PERFORMANCE EVALUATION OF BONGA RAMS AND THEIR PROGENIES IN DIFFERENT AGRO-ECOLOGIES OF SOUTHERN ETHIOPIA

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BY

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A THESIS SUBMITTED TO POST GRADUATE RESEARCH, COLLEGE OF AGRICULTURE AND VETERINARY MEDICINE, SCHOOL OF GRADUATE STUDENTS, JIMMA UNIVERSITY,

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BIOGRAPHICAL SKETCH

The author, Mr. Zelalem Abate, was born on September 10, 1990 at Saylem District, Kaffa Zone, Southern Nation Nationalities Peoples of Regional State, Ethiopia from his father Ato Abate Ambecho and his mother W/ro Abebech W/Tsaddik.

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List of Abbreviations

AFL	Age at First Lambing
AFS	Age at First Service
AGSBMC	Amed Guya Sheep Breeding and Multiplication Center
ANRSBoARD	Amhara National Regional State Bureau of Agriculture and Rural Development
ALS	Average Litter Size
BC	Before Christ
BED	Breed Evaluation and Dissemination
BRU	Bonga Ram Users
CSA	Central Statistics Authority
DA	Development Agents
DBARC	Debre Birhan Agricultural Research Center
DBSBMC	Debre Birhan Sheep Breeding and Multiplication Center
ESGPIP	Ethiopian Sheep and Goat Productivity Improvement Program
FAO	Food and Agricultural Organization
FM	FM Radio
GLM	General Linear Model
HL	High land
ICARDA	International Center for Agricultural Research in the Dry Areas
ILRI	International Livestock Research Institute
Kg	Kilogram
Km	Kilometers
LI	Lambing Interval
LL	Low land
ML	Mid Land
MM	Millimeters
NBRU	Non Bonga Ram Users
RLS	Reproductive life span
SAS	Statistical Analysis System
SNNPR	Southern Nations Nationalities and Peoples Region
SPSS	Statistical Package for Social Sciences
Sq. Km	Square Kilometers
USAID	United State AID

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ABSTRACT

Monitoring studies in four selected districts of southern Ethiopia were conducted from October 2016 and June 2017 on whole sampled households with general objective of evaluating performances of Bonga rams and its progenies in the areas. A total of 320 HH were considered purposively for the household survey and 382 pregnant ewes mated with either Bonga or local ram were monitored. Descriptive statistics and comparative means of data from survey were analyzed by using SPSS, 2011 ver. 20 and an index was used for qualitative data ranking. The growth performance data were subjected to Generalized Linear Model procedures of the SAS, 2012 ver. 9.3 and Tukey Kramer test was used to compare means which were significant in the least squares analysis of variance.

The growth performances of Bonga cross were 2.9±0.2, 8±0.5, 11.4±0.6, 13±0.6 and 17.4±0.8 kg for birth, two, three, four and six months' weights, respectively and average daily gain for pre-weaning and post-weaning (ADG) weights were 92.2±5.4 and 86±4 gm respectively. Whereas for local sheep the values were 2.4±0.2, 5.5±0.5, 8.3±0.6, 9.8±0.7, and 13±0.8 kg for birth, two, three, four and six months' weights respectively, and average daily gain for pre-weaning and post-weaning ADG weights were 64.8±5.5 and 63.4±4 gm, respectively. Location (except 6-month weight), genetic group, parity ($P<0.001$) (except, 3, 4, 6-month weights and post-ADG), season of birth (except,6-month weight and post-ADG), birth type and sex had significant ($P< 0.05$ and $P<0.001$) effect on pre-weaning and post- weaning weights. The reproductive performances of average first service (AFS) for male, AFS for female, average fist lambing (AFL) and lambing interval (LI) for Bonga crosses were 5.9±0.8, 6.3±0.8, 11.5±0.9, and 7.5±0.7 months, respectively and for local sheep the values were 8.6±1.6, 8.6±1.5, 13.9±1.6 and 8.5±1.1 months, respectively. Average litter size (ALS) of ewes mated by Bonga and local ram were 1.75±0.3 and 1.46±0.5, respectively. The reproductive performances varied ($P<0.001$) among locations.

