts and across different seasons

Season	Overall	Location			
		Debre Birhan (N)	Con	Menz(N)	Con
Long rain	0.56	2300	57.74^{a*}	1311	53.09^{a}
Dry	0.42	4454	39.74^{b}	1365	48.94^{b*}
Short rain	0.35	1568	32.72^{c}	1778	37.12^{c*}

$^{a, b}$ P<0.05 values across the columns are different. * P<0.05 values across rows are different

4.2.3. Fertility of Awassi rams in different ewe breeds

Means of ewe breeds on conception of by using Awassi ram are presented in Table 10. The results indicate that there were no differences in conception across the genotypes (of the ewes) when it came to nicking with the Awassi rams.

Table 10: Conception (LSM ± SE) of different genotypes of ewes mated to Awassi Rams

Details	Overall	Ewe breed					
		75% A XM	AXM	Menz	Bonga	Awassi	Washera
N		171	3090	8798	212	161	344
Conception	0.44	0.46(0.03)	0.44	0.44	0.41	0.47(0.3)	0.45(0.02)

4.2.4. Genetic and seasonal variability influencing the fertility of rams

Means of seasons and breed on conception of ewes are presented in Table 11. There was a difference ($p<0.001$) in fertility in overall seasons. Long rain season was higher conception ($p<0.001$) across all the genotypes than the rest of two seasons (dry and short rain). The results indicate that the fertility was highest ($P<0.05$) among the Dorper rams during the long rainy season with the values being lowest among the A x M. The study further indicates that during the dry and short rainy season the fertility of the Menz rams were higher when compared to their counterparts. The fertility in the dry and short rainy season was lowest among the Awassi and Dorper rams respectively. When we compare the effects of seasons across the genotypes it transpires that the value for the Awassi rams were lower across seasons i.e. from Long rain to dry, the A x M rams had lower fertility during the long rains while the values improved during the short rainy season. Among the Menz rams there were no differences in fertility across the seasons, while there was a sharp decline ($P<0.05$) in the fertility of the Dorper rams across seasons from long rain to the short rain.

Table 11: Genetic and Seasonal variability influencing fertility of rams of different genotypes

Genotype	Overall	Conception					
		Long rain		Dry		Short rain	
		N	Con (%)	N	Con (%)	N	Con (%)
Awassi	44.12	3611	56.05^{Xa}	5819	41.9^{Yb}	3346	35.6^{Yc}
AXM	53.36	75	30.67^{Yb}	-	-	223	60.99^{Xa}
Menz	84.83	-	-	101	86.14^{W}	565	84.6^{W}
Dorper	70.62	451	78.05^{Wa}	114	62.28^{Xb}	51	23.53^{Zc}
Overall		4137	57.99^{a}	6034	43.02^{b}	4185	42.99^{b}

$^{W, X, Y, Z}$ Means with different letters are significantly different (p<0.001) across column

$^{a\ b\ c}$ Means with different letters are significantly different (p<0.001) across rows

4.2.5. Effect of years on Fertility of rams

Means of breeds and years on conception of ewes in different breeds are presented in Table12. The fertility (conception of the ewes mated) among the Awassi rams improved across the years with the lowest being recorded at 2012 and the highest in 2016. The study further indicated that among the Dorper rams the fertility peaked at 2013 thereafter there was a steady decline over the years studied. The results pertaining to the fertility among the Menz rams were low during the beginning of the study thereafter there was a consistent improvement in the fertility across all the years studied.

Table 12: Means of fertility of rams in different years and genotype

Genotype	Conception	Year					
		2011	2012	2013	2014	2015	2016
Awassi	41.13^{y}	35.9^{Xd}	33.6^{Yd}	40.35^{Xc}	50.63^{Xb}	43.5^{Xc}	58.3^{Xa}
Dorper	70.62^{x}	-	62.28^{Xc}	95.16^{Wa}	70.14^{Wb}	-	57.96^{Xd}
Menz	84.10^{w}	77.78^{Wb}	88.14^{W}	87.83^{W}	-	87.04^{W}	88.51^{W}
Overall		37.9	36.4	43.92	52.7	45.7	62.6

$^{W, X, Y}$ Means with different letters are significantly different (p<0.001) across column

$^{a\ b\ c}$ Means with different letters are significantly different (p<0.001) across rows

4.3. Genetic component

4.3.1. Estimation of genetic parameters influencing the fertility traits

Estimate of variance components and genetic parameters influencing the fertility of the rams are presented in Table 13. The results indicate that the estimated additive genetic variance of the Awassi rams was lower than those of the Menz and Dorper rams. The additive genetic variance was more or less similar across the genotypes while the phenotypic variance differed across genotypes. The result indicates that environmental factors varied across genotypes indicating their adaptability towards the studied areas. Repeatability of this trait was too varied across genotypes with values from 0.67, 0.38 and 0.66 for Menz, Awassi and Dorper rams respectively.

Table 13: Estimate of variance components for ram fertility

Genotype	Numbers	σ_a^2	σ_p^2	σ_e^2	σ_{pe}^2	r_e	h^2
Menz	666	0.012	0.029	0.01	0.01	0.67	0.41
Awassi	12776	0.01	0.08	0.05	0.02	0.38	0.1
Dorper	680	0.014	0.03	0.01	0.006	0.66	0.46

σ_a^2, σ_p^2, σ_e^2, σ_{pe}^2, r_e, h^2 are; additive genetic variance, phenotypic variance, error variance, permanent environmental variance repeatability and heritability respectively.

4.3.2. Sire ranking of different breed based on estimated breeding value

The results pertaining to the sire ranking of the different genotypes for the fertility related values are presented in Table 14. There was variation in fertility of rams between and within breeds of rams. The estimated breeding value (EBV) of the rams indicated that the values were highest for ram number 5076, 3502 and 9391 for Awassi, Dorper and Menz respectively , while the lower values were recorded for 4702, 947 and 10746, the differences between the higher and the lower ranged being quite high across the breeds

Table 14: Sire ranking based on estimated breed value (EBV) of fertility trait

Genotypes					
Awassi		Dorper		Menz	
RID	EBV	RID	EBV	RID	EBV
5076	0.11	3502	0.11	9391	0.065
5074	0.093	11546	0.10	9394	0.065
5073	0.09	18211	0.09	9446	0.065
2003	0.08	11852	0.086	10768	0.061
4702	0.07	947	0.063	10746	0.047

RID =rams identification number, EBV=estimated breeding value

5. Discussions

5.1. Evaluation of semen parameters

5.1.1 Effects of genotypes on semen quality parameters of the rams from different genotypes

The results as presented in Table 1 shows that there is differences in body weight (BW) of the rams, the BW of the Awassi cross with Menz rams values were lower than those reported by Zohara et al., (2014) on Awassi rams. The results also show that the BW of the Dorper rams are comparable with those reported by Malejane et al., (2014) from South Africa, contrary to the same the BW of Menz rams are higher than those reported by Solomon et al., (2009) . The differences in BW across the breeds are by large genetic in nature (Falconer, 1989). The body condition score (BCS) too varied across the breeds and this too is by large genetic in nature, this too is based on genotype by environment (G x E) (Falconer, 1989; Nouman & Abrar, 2013; Jawasreh et al., 2012; David et al., 2015).