The survival rate of Bonga rams at Arbegona, Ezha, Damot Pulasa and Alicho Worero were 93.3, 89.3, 97.2 and 95.2% respectively. The pre and post weaning mortality rate for Bonga cross lambs at Alicho Worero (4.8 and 2.5 %), Ezha (2.1 and 0 %), Arbegona (1.1 and 1.1%) and Damot Pulasa (1.6 and 0 %), respectively significantly ($P<0.001$) lower than local sheep in the areas. The Bonga sheep crosses as well as rams, highly adapted to locally available feeds and waters; tolerant to disease and parasite load in the areas. The overall average body condition score (BCS) scrotal circumference (SC) and body weight of Bonga sires in the disseminated areas were 3.7, 31 cm and 51.8kg, respectively.

Key words: *Crossbreeding, Growth, Reproductive, preference, Gurage, Silte, Wolayta, Arbegona*

1. INTRODUCTION

1.1. Background and Justification

Ethiopia is believed to be one of the major gateways for domestic sheep migration from Asia into Africa (Devendra and McLeroy, 1982; Melesse et al, 2013). With 30.7 million sheep among this 99.72% indigenous, 0.22% crossbred and 0.06% exotic (CSA, 2016/17) and there are highly diversified indigenous sheep types (14 traditional populations according to Gizaw et al., 2008) which are parallel to the diverse Agro-ecology, ethnic communities and production systems (Galal, 1983). These sheep types are highly adaptable to a broad range of environments (Tsedeke, 2007). They support regular income in both tangible and/or intangible manners to a large human population through the sale of live animals and skins (Abebe et al., 2010) and provide their owners with a vast range of products and services such as immediate cash income, meat, milk, skin, manure (Adane and Girma, 2008). They are also considered as living bank against the various environmental calamities (crop failure, drought and flooding) and have socio-cultural values for diverse traditional communities (Edea et al., 2010; Melesse et al., 2013).

In spite of such a wide range of genetic diversity and vast number of sheep in the country, the average productivity is generally below optimum. Thus, sheep improvement efforts were started as far back as in 1944 in Ethiopia; through cross breeding indigenous sheep types with sheep breeds imported from various countries. But, most crossbred sheep were neglected by farmers as they did not meet the preference of the farmers (Tibbo, 2006; Gizaw and Getachew, 2009). This is mainly because of the inadequate participation of sheep rearers in the implementation of the breeding program. The productivity of sheep in the country is largely constrained by feed shortage, disease, poor infrastructure, lack of market information and technical capacity, besides lack of planned breeding programs and breeding policies (Solomon et al., 2013). The International Center for Agricultural Research in the Dry Areas (ICARDA), International Livestock Research Institute (ILRI) and BOKU University, Vienna in collaboration with national and regional research systems in Ethiopia initiated community-based breeding programs in four regions representing different Agro-ecologies that are the habitats of four indigenous sheep breeds (Afar, Bonga, Horro, and Menz) (Haile et al., 2011). According to Haile et al. (2014) and Gutu et al. (2015), preliminary results of the evaluation carried out on performance of the breeding programs indicated a promising result of the breeding programs in three communities (Bonga, Menz and Horro) and the efforts

of community-based breeding programs for small ruminants where successful in the Country (FAO, 2015).

Currently, Southern Agriculture Research Institute (SARI) Bonga Agricultural Research Centre and ICARDA are undertaking Bonga sheep community-based breeding program through organizing cooperatives. From 16 Bonga sheep community-based breeding cooperatives, 2637 breeding rams were selected from Boka-Shuta Bonga sheep community. Out of these selected rams, 1435 rams were distributed for genetic improvement in the local sheep of different areas in Ethiopia from year 2012 up to 2014.

However, there is no information on either the performance of these disseminated elite Bonga rams or their crossbred progenies in their new environments. Farmers adoption and perception about the breeding programs using Bonga rams in different Agro-ecologies of the disseminated areas has also not collected. Due to this reason, Gutu et al (2015) recommended that; it is equally important to consider adaptability of Bonga sheep to other areas before wider scale distribution of breeding rams to different parts of the region/country. Therefore, the present study aims to generate information on performance of the disseminated rams and their progenies that would help in further improvements of the dissemination strategy and develop suitability map for disseminating improved elite Bonga rams in future.