The scrotal circumference (SC) too is influenced by the breed and therefore rams with low body weight have SC which were small (Salhab et al., 2003, Mohammed et al., 2006, Tabbaa et al., 2006, Olah et al.,2013). The results also indicate that the libido too varied across the breeds. Findings by (Mohammed et al., 2006; Babiker, 2010; Al-Samarrae S.H, 2009, 2015;Zohara et al., 2014;Maksimović et al., 2016) have indicated that rams with poor or very high body condition usually have low libido when compared to those which have an optimum body weight. The color of the semen is influenced by the both the breed of the ram but also the nutrition it receives (Salhab et al.,2003; Tabbaa et al., 2006), rams reared on good diet usually have semen which are creamy in color, moreover if the semen are not collected regularly or are collected very frequently have different color (Martin et al., 2013; Mohammed et al., 2006; Tabbaa et al.,2006; Malejane et al., 2014). The volume of semen as recorded in the study too varied across the breeds which is in close accordance with the findings of (Mohammed et al., 2006; Al-Sammarrae, 2009; Olah et al., 2013; Moghaddam et al., 2012). The volume of the semen as obtained in the present study was higher than what was reported by (Al-Samarrae, 2009). The volume of semen in Karradi and Arrabi breeds was assessed to be 0.61ml and 0.59ml respectively which was comparable with on the findings of Tejaswi et al., (2016) and however the volume was lower than what was reported for Ile de France 1.75ml during autumn, 1.89ml in the winter and 1.75 in the spring reported (Oláh et al., 2013). The average semen volume of Awassi rams varied from 1.2-1.53 ml (Salhab et al., 2003 and Oláh et al., 2013) in growing and adult rams.

The volume of semen from Dorper rams as recorded in this study was similar to what was reported by Malejane et al., (2014). The volume of the ejaculate of the cross breed rams are lower than reports of several authors (Salhab et al., 2003; Kridli et al., 2006; Casaco et al., 2010). The differences as observed might be ascribed to the genetic makeup of the animals, besides several intrinsic and non-intrinsic factors viz method of collection and location. The volume of ejaculate of Menz rams was lower than those of native x crossbred rams from Iraq (Martin et al, 2015). The volume of semen is correlated with the body weight of the rams and also the scrotal circumference. However, the volume of semen is not a good indicator of its conception, as the former may have high amount of seminal fluid and not the amount of the sperm cells.

The concentration of the sperms also depends on the frequency of collection besides the age of the rams and also the breed (Rege et al., 2000; Salhab et al., 2003; Martin er al., 2013; Malejane et al., 2014). Rams which are very young or aged have low concentration when compared to those who are at prime of their age (Salhab et al., 2003; Kridli et al., 2006; Zohara et al., 2014). The results pertaining to the concentration of spermatozoa obtained from Awassi x Menz rams was assessed to be 3.34×10^9 sperm/ml which was lower than the value of 4.9×10^9 sperm/ml as reported by Ibrahim, (1997) for native Awassi rams reared in United Arab Emirate, while the value was 4×10^9 sperm/ml among growing Awassi rams from Syria Salhab et al., (2003). The concentration of the semen also depends on the nutrition it receives, rams which are not well adapted to a particular agro climate have poor concentration (Salhab et al., 2003; Martin et al., 2013; Moghaddam et al., 2012, Nikolovski et al., 2012).

Several studies (Dachenx et al., (1981); Mandiki et al., (1998); Al-Samarrae, 2009) have also indicates that motility of the sperms did not vary across breeds, studies have indicate that the motility of the sperms depend on the age of the rams (Ibrahim, 1997; Salhab et al., 2003; Mohammed et al., 2006; Al-Samarrae et al., 2009) frequency of collection time and can vary across the rams (Martin et al., 2013; Moghaddam et al., 2012). The rams having low sperm motility have low fertilizing capacity and hence need to be identified and culled (David et al., 2015). The numbers of abnormal sperms too are influenced by the individual rams and rarely vary across breeds (Moghaddam et al., 2012). Studies by (Shamir et al., 2010; Velck et al., 2004; David et al., 2015) have indicated that the numbers of abnormal spermatozoa is influenced by inbreeding and inbred rams usually have high numbers of abnormal spermatozoa. The numbers of abnormal spermatozoa were higher among the Awassi and

Dorper rams, the values being comparable with than those reported by (Moghaddam et al., 2012; Babiker, 2010; Zohara et al., 2012) however the values were more or less similar than those reported by (Salhab et al 2003; Malejane et al., 2014). The abnormality in the size of the sperm head too are within the range of values reported by (Martin et al., 2013; Malejane et al., 2014). Studies by Tabbaa et al., (2006); Al-Samarrae et al., (2009) have indicated that small size of the sperm head can have an effect on the fertilizing capacity and those which have small head have poor fertilizing capacity, same is true for oversized heads of the sperms (Babiker, 2010; Milosevic et al., 2012; Zohara et al., 2012; Martin., 2013;Tejaswi et al., 2016).

The size of the tail too varied across the breeds and rams with small tails usually are breed dependent (Rege et al., 2000; Milosevic et al.,2012; Mozo et al., 2015; Tajaswi et al., 2016). The numbers of headless sperms too varied across the breeds which too are influenced by the rate of inbreeding and the rams which are highly inbred usually have large numbers of headless sperms (Shamir et al., 2010). Therefore, it is imperative to access the semen related traits of the rams prior to including them in a breeding program (Babiker, 2010; Martin et al., 2013; Kridli et al., 2007; Mozo et al., 2015; Tajaswi et al.,2016). Findings of a study by (Yavarifard et al., 2015) have indicated that the traits are lowly to moderately heritable and hence the rams need to be screened for these traits prior to being included in any breeding program.

5.1.2 Effect of season on semen quality traits of rams from different genotypes

The results as presented in Table 2 indicate that the color of the semen from Dorper and AxM rams did not vary across season (long rain, short rain and dry) which is in consonance with those of (Zohara et al., 2012,). The results from a study by (Salhab, et al., 2003, Malejane et al., 2014) indicate that the color of the semen can vary across seasons because of the type of feed provided to the rams. It has also been reported by (Salhab et al., 2003; Mohammed et al., 2006) that the color of the semen also is influenced by the frequency of collection. Studies by (Mohammed et al., 2006; Babiker, 2010; Al-Samarrae , 2009; Mozo et al.,2010) have indicated that the color of the semen is waterish in color if the semen is collected frequently is more than several times a week.

The findings also show that the volume and motility of the spermatozoa also did not vary across the seasons and is uniform within a genotype which is in accordance to the findings of (AbiSaab and Sleiman, 1987). This also depends on the age of the rams where rams of same age have equal volumes of semen (Salhab et al., 2003). However, the concentration of the semen is also influenced by the numbers of ewes covered by the rams or by frequency of semen being collected (Mohammed et al., 2006; Babiker, 2010; Martin et al., 2013; Maksimović et al., 2016). The numbers of live and abnormal sperms are negatively correlated, the findings are in consonance with the findings of (Babiker, 2010; Malejane et al., 2014, Moghaddam et al., 2012; Zohara et al., 2014). The results of a study by (Rege et al., 2000; Mohammed et al., 2006; Olah et al., 2012; David et al., 2015) indicated that the numbers of abnormal sperms are influenced by both genetic and non-genetic factors. The numbers of abnormal sperms too are influenced by season (Rosa & Bryant, 2003; Moghaddam et al., 2012; Zohara et al., 2014) this might be because of seasonality of estrus, and in the first few days of mating the numbers of abnormal/dead sperms are high.

5.1.3 Effect of season on body weight, body condition, scrotal circumference and libido of different genotypes of rams

The results as presented in Table 3 indicate that the influence of season was observed in the body weight of the Dorper rams, while the corresponding increment in weight was also recorded in the other two genotypes during the long rainy season, which can be ascribed to availability of green fodder during the season (Salhab et al., 2003; Mohammed et al., 2006; Al-Samarrae, 2009, 2015). Improvement in body weight is also correlated with improvement in body condition of the rams, the values were however not quite significant which may be ascribed to uniform management (Zohara et al., 2012; Moghaddam et al., 2012). There was no difference in scrotum circumference of the rams across the seasons; the observations are in close accordance with those of (Malejane et al., 2014). The libidos of the Dorper rams were higher in the long rainy season, while the reverse was true for the Menz rams. yesterday

5.1.4. Correlation studies between scrotum circumference, body condition, libido and some the semen quality of the different genotypes of rams

The results as presented in Table 4 and 5 shows the effects of body condition of the Menz rams is correlated with the scrotum circumferences (SC), and libido (LIB) the observations are in close accordance with those of reported (Moghaddam et al., 2012) . This may be related to the spermatogenesis and testosterone secretion during the phase (William H. Wolker, 2011;Maksimovic et al., 2016). The findings also indicate that SC is related to the LIB which indicates the enhancement of the testicular function which also influences the spermatogenesis and hence the motility of the sperms too is improved (Niehaus, 2004).

In many cases the enhancement of LIB is related to the numbers of defective sperms, which can be attributed to release of immature sperms under condition of enhanced testosterone secretion (Preston et al., 2012). The study further indicates that the concentration of the semen and volume are related, while it may be related to the amount of the seminal fluid secreted from the accessory male sex organs (Niehanus, 2004; Preston et al., 2012). The study further indicates that the motility of the sperms and the numbers of live and dead sperms with the numbers of abnormal defective sperms are negatively correlated, findings are in close accordance with those of (Moghaddam et al., 2012; Zohara et al., 2014) as the defective sperms usually are dead and may lack proper swimming ability if alive.

The results pertaining to the correlation between the BC, SC, libido and semen quality traits of Menz rams indicate that the SC of the Menz rams is correlated ($P<0.001$) with the libido, this may be ascribed to the fact that the wider SC is expected to have optimum size of the testis which is expected to secrete higher amount of testosterone (William H. Walker, 2011; Maksimovic et al., 2016). Similarly rams exhibiting higher libido are correlated ($P<0.01$) with higher concentration of semen as both of them are related to the secretion of testosterone hormone (Perston et al., 2012; William H. Walker, 2011).

The results also show that volume of semen and the concentration are correlated, however the same is influenced by the duration of collection with lower concentration of semen among rams of older age and frequent sperm donors (Ibrahim,1997; Salhab et al., 2003; Mohammed et al.,2006; Al-Samarrae et al., 2009; Babiker, 2010). Semen color of the Menz rams also are correlated (P<0.01) with motility, rams which are creamish in color have higher motility when compared to those which are of different colors or are watery (Rodriguez-Martinz, 2013; Kridli et al., 2007; Olah et al., 2013) this may be because of the presence of live/dead sperms or semen which is infected with diseases or pus cells have off colors and hence less motile (Mohammed et al., 2006).

The results as presented in Table5 indicate that the SC and BC of Dorper rams were correlated as indicated ahead while the BC and motility (MOT) are negatively (P<0.05) correlated studies by (Salhab et al., 2003; Moghaddam et al., 2012; Zohara et al., 2014) have indicated that over conditioned and under conditioned rams usually have more numbers of dead sperms. The above results are also indicative with the correlation (P<0.05) with the numbers of defective sperms. The results from a study by Maksimović et al., (2016) have also indicated that SC is negatively correlated (P<0.05) with the volume of semen. The results pertaining to the correlation between LIB and the volume is correlated (P<0.05), as libido is correlated with the amount of testosterone (Niehanus, 2004; Preston et al., 2012; Maksimovic et al., 2016).

The study further indicates that the volume of the semen was negatively correlated with its color in Dorper rams. The volume of the semen and motility and concentration too are correlated, finding a consonance with those of several researchers (Moghaddam et al., 2012; Maksimovićet al., 2016). Semen with creamy color is considered to be a good quality and hence higher motility (Salhab *et al.,* 2003; Mohammed et al., 2006; Babiker, 2010; Malejane et al., 2014). The study also indicates that higher concentration of semen higher is the motility which is in accordance with those of several researchers (Moghaddam et al., 2012; Zohara et al., 2012). The findings also show that if the numbers of live sperms are higher and lower are the numbers of defective sperms which is also in close accordance of Moghaddam et al., (2012).