1.2. Objectives

1.2.1. General objective

- To evaluate performances of Bonga rams and its progenies in selected areas of southern Ethiopia

1.2.2. Specific objectives

- To evaluate reproductive performances and breeding soundness of Bonga rams distributed in south Ethiopia;
- To evaluate growth performances of crossbred progenies of Bonga and local sheep in these areas;
- To understand the farmers' perception about use of Bonga ram in their areas; and
- To identify opportunities and constraints of cross breeding efforts using Bonga sheep breed as one of the parents.

2. LITERATURE REVIEW

2.1. Origin of Ethiopian Sheep Breeds

The history of the domesticated sheep goes back to between 11000 and 9000 BC, with the domestication of the wild mouflon in ancient Mesopotamia. A minority of historians once posited a contentious African theory of origin for Ovis Aries (Blench et al, 1999). These sheep were primarily raised for meat, milk, and skins. However, the exact line of descent between domestic sheep and their wild ancestors is unclear (Hiendleder et al, 2002).

A number of theories have been advanced as to the time and the routes by which sheep were introduced into Ethiopia. African sheep are thought to be of Near Eastern origin (Epstein, 1954; Epstein, 1971; Edea, 2008). According to Epstein, (1954) Epstein (1971) and Ryder, (1984), the earliest sheep in Africa were thin-tailed and hairy and fat-tailed and introduced to East Africa through North Africa.

2.2. Sheep Breeds of Ethiopia

Ethiopia is believed to be one of the major gateways for domestic sheep migration from Asia to Africa (Edea, 2008) and has a large farm animal genetic diversity. The existence of this diversity is largely due to its geographical location near the historical entry point of many livestock populations from Asia, its diverse topographic and climatic conditions; the huge livestock population's size and wide range in production systems (Workneh et al., 2004; Assefa, 2010). However, according to Gizaw (2008), the Ethiopian sheep can be broadly grouped in four groups (sub-alpine short-fat-tailed, highland long-fat-tailed, lowland fat-rumped, lowland thin-tailed), and nine genetically distinct breeds encompassing all traditional types (Fourteen) of sheep. In spite of such a wide range of genetic diversity and vast number of sheep, with average holding ranges between 3.7 (Abebe, 2010) to 31.6 (Getachew et al.2010) of sheep per household. The present Ethiopia's sheep population the second in Africa and sixth in the world (Demelashet al. 2006; Mengesha and Tsega, 2012).

2.3. Sheep Crossbreeding Efforts in Ethiopia

According to FAO (2010) Cross-breeding is an alternative means of generating genetic change in a population and is a way of realizing quicker genetic improvement than by selection, matching genotype with the environment and benefiting from the complementarity of the breeds involved. It may be implemented in various forms including sustained cross-breeding (in which all breeds contributing the cross also have to be maintained as straight-bred populations), the development of a new synthetic breed, or breed substitution carried out by recurrent crossing.

The first introduction of exotic sheep breeds into Ethiopia traced back to 1944 when Merino sheep were introduced from Italy by an American aid organization and were maintained at Entoto (located near Addis Ababa) sheep breeding station (DBHBMC, 2007; Getachew et al, 2016). Introduction of Romney, Corriedale, Hampshire, and Rambouillet from Kenya in 1967 was targeted to cross them with local sheep breeds aiming to supply wool for the Debre Berhan blanket factory established in 1967 (Getachew et al, 2016). Subsequently, later in 1980, Awassi sheep were introduced from Israel and kept at DBSBMC and Amed Guya Sheep Breeding and Multiplication Center (AGSBMC) and in 2011, about 170 pure Awassi sheep were imported from Israel to recommence crossbreeding in the farms. Dorper sheep were introduced into the Jijiga area (Somali Region) in the late 1980s (Awgichew and Gipson, 2009).

According to Awgichew and Gipson (2009) the Ethiopian Sheep and Goat Productivity Improvement Program (ESGPIP), a USAID funded 5year project launched in 2006, operated with the goal to sustainably increase sheep and goat productivity in Ethiopia and consequently to enhance economic and food security. Thus, a total of 120 Dorper sheep (ewes and rams) were imported again from the Republic of South Africa in 2007. Regional research institutions also showed interest in Dorper sheep and additional 250 sheep were imported in 2011, aiming to establish new nucleus flocks. Thus, the project was implemented in collaboration with local universities and research centers at 2 nucleuses and 10 Breeding, Evaluation and Distribution (BED) sites, established in different parts of the country since 2007 (Getachew et al, 2016). The nucleus sites were used to multiply the imported purebred Dorper sheep and provide a continuous supply of pure Dorper sheep to the BED sites, farm land commercial or cooperative farms and to those individuals who wished to establish their own pure breed producing farms.