5.2. Evaluations of ram fertility

5.2.1. Genetic variability of rams in conception of ewes

The results as presented in Table 6 show that there conception of the ewes varied across genotypes which can be ascribed to several factors the quality of the semen of the rams (Rosa & Bryant, 2003;Duguma et al., 2002;Afolayan et al., 2014). Conceptions of the ewes are also ascribed by their genotype and gynecological status (Foote, 1964; Duguma et al., 2002; Rosa & Bryant, 2003; Afolayan et al., 2014). The differences in conception (of the ewes) mated to the Awassi rams too varied across the locations , which can be ascribed to the genotype by environment interaction and the gynecological status of the ewes mated to the rams (Duguma et al., 2002; Tesfaye et al.,2013; David et al., 2015).

The genetic variation pertaining to fertility of rams was recorded and the capacity of fertilizing varied across the genotypes Menz (84.85%), Dorper (70.62%), and Awassi x Menz (53.36%) and Awassi (44.11%) The findings also indicated that the fertilizing capacity of the Awassi rams (irrespective of the locations) was below the 45.44%Menz rams reared at in Debre Birhan ranch and 43.38% among the Menz rams reared at Amedguya (Menz) ranch. The findings indicative of the low fertility of the Awassi rams which is in close accordance with the findings of Getachew et al., (2013) .

The low fertility of Awassi rams may be ascribed to inbreeding within the flock. Awassi breeds were highly inbred when compared to Menz sheep which ranged between 1 to 2.6 % (Tesfaye et al., 2015). High inbreeding within the Awassi flock too has been reported by Shamir et al. (2010) who observed that inbreeding resulted in day blindness among Awassi sheep flock at EinHarod), Studies by; (Foote, 1964,Kridli et al., 2007; David et al., 2015) indicated correlation between fertility of rams and fecundity of ewes, which indicated that there was strong correlation between spermatozoa motility and fecundity of ewes and mass motility and is also associated with fertility. It has been reported that fertility among the Menz rams is higher due to low inbreeding and high viability.

5.2.2. Seasonal variability of Awassi rams fertility in different location

The results as presented in Table7 indicate that there were genotype by environmental interaction pertaining to the conception of the ewes mated to Awassi rams across seasons and locations. The results also indicate that the conception (of the ewes) mated to Awassi rams was much below the desired levels which can be ascribed to the adaptability of the rams (Tesfaye et al., 2013). The fertility of Awassi rams during the long rain season was ($P<0.05$) higher than short rain and dry season respectively. This is due to seasonality of breeding and better availability of forages thereby assisting in the availability of vitamins the observations being in agreement with those of several authors (Kridli et al., 2007; Tabbaa et al., 2006; Ababneh et al., 2017). These observations however are contrary to the findings of Langford et al., (1998) and Salhab et al., (2003) who reported that photoperiod and seasonal changes did not influence the semen characteristics. Based on such changes, rams continue to produce viable and fertile spermatozoa and exhibit sexual behavior throughout the year.

5.2.3. Fertility of Awassi rams in different ewe breeds

The findings from Table (8) further justifies the observations from Table 7 indicating suboptimal conception across different genotypes of the ewes mated to the Awassi rams, this can be further ascribed to the nicking effect or the quality of the rams themselves. Findings from studies by (Duguma et al., 2002; Nouman&Arar, 2013; Afolayan et al., 2014) indicated that the rams with poor semen parameters and which are highly inbred can have suboptimal fertilizing capacity thereby affecting the overall conception of the ewes.

5.2.4. Genetic and seasonal variability of ram fertility

The findings from Table 9 show that the conception of the ewes mated to rams of the different genotypes varied across the season which can be ascribed to temporary environmental effect on the levels of testosterone and spermatogenesis (Niehaus, 2004). Studies by Niehans, (2004); William H. & Walker, (2011) have also indicated that the spermatogenesis is influenced by genotype by environmental interaction and hence an environment favorable for a particular genotype would result in better fertility and conception. The result indicates that there is association between genetic and environment. The findings are in close agreement with the observations of (Nouman & Abrar, 2013; Jawasreh et al., 2012; David et al., 2015)

5.2.5. Fertility of rams in different breeding years

The findings regarding Table 10 indicate that the fertility/conception varied across the years and the findings contrary to the same, results of studies by (Sisay et al., 2012a) have also indicated that under on station condition the effects of years is non-significant on fertility and conception. This may be attributable to uniform management of the rams across the years in a farm. However, as Doper and Awassi are exotic breeds there are chances that these rams had difficulties in adapting to the agro climate of the region (Philipson et al., 2011; Tesfaye et al., 2016). Hence, when the agro climate was favorable resulted in better fertility and therefore better conception. On the other hand Menz rams being native of the area adapted well to the farm condition and therefore the fertility was above the values for the exotic genotypes (Tesfaye et al., 2013, 2016).

The differences across years may be ascribed to meteorological variations between years and also seasons within a particular year (Malejane et al., 2014). This leads to differences in the availability of forages and also incidences of diseases and parasites. The variations are expected to be less in organized farms, however the management of the farms can vary across years which can have both favorable and adverse effect on the fertility and overall productivity of the animals within a farm (Tabbaa et al., 2006; Kridli et al., 2007; Martin et al., 2013).

5.3. Genetic component

5.3.1. Estimation of genetic parameters influencing the fertility traits

The results pertaining to the heritability estimates indicate that the values differed across genotypes with lower values reported among the Awassi rams, this can be ascribed to poor adaptability of the Awassi rams in the studied agro climate which is evident from the high environmental variance (Snowder et al., 2004; Yavarifard et al., 2015). Higher environmental variance influenced the total phenotypic variance influencing the heritability of the trait (Vleck et al., 2004; David et al., 2008). Lower adaptability also results in poor genotype by environmental variance and which consecutively will influence the overall fertility of the rams (Snowder et al., 2004; Afolayan et al., 2014).

The estimated heritability for fertility traits as obtained in this study is in close agreement with the results of Vleck, (2004) for Colombia and Polypay rams. According to Vleck, (2004) because, of low genetic correlation between sexual performance score and number of lambs born (ewe reproductive traits), selection and use of rams with high sexual performance scores would not be expected to result in much indirect response for improved reproduction of ewes. The observations as mentioned ahead are contrary to the present observations as sexual performance score may not be expressed as fertility among the rams. The results from the present study shows higher estimated heritability for the traits which might be ascribed to fewer numbers of rams and both random and systemic errors, which were reflected in deviation in the estimation of heritability for the traits studied.

On the other hand the overestimation of heritability among the Menz and Dorper indicates the existence of phantom heritability which can be ascribed to small sample size and also fewer numbers of rams involved in the program (Falconer, 1989).

6. Summary and conclusion

6.1. Summary

The study was conducted at Debre Birhan Agricultural Research Center (DBARC) Semen quality parameters were assessed in 6 rams each of Menz, Dorper and Awassi x Menz. The fertility traits were assessed for 155 rams mated to 14357 ewes Data were obtained from Amedguya Sheep Breeding and Multiplication center (ASBMC), Debre Birhan Sheep Breeding and Multiplication center (DBSBMC) and Debre Birhan Agricultural Research Center (DBARC).The data pertaining to the fertility status of Awassi rams were from the years 2001-2016 whereas for Menz and Dorper 2010-2016 and 2012-2016 respectively.

The overall least square means for body weight (kg), body condition, libido, semen mass motility and color were assessed using standard scales, while scrotal circumference (cm), semen volume (ml), semen concentration (10^9), live sperm cell (%) and abnormal spermatozoa (%) of were 74.4±0.58, 4.48±0.07, 32.3±0.15, 3.3±0.07, 2.1±0.036, 1.14±0.04, $4.1\text{x}10^9$ ±0.14, 3.18±, 83.6±0.27 and 10.04±0.38, for Dorper, 41.7±0.49, 3.65±0.06, 28.8±0.13, 3.2±0.05, 2.3±0.03, 0.7±0.04, $2.44\text{x}10^9$±0.13, 3.17±0.08, 84.65±0.25 and 6.78±0.35 for Menz and 58.9±0.5, 4.01±0.06, 30.4±0.13, 3.7±0.06, 2±0.034, 0.92±0.04, $3.34\text{x}10^9$ ±0.13, 3.4±0.08, 83.87±0.26 and 9.41±0.36 for Awassi cross with Menz rams respectively. Semen mass motility was not influenced by genotype of the same.

Body weight, body condition, live spermatozoa (%) of Dorper rams were influenced by the seasons. Long and short rain seasons were higher value of body condition and body weight while higher abnormal spermatozoa percentage was showed during long rain season. Among the Awassi cross Menz rams season influenced only the libido, live spermatozoa (%) and abnormal spermatozoa; the long rain season had higher libido and abnormal spermatozoa percentage and lower live spermatozoa percentage while among the Menz rams color of the semen, libido and semen concentration were influenced by seasons. The color of semen was thick creamy during dry season and higher sperm concentration in dry and short rain seasons while higher abnormal spermatozoa showed during long rain season. It was also assessed that the volume of the semen and its concentration were correlated among the Menz rams, mass motility of the semen as negatively correlated with abnormal spermatozoa and live/dead spermatozoa.

Body weight, scrotal circumference, body condition, semen volume and concentration of Dorper rams were higher than those of A x M across all season and mass motility and live spermatozoa were not influenced by the same. Color of the semen varied across genotypes while the color of the semen of the Menz rams was thick creamy while those of the Dorper and AXM was during short rain and dry seasons. Libido of the AxM was higher when compared to the Menz and Dorper counterparts especially during long rain and short rain seasons. The numbers of abnormal sperms were lower in the Menz rams when compared to their Dorper and AxM counterparts and across all the seasons studied.

Fertility rate of Awassi, Awassi cross with Menz, Menz and Dorper rams in Debre Birhan were 45.44, 53.36, 84.85 and 70.62 respectively whereas fertility rate of Awassi in Amedguya was 43.38. The differences in conception (of the ewes) mated to the Awassi rams too varied across the locations and seasons, which can be ascribed to the genotype by environment interaction. The effects of seasons varied across the genotypes its influence was more for the Awassi rams which had lower fertility across all the seasons while, AxM rams had lower fertility during the long rains only. Season did not influence the fertility of the Menz rams and fertility of the Dorper rams was higher during the long rains. Fertility rate of rams were influenced by genotype and all non-genetic factors. Menz rams had higher fertility rate than all other breeds in all seasons. Heritability and sire ranking were estimated based on pedigree data of the three breeds. Estimated heritability to fertility of Awassi, Menz and Dorper rams were 0.1, 0.41 and 0.46 respectively.

6.2. Conclusions

The results indicate that Menz rams had a better fertility rate when compared to Awassi, AxM and Dorper in all season and years, which may be ascribed to better genotype by environment interaction. The results further indicate that conception (of the ewes) mated to the Awassi rams too varied across the locations, which might be ascribed to their adaptability to the environment where they were reared. The fertility among the Awassi rams were the lowest followed by AxM, while Menz rams were superior in natural mating and had high numbers of normal spermatozoa Dorper rams were also well suited for natural mating and semen volume and concentration were also higher making them suitable for AI program.

7. Recommendations

Awassi rams had lower fertility rate throughout the studied location and seasons, further investigation will be needed to the cause of low fertility of these rams based on semen evaluation and genotyping to identify candidate gene which responsible for fertility trait and level of inbreeding of these breed.

Based on semen evaluation and natural mating Dorper rams were best to artificial insemination program due to low cost of production than introduction of live Dorper form South Africa while Menz rams were superior in natural mating due to high fertility rate without the influence of season and the year.

Before we are going to introduction of the improved breed, evaluation of the growth and reproduction performance of the selected breed must be evaluated on station with the consideration of farmer's sheep production practices.

Heritability of fertility trait of Dorper and Menz were overestimated due to small sample size. Therefore pedigree record will be continued for better heritability estimation of fertility of these breed.

8. References

Ababneh, M., Talafha, A. Q., & Ababneh, M. M. 2017. Awassi sheep reproduction and milk production. *Journal of Reproduction and Fertility, 46,7 11*.

Afolayan, R. A., Fogarty, N. M., Gilmour, A. R., Ingham, V. M., Gaunt, G. M., & Cummins, L. J. 2014. Reproductive performance and genetic parameters in first cross ewes from different maternal genotypes. *Australian Journal of Agricultural Research, 1, 804–814.*

Amann, R. P. 1970. Sperm production rates. In A. D. Johnson, W. R. Gomes and N. L. VanDemark (Ed.) The Testis. Vol. I II . , Academic Press, New York.