At BED sites, purebred sires were crossed with indigenous dams to obtain F1 sires for dissemination to farmers.

The funding of ESGPIP terminated in 2011 and the activities were handed over to local universities and research centers for further implementation of the crossbreeding program. Crossbreeding among indigenous breeds has also been practiced at DBARC as an alternative to the use of exotic genotypes for crossbreeding. Indigenous Washera rams were distributed in the highlands of North Shewa, South Wollo, North Wollo, and Gondar areas (ANRSBoARD, 2004). In 2005, a village-based Farta × Washera sheep crossbreeding program has been started (Mekuriaw et al., 2013) with the aim to increase productivity of medium sized indigenous Farta (Gizaw et al., 2008) by crossing with introducing male and females of indigenous Washera sheep. However, these genetic improvement programs failed to produce a significant effect on sheep productivity on the farmers' and pastoralists' livelihoods and the national economy at large (Gizaw et al, 2013).

The major drawback in the cross-breeding programs is lack of a clear and documented breeding and distribution strategy (Addis et al, 2015). According to Gizaw et al (2013) there has been very little consideration of the needs of the farmers and pastoralists, their perceptions, and indigenous practices. Additionally, they have had limited or no participation in the design and implementation of the breeding programs. Further, the breeding programs lacked breeding schemes to sustain cross-breeding at the nucleus centers and at the village level. The distribution of the improved genotypes of these programs was indiscriminate and unplanned, resulting in failure of the breeding programs and threatened to dilute the sheep genetic diversity in the country.

However, Bereket et al (2017) recommended that improvements to the current Bonga sheep crossbreeding systems should be based on simple crossbreeding options that are applicable under the existing and emerging breeding practices in Ethiopia.

2.4. Reproductive Performances of sheep in Ethiopia

Good reproductive performance is a prerequisite for any successful genetic improvement and it determines production efficiency (Edea, 2008). Study suggests that differences exist in reproductive performance between indigenous sheep breeds and their variation allow for the

selection of suitable breeds for a given environment (Mukasa-Mugerwa and Lahlou-Kassi, 1995).

Age at first parturition is a good indicator of early sexual maturity in ewes. It is an economically important trait as greater population turnover and more rapid genetic progress can be obtained when sheep produce their first progenies at an earlier rather than later age. Early maturing females are also known to have a relatively long and fruitful reproductive life (Mukasa-Mugerwa and Lahlou-Kassi, 1995). Reproductive performance depends on various factors including age at first lambing, litter size, lambing interval and the life time productivity of the ewe, the last one being related to longevity (Sulieman et al., 1990; cited by Amelmal, 2011).

2.4.1. Age at first service

Results revealed that age at first mating for both sexes is not fixed and sheep are left to nature to reproduce. According to Edea (2008) age at first service for Bonga breeds were 7.51 ± 2.14 and 9.3 ± 2.2 months for males and females, respectively and for Horro breeds were 7.1 ± 3 and 7.8 ± 2.4 months for males and females, respectively. The age at first service of 10 months reported by Edea (2008) seem to be lower than that reported in traditional systems for Menz sheep (Mukasa-Mugerwa and Lahlou-Kassi 1995). According to the Amelmal (2011) Age at sexual maturity (puberty) was 11.05±1.6, 10.88±1.7 and 9.5±1.4 months for males and 11.13±2.7, 10.8±1.9 and 9.5±1.4 months for females in Tocha, Mareka and Konta, respectively.

The sexual maturity (puberty) in local sheep in Illu Abba Bora and Gumuz female sheep was reported to be 5-8 and 7.21 ± 1.75 months, respectively (Dhaba, 2013 and Solomon, 2007). The result of Tsedeke (2007) for age at puberty of local Alaba sheep were 6.7 and 6.9 months for male and female respectively. These were in close agreement with Edea (2008) and Dhaba (2013) but not with Amelmal (2011).

2.4.2. Age at first lambing

Total life time production (life time lamb crop) can be increased by encouraging first lambing at an early age (Amelmal, 2011). Age at first lambing is affected by breed, husbandry and management practices and has wide variation among African sheep. In most traditional systems, first lambing occurs at 450-540 days (15 – 18 months) when ewe weights are 80-85 percent of

mature size (Wilson, 1986) and Poor nutrition, disease or parasitic burdens and genotype limit early growth and which may delay early sexual maturity resulting in late age at first lambing. Year and season of birth in which the ewe lamb was born influence age at first lambing through their effect on feed supply and quality during different season (Mukasa-Mugerwa and Lahlou-Kassi, 1995). The difference was attributed to the variation in availability and quality of feed resource across the difference seasons. Wilson and Murayi (1988) investigated that lambs born for twins had longer age at first lambing than their counterpart singles born lambs. The age at first lambing for some of indigenous sheep breeds / types has been summarized in table 1.

Table 1: Age at first lambing of Ethiopian indigenous sheep breeds/types

Breed/Type	AFL(months)	Source
Gumuz	13.67	Solomon (2007)
Menz	16.5	Gautsch (1987)
Menz	15.22	Abebe (1999)
Menz	17.06	Niftalem, 1990
Thin-tailed sheep	13.7	Mukasa-Mugerwa et al. (1986)
Washera	15.46	Mengiste, 2008
Blackhead Ogaden	23.56 ± 3.63	Fikrte, 2008
Bonga	14.9 ± 3.1	Edea, 2008
Horro	13.3 ± 1.7	Edea, 2008
Arsi-bale	12.7	Tsedeke, 2007
Adilo	14.6	Getahun, 2008
Local sheep in Adaa Liban	17.07	Samuel, 2005
Local sheep in Alaba	12.7	Tsedeke, 2007
Local sheep in Tocha	12.88±1.7	Amelmal, 2011
Local sheep in Mareka	14.75±1.8	Amelmal, 2011
Local sheep in Konta	14.77±1.8	Amelmal, 2011
Local sheep in Illu Abba Bora	10 – 13	Dhaba , 2013
Local sheep in Gamogofa Zone	12.4±0.28	Fsahatsion, 2013
Local sheep in Ada Barga and Ejere	14.29±0.08	Yadeta, 2015

3.4.3. Lambing interval

The interval between two successive parturitions is called lambing interval and one of the main components of reproductive performance which is affected by the breed (Wilson and Murayi, 1988), season (Abebe, 1999), year of lambing (Niftalem, 1990), season (Mengiste, 2008) parity of ewes, post-partum body weight and management practice (Gautsch, 1987), type of

management, nutrition, type of mating (Mukasa-Mugerwa and Lahlou-Kassi, 1995; Gbangboche et al., 2006). Management practices and restrictions on breeding also prolong the interval between lambing (Suleiman et al., 1990).

In condition of good management adequate nutrition lambing interval of 8 months can be achieved facilitating three lambing from indigenous sheep in two years (Sani and Tiwari, 1974). According to Gizaw et al (2007) in association with the above thought Gumuz breed had an average lambing interval of 6.64 ±1.13 months and thus this breed can produce three lambing in two years even under the traditional management system but the work of (Belete, 2009) and Edea (2008) indicates that lambing interval of Bonga and Horro ewes were around 8 and 7.8 ± 2.4 month respectively. Among other breeds of sheep in Ethiopia that had short lambing interval were Menz (8 and half month) and Afar sheep (9 month) Tesfaye (2008). Genetic and environmental differences led to wide variation of LI among different sheep breeds. The lambing Interval for some of indigenous sheep breeds/types are summarized in Table 2.

Table 2. Lambing Interval of Ethiopian indigenous sheep breeds/types

Breed/Type	**LI(months)**	**Source**
Gumuz	6.64 ±1.13	Solomon (2007)
Menz	8.5	Tesfaye (2008)
Menz	12.7-13.6	Niftalem, 1990
Menz	7.6-9.1	Abebe (1999)
Local sheep around Dire Dawa	11.2-11.3	Aden (2003)
Afar sheep	9	Tesfaye (2008)
Washera	9.16	Mengiste, 2008
Blackhead Ogaden	10.46	Fikrte, 2008
Bonga	8	Belete, 2009
Bonga	8.9 ± 2.1	Edea, 2008
Horro	7.8 ± 2.4	Edea, 2008
Arsi-bale	12.7	Tsedeke, 2007
Local sheep in Gamogofa Zone	7.34±0.13	Fsahatsion, 2013
Local sheep in Gomma district	7.87-8.04	Belete, 2009
Local sheep in Alaba	9.19±0.08	Deribe, 2009
Local sheep in Tocha	11.62±3.8	Amelmal, 2011
Local sheep in Mareka	10.33±4	Amelmal, 2011
Local sheep in Konta	11.02±3.8	Amelmal, 2011
Local sheep in Illu Abba Bora	9-12	Dhaba , 2013
Local sheep in Ada Barga and Ejere	8.83±0.44	Yadeta, 2015