Asof, M.K., Abid, W.I. and Al Shakargee, N.A., 1997. Efect of some extenders and storage on serum quality of Awassi rams. IPA *Journal of Agricultural Research*, 1,100 108

Al-Samarra S.H, (2009). Semen quality of Arabi and Karradi iraqi rams . *Diyala Agricultural Sciences Journa*l ,**1**(**2**) ; 30 – 36 ,2009

Al-Samarrae S.H. 2015. Breeds variation in semen quality of some local Iraqi rams. *Brazilian. Journal. Veterinary. Research. 14(*1), 274-281

AbiSaab, S. and Sleiman, F.T., 1987. The contribution of artificial insemination in the improvement of some reproductive traits of cross bred Awassi sheep. In: Proceedings of the International Conference on Animal Production in Arid Zones (ICAPAZ), Damascus, Syria, 1985, Part 2 (ACSAD, Damascus, Syria), 1225 1241.

Babiker Abdel, *2010.* Reproductive traits and freezability of semen of rams from two desert sheep ecotypes in the Sudan. MSc Thesis. Agricultural University, Wageningen, The Netherlands. 78 pp.

Casao, A., Cebrian, I., Asumpcao, M.E., Perez-Pe, R., Abecia, J.A., Forcada, F., Cebrian-Perez, J.A. &Muino-Blanco, T. (2010a). Seasonal variations of melatonin in ram seminal plasma are correlated to those of testosterone and antioxidant enzymes.*Reproductive Biology and Endocrinology*, 8, (Jun), 1477-7827,

Dachenx, J.L., Pisslet, C., Balance, M.R., Hochereal de Reviers, M.T. and Courot, M., 1981.Seasonal variations in rete testis fuid secretion and sperm production in diferent breeds of rams. *Journal of Reproduction and Fertility*, 61, 363 371

David, I., Robert-Granie, C., Manfredi, E., Lagriffoul, G. &Bodin, L. (2008). Environmental and genetic variation factors of artificial insemination success in French dairy sheep. *Animal*, Vol. 2, No.7, (Jul), pp. 979-986, 1751-7311

Donald, H. P. and J. L. Hancock. 1953. Evidence of gene-controlled sterilitv in bulls. *Journal .Agricultural. Science. 4 3:178.*

Darius, Zpiwczyński and Bognako, waliszyn. (2013). Heritability and breeding value of sheep fertility estimated by means of the gibbs sampling method using the linear and threshold models. *Small Ruminant Research 14(1), 23–32.*

David, I., Kohnke, P., Lagriffoul, G., Praud, O., Plouarboué, F., Degond, P., & Druart, X. (2015). Mass sperm motility is associated with fertility in sheep. *Animal Reproduction Science*, *161*, 75–81.

Duguma, G., Cloete, S. W. P., Schoeman, S. J., & Jordaan, G. F. 2002. Genetic parameters of testicular measurements in Merino rams and the influence of scrotal circumference on total flock fertility. *South African Journal of Animal Sciences*, *32*(2), 76–82.

Evans, G. & Maxwell, W.M.C., 1987.Salamon's Artificial Insemination of Sheep and Goats. Butterworth. Sydney, Australia.

Falconer D S. 1989. Introduction to Quantitative Genetics. 3rd ed. Longman Scientific &Technical

Foote, R. H. 1970. Inheritance of fertility facts, opinions and speculations. *Journal . Dairy Science. 5 3 :936.*

Fekadu, K. 2015. Ethiopian Seasonal Rainfall Variability and Prediction Using Canonical Correlation Analysis (CCA), *4*(3), 112–119.

Galal, S., Gursoy, O. and Shaat., I., 2008. Awassi sheep as a genetic resource and efforts for their genetic improvement a review, *Small Ruminant Research, 79, 99–108*

Hassan, M. R., Pervage, S., Ershaduzzaman, M., & Talukder, M. A. I. (2009). Influence of age on the spermiogramic parameters of native sheep, *Australian Journal of Agricultural Research, 7(2), 301–304.*

Jawasreh, K. I. Z., Ababneh, H., Awawdeh, F. T., Al-Massad, M. A., & Al-Majali, A. M. 2012. Genotype and allelic frequencies of a newly identified mutation causing blindness in Jordanian Awassi sheep flocks. *Asian-Australasian Journal of Animal Sciences*, *25*(1), 33–36..

Ibrahim, S.A., 1997. Seasonal variations in semen quality of local and crossbred lambs in the United Arab Emirates. *Animal Production Science, 49, 161 167*

Kridli, R. T., Abdullah, A. Y., Obeidat, B. S., Qudsieh, R. I., Titi, H. H., & Awawdeh, M. S. 2007. Seasonal variation in sexual performance of Awassi rams. *Animal. Reproduction. 4, (1/2), 38-4.*

Kridli, R. T., Abdullah, A. Y., & Shaker, M. M. 2006. Sexual Performance and Reproductive Characteristics of Young Adult Awassi , Charollais-Awassi and Romanov-Awassi Rams, *Animal Production Science, 21, 12–16.*

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

Langford GA, Shrestha JNB, Sanford LM, Marcus GJ. 1998. Reproductive hormone levels of early post pubertal ram lambs in relation to breed, adult testis size and semen quality. *Small Rumin Res,* 29:225–231

Maksimović, N., Hristov, S., Stanković, B., & Petrović, M. P. 2016. Investigation of serum testosterone level , scrotal circumference , body mass , semen characteristics , and their correlations in developing MIS lambs, *Small Ruminant Research 48,* 53–59.

Malejane, C. M., Greyling, J. P. C., & Raito, M. B. 2014. Seasonal variation in semen quality of Dorper rams using different collection techniques, *Animal Production Science, 44(1).*

Martin, N., Branko, A., Monika, D., Vladimir, P., & Toni, D. 2013. variations in semen quality parameters of ovchepolian pramenka rams according to the method of collection and the meteorological season, *Original Scienti fic Article 35(2), 79–86.Hruska U.S. Meat Animal Research Center.*Paper 250.