2.4.4. Litter size

Litter size is largely determined by ovulation rate but is also modified by fertilization rate and embryonic and fetal losses (Gatenby, 1986) and ovulation rate can be dependent on breed, level of nutrition, season and age (Haresign, 1985). Significantly age of the dam can have effect on number of lambs per lambing. Until the age of five years or fourth parity liter size increases then it decreased slightly above this age (Wilson et al., 1984). Some studies have shown that there is increased litter size with an increase in parity and higher litter size at fifth parity (Berhanu and Aynalem, 2009); peak prolificacy is generally achieved between 4 and 8 years of age (Notter, 2000).

Level of nutrition has effect on litter size in that, poor nutrition during service period lead to reduced ovulation rates and increase embryonic mortality and consequently decrease litter size (Gautsch, 1987). The percentage of ewes having twins in tropical sheep breeds, generally range between 0 and 50% (Gatenby, 1986) and while under traditional management conditions the percentage tends to fall below 10%. According to Edea (2008) a twining rate of 39.9 % or litter size of 1.40 and 36 % or litter size of 1.36 were obtained for Bonga and Horro sheep breeds, respectively, whereas low twining rate was reported for both Menz1.13 (Mukasa-Mugerwa et al. 2002) and Afar sheep 1.03 (Wilson, 1982). Litter size is influenced by genotype, parity, season, and ewe body weight at mating (Mukasa-Mugarwa and Lahlou-Kassi, 1995) and management system is also a major source of variation in litter size as reported by Mekuriaw et al. (2013). Some representative litter size of indigenous sheep of Ethiopia Has been summarized in Table 3.

Table 3. Litter size of Ethiopian indigenous sheep breeds/types

Breed/Type	Litter size	Source
Gumuz	1.17	Solomon (2007)
Menz	1.08	Gautsch (1987)
Menz	1.14	Agyemang et al. (1985)
Menz	1.13	Mukasa-Mugerwa et al. (2002)
Menz	1.02	Niftalem (1990)
Thin tailed	1.30	Mukasa-Mugerwa and Teklye (1988)
Afar sheep	1.03	Wilson (1982)
Washera	1.11	Mengiste, 2008
Blackhead Somali	1.04	Galal (1983)
Bonga	1.40	Edea, 2008
Horro	1.36	Edea, 2008
Horro	1.34	Abegaz et al. (2002) &Solomon and Gemeda (2000)
Adilo sheep	1.42	Getahun (2008)
Local sheep in Gamogofa zone	1.3±0.04	Fsahatsion, 2013
Local sheep in Alaba	1.51+0.04	Deribe, 2009
Local sheep in Ada Barga and Ejere	1.19±0.42	Yadeta, 2015
Twining rate (percent)		
Local sheep in Tocha	24.75±7.9	Amelmal, 2011
Local sheep in Mareka	37.8±12.9	Amelmal, 2011
Local sheep in Konta	39.06±17.9	Amelmal, 2011

2.4.5. Reproductive life span and life time lamb crop

Long reproductive life span in tropical (unfavorable) condition is one of the adaptation traits of tropical livestock. According to Edea (2008) the average reproductive life span of Horro and Bonga ewes were 7.9 ± 3.1 years and 7.4 ± 2.7 years, respectively. Long term reproductive performance (long living, high fertility, ability to produce more offspring) of dams should be given more importance in selection programs (Edea, 2008). According to Gizaw (2008) in a circumstance that of lack of comparative figures for Ethiopian breeds, quite long reproductive life span of Gumuz breed (8.5 years for ewes and 3.67 years for rams) was reported.