Milosevic, B., & Stojkovic, J. 2012. some important factors affecting fertility in sheep, *Animal Production Science, 28(3), 517–528.*

Mandiki, S.N.M., Derycke, G., Bister, J.L. and Paquay, R., 1998. Infuence of season and age on sexual maturation parameters of Texel, Sufolk and Ile de France rams. I. Testicular size, semen quality and reproductive capacity. *Small Ruminant Research,* 28, 67 79

Matthews, N., Bester, N. &Schwalbach, L.M.J., 2003.A comparison of ram semen collected by artificial vagina and electro-ejaculation. *South. Africa. Journal. Animal. Science. 33, 28-30.*

Mohammad J. Tabbaa, Rami T. Kridli, Mohammad G. Amashe and Faisal S. Barakeh 2006.Factors Affecting Scrotal Circumference andSemen Characteristics of Awassi Rams. *Journal of Agricultural Science, Cambridge, 79, 83 89*

Moghaddam, G. H., Pourseif, M. M., & Rafat, S. A. (2012). seasonal variation in semen quantity and quality traits of iranian crossbred rams, *Journal of Agricultural Science, Cambridge, (3), 67–75.*

Mozo, R., Galeote, A. I., Alabart, J. L., Fantova, E., & Folch, J. (2015). Evaluating the reproductive ability of breeding rams in North-Eastern Spain using clinical examination of the body and external genitalia. *Brazilian Veterinary Research*, *11*(1), 289.

Mueller B., Acero F., EstruchE**..**2017. Creating employment potential in small-ruminant value chains in the Ethiopian. *Journal of Agricultural Science, Cambridge, 73, 83 91.*

Meyer K. 2006. WOMBAT: Digging deep for quantitative genetic analyses by restricted maximum likelihood. Proc. 8th World Congress on Genetics Applied to Livestock Production, *August 13-18, 2006, Belo Horizonte, Brazil Communication. 27: 4.*

Niehaus,M.(2004).The role of testosterone in spermatogenesis. publication/ 235703542

Nicholls PK, Harrison CA, Gilchrist RB, Farn worth PG, et al. (2009). Growth differentiation factor 9 is a germ cell regulator of Sertoli cell function. *Endocrinology* 150: 2481-2490

Nouman, S., & Abrar, Y. (2013). Estimates of phenotypic and genetic parameters for ewe productivity traits of Lohi sheep in Pakistan. *Small Ruminant Research 48, 155–171*

Oláh, J., Kusza, S., Harangi, S., Posta, J., Kovács, A., & Pécsi, A. (2013). Seasonal changes in scrotal circumference , the quantity and quality of ram semen in Hungary. *Journal of Agricultural Science, Cambridge, 102–108*

Preston, B. T., Stevenson, I. R., Lincoln, G. A., Monfort, S. L., Pilkington, J. G., & Wilson, K. 2012. Testes size , testosterone production and reproductive behaviour in a natural mammalian mating system. *Journal of Agricultural Science, Cambridge, 79, 94--98*

Petrovic1, M.P., Caro Petrovic1, V., Ruzic Muslic1, Maksimovic1, D.N., Milosevic2, B., Stojkovic **,**J. 2012**.** Some important factors affecting fertility in sheep**.** *Biotechnology in Animal Husbandry 28 (3), p 517-528, 2012*

Philipsson J., Rege J.E.O., Zonabend E. and Okeyo A.M. 2011. Sustainable breeding programmes for tropical farming systems. In: Animal Genetics Training Resource, version 3, 2011. Ojango J.M., Malmfors, B. and Okeyo, A.M. (Eds). International Livestock Research Institute, Nairobi, Kenya, and Swedish University of Agricultural Sciences, Uppsala, Sweden.

Rege, J.E. , F. Toel, E. Mukasa-Mugerwa, S. Tembely, D. Amindo, R. L. Baker and A. Lahlou-Kassi .2000. Reproductive characteristics of Ethiopian highland sheep. II. Genetic parameters of semen characteristics and their relationships with testicular measurements in ram lambs. *Small Ruminant. Research. ; 37(3):173-187* .

Rodríguez-Martínez, H. (2013). Semen evaluation techniques and their relationship with fertility. *Animal Reproduction*, *10*(3), 148–159.

Rosa, H. J. D., & Bryant, M. J. 2003. Seasonality of reproduction in sheep, *Small Ruminant Research 48 (2003) 155–171*

Rosati, A.; Mousa, E.; Van Vleck, L. D.; and Young, L. D., "Genetic Parameters of Reproductive Traits in Sheep" *Journal of Agricultural Science, Cambridge, 74, 83* 89

Rummel, T., Valle Zárate, A. & Gootwine, E., 2005. The worldwide gene flow of the improved Awassi and Assaf sheep breeds from Israel. *Verlag Grauer, Beuren, Stuttgart.pp. 27–29.*

Salhab, S. A., Zarkawi, M., Wardeh, M. F., & Kassem, R. 2003. Characterization and Evaluation of Semen in Growing Awassi Ram Lambs. Trop. *Anim.Health prod; 35, 455–456.*

Shenkute, G., Solomon, G., Asfaw, B., Shanbel, B. 2014. Comparative growth performance and survival rate of Dorper X Improved Menz, Dorper X Menz type and Dorper X Afar CrossbredSheep at Debre Berhan Research Center. Proceedings of the 6th and 7th Annual Regional Conference on Livestock Completed Research Activities 25-27January, 2012 and 22-24 January, 2013, Amhara AgriculturalResearch Institute (ARARI), Bahir Dar, Ethiopia. pp. 412-419

Solomon, G., & Tesfaye, G. 2009. The Awassi × Menz Sheep Crossbreeding Project in Ethiopia : *Achievements , Challenges and Lessons Learned, 53–62.*

Solomin, G., Tesfaye, G., Aynalem, H., Rischkowsky, B., Sölkner, J., & Tibbo, M. 2013. Optimization of selection for growth in Menz Sheep while minimizing inbreeding depression in fitness traits. *Genetics Selection Evolution*, *45*, 1.

Solomon, G., Shenkute, G., Tesfaye, G., Aynalem, H., Rischkowsky, B., van Arendonk, J., … Mwai, A. O. 2014. Feasibility of pedigree recording and genetic selection in village sheep flocks of smallholder farmers. *Tropical Animal Health and Production, 46*(5), 809–814

SAS Software (Statistical Analysis System, SAS Institute Inc., Cary, NC, USA).

Sang L, Du QZ, Yang WC, Tang KQ, 2011. Polymorphisms in follicle stimulation hormone receptor, inhibin alpha, inhibin beta A, and prolactin genes, and their association with sperm quality in Chinese Holstein bulls. *Animal. Reproduction. Science.* 126: 151-156.

Shamir, M.H., Ofri, R., Bor, A., Brenner, O., Reicher, S., Obolensky, A., Averbukh, E., Banin, E. and Gootwine, E., 2010. A novel dayblindness in sheep: epidemiological, behavioural, electrophysiologicaland histopathological studies, *The Veterinary Journal, 185, 130–137.*

Sisay, L., Kassaun, A., Getachew, W., Adugna K. and Fletcher, I. 1989. Comparative evaluation of Menz and Awassi × Menz crossbred sheep. Reproductive and mature body weight. In: IAR. Proceedings of the 3rd national livestockimprovement conference, Addis Ababa, Ethiopia, 24–26 May 1989. Addis Ababa, Ethiopia: IAR.

Sisay Lemma, Solomao, G., AyeleAbebe and TesfayeGetachew.2012a. Growth and reproductive performance of Menz,Washera × Menz and Bonga × Menz sheep in the cool central highlands of Ethiopia. In: ARARI. *Proceedings of the5th annual regional conference on completed livestock research activities, December 2010*. Bahir Dar, Ethiopia: AmharaRegional Agricultural Research Institute.

Sisay Lemma., Solomon Gizaw., Tesfaye Getachew and Ayele Abebe. 2012b. On-farm productivity performance of purebred local and Awassi x Local crossbred sheep. Proceeding of the 6th and 7th Annual Regional conference on completed livestock research activities Amhara Agricultural research institute Bahir Dar, Ethiopia.

Snowder, G., Stellflug, J. N., and Van Vleck, L. Dale, 2004. Genetic correlation of ram sexual performance with ewe reproductive traits offour sheep breeds. *Publications from USDA-ARS / UNL Faculty*. 191

Sun1, Y.P. Song1, Q.Z. Du1, L.W. Song2, Y.Z. Tian3, S.L. Zhang4, G.H. Hua1 and L.G. Yang.2014. Polymorphisms in the bone morphogenetic protein 15 gene and their effect on sperm quality traits in Chinese Holstein bulls *Genet. Mol. Res.* 13 (1): 1805-1812.

Tejaswi, V., M. Narayanaswamy, M. and N. Govardhana Sagar,N. 2016. Studies on certain fresh semen characteristics in rams of Indian twining breed -the nari suvarna during winter months (short photoperiod). *International Journal of Science, Vol. 5, No 3, 2016, 1697 – 1706*

Tesfaye Getachew. 2015. Genetic diversity and Admixture analysis of Ethiopian fat tailed and Awassi sheep using SNP markers for designing crossbreeding schemes. *BMC Genetics (2017)*

Tesfaye, G., Solomon, G., Wurzinger, M., Solomon, A., & Sölkner, J. (2013). Effect of Crossbreeding Indigenous Sheep with Awassi and Corriedale Sires on Reproductive Performance under Smallholder Production System in. *Agriculturae Conspectus Scientificus*, *78*(3), 187–191.

Tesfaye, G., Aynalem, H., Wurzinger, M., Barbara, R., Solomon, G., Ayele, A., & Johan, S. 2016. Review of sheep crossbreeding based on exotic sires and among indigenous breeds in the tropics: An Ethiopian perspective. *African Journal of Agricultural Research*, *11*(11), 901–911.

Tabbaa, M., Kridli, R., & Amashe, M. 2006. Factors affecting scrotal circumference and semen characteristics of Awassi rams. *Jordan Journal of Agricultural*, *2*(3), 243–250.

Vleck, L. D. Van. 2004. Genetic correlation of ram sexual performance with ewe reproductive traits of four sheep breeds. *Journal of Agricultural Science, Cambridge, 79, 28-33*

VanDemark, N. L., G. R. Fritz and R. E. Mauger. 1964. Effect of energy intake on reproductive performance of dairy bulls. I. Semen production and replenishment. *Journal . Dairy Science. 4 7:898.*

William, H. Walker. 2011. Testosterone signaling and the regulation of spermatogenesis, Spermatogenesis, *Journal of Animal Ecology 2012, 81, 296–305*

William, C., Gopralakrishnan, C.A., Gneniah, P.H. and Rahman, K.C., 1970. Norms for the Remand breed of sheep. II. Semen characteristics and infuence of season. *IndianVeterinary Journal, 47, 417 421.*

Wolf, J. 2010. Heritability's and genetic correlations for litter size and semen traits in Czech Large White and Landrace pigs. *Journal. Animal. Scienc.* 88: 2893-2903.

Yang WC, Tang KQ, Yu JN, Zhang CY, et al., 2011. Effects of *Mbo*II and *Bsp*MI polymorphisms in the gonadotropin releasing hormone receptor (GnRHR) gene on sperm quality in Holstein bulls. *Mol. Biol. Rep.* 38: 3411-3415.

Yavarifard, R., Hossein-zadeh, N. G., & Shadparvar, A. A. 2015. Estimation of genetic parameters for reproductive traits in Mehraban sheep, J*ournal. Animal. Science* (6), 281–288.

Zohara, B. F., Bari, F., & Alam, G. S. 2014. Baseline Study of Reproductive Performances of Indigenous Rams in Bangladesh, J*ournal. Animal. Science 7*(6), 83–89.

Zhao L, He J, Guo Q, Wen X, et al. (2011). Expression of growth differentiation factor 9 (GDF9) and its receptor in adult cat testis.*ActaHistochem.*113: 771-776.

9. Appendices

Table1. Major equipment would be used for the study

Equipment	Function	Remark
Artificial vagina with full set	Semen collection	
Water bath	To store fresh semen during evaluation	
Spectrophotometer	To determine semen concentration	
Phase contrast microscope/computer	Semen motility and morphology	
Microscopic glass	Smearing of semen	
Hot plate	To warm the slide glass	
Physiological saline solution	Semen dilution	
Micropipette	Sterilizer	
Thermometer	To measure AV temperature	
Sensitive balance	To measure Nigrosin and eosin	

10. Biographical sketch

The author of the thesis was born at Mehal Meda, North Shewa Zone, Ethiopia in 26, February 1985. He attended his Elementary and high school at Mehal Meda Elementary and high school from 1992 to 2001. He attended his Preparatory School at Molale preparatory School from 2002 to 2003. He thereafter graduated in BSc (Animal science) at Haramaya University from 2004 to 2006. After graduation he served with the Menz Gera Midir (Mehal Meda) Agricultural Office as an animal science expert from September 2007 to June 2010. He was then recruited by Debre Birhan Agricultural Research Center at Debre Birhan as junior researcher (Animal Breeding and Genetics) from June 2010 till October 2015. The author was enrolled in October 2015 to pursue his higher studies at Hawassa University, majoring in Animal Breeding and Genetics.