The average reproductive life span of Tocha, Mareka and Konta local ewes were 9.17±1.70, 9.82±1.51and 9.28±1.62 years, respectively (Amelmal, 2011) which is longer than the above

reported. These were in close agreement with Yadeta (2015) 10.52 ± 1.3 years for Local sheep in Ada Barga and Ejere districts.

The life time lamb crop is very important trait to improve sheep productivity and profitability. According to Edea (2008) on an average a Bonga and Horro ewe delivers 12.2 ± 1.80 and 15.3 ± 4.3 lambs in her life time. Also, similar result was reported for Gumuz sheep (13.5 ± 1.76 lambs) in Metema areas (Gizaw et al, 2007).

The results of the study for local ewe produce on average 8.57±3.7 (Tocha), 8.62±4.1 (Mareka) and 10.78±4.7 (Konta) lambs in her life time (Amelmal, 2011). This figure is much lower than the figure reported by above two author and Average reproductive life span and life time lamb crop of some indigenous sheep breeds/types are summarized in table 4.

Table 4. Average reproductive life span and life time lamb crop of some indigenous sheep

Breed/type	**RLS of female (year)**	**life time lamb crop**	**Source**
Bonga	7.9 ± 3.1	12.2 ± 1.80	*Edea (2008)*
Horro	7.4 ± 2.7	15.3 ± 4.3	*Edea (2008)*
Gumuz	8.5	13.5 ± 1.76	*Solomon (2007)*
Tocha local sheep	9.17±1.70	8.57±3.7	*Amelmal (2011)*
Mareka local sheep	9.82±1.51	8.62±4.1	*Amelmal (2011)*
Konta local sheep	9.28±1.62	10.78±4.7	*Amelmal (2011)*
Shinile and Erer local sheep	9.12 ± 1.6	8.18 ± 2.27	*Fikrte (2008)*
Ada-Barga and Ejere	10.52 ± 1.3		*Yadeta (2015)*

2.5. Productive performance of Sheep in Ethiopia

Growth performance is a key production indicator as it has implication on the reproductive efficiency of sheep (Momoh et al., 2013). Fast growth performance allows sheep to breed early and contribute more numbers of lifetime lamb crop. Faster rate of growth enables attaining an early marketable weight (Berhanu and Aynalem, 2009). It is an important trait especially for mutton type breeds. An optimum level of growth determines the overall productivity of the flock and the economic return from the small ruminants. Growth performance of lambs is determined by their body weight at various stages and daily body weight gain. Growth rate of lambs particularly during the early stages of life, is significantly influenced by breed (genotype), nursing ability of the ewe, the environment under which the animals are maintained including the availability of adequate feed supply in terms of both quantity and quality

(Kassahun, 2000; Mengiste, 2008). Parity, pre-mating weight of the dam, type of birth, sex and season of birth also affect the growth.

Studies indicated that variation exits between indigenous sheep breeds for body weight traits (Kassahun; 2000; Sisay; 2002; Tibbo, 2006; Solomon; 2007). Among the indigenous sheep breeds Horro and Bonga sheep breeds are large sized breeds and are superior in their body weight Gizaw et al (2007) compared to most of the local sheep breeds.

The birth weight (3.24 kg) of the crossbred Local rift valley sheep with Dorper Sirinka agricultural research center, BED site in eastern Amhara region was heavier than the birth weight (2.36 kg) of the indigenous sheep breeds in the area (Lakew et al, 2014) and birth weight (2.25 kg) of Dorper sheep lamb crosses in Wolayita and Siltie zones, southern Ethiopia (Ermias, 2014) but, lower than indigenous Bonga sheep breed reported 3.42 kg and 3.6 kg by Haile et al (2014) and Metsafe (2015) respectively. Which is also, greater than Dorper sheep cross of 2.25 kg in for zones of southern region (Belete, 2014) as shown in table 5. However, non-genetic factors (sex, birth season, environment and birth type) have effect on growth performance of sheep.

Table 5. Birth weight, three months' weight, six months' weight, pre-& post-ADG

Breeds	**Birth weight**	**3-month weight**	**Pre-ADG**	**6-month weight**	**Post-ADG**	**Reference**
Menz	2.3±0.04	9.3±0.6	80±7	13.7±0.3	40±3	Haile et al (2015)
Bonga	3.6±0.01	15.5±0.08	129.1±1.16	22.2±0.21	69.3±1.4	Metsafe (2014)
Horro	3.12±0.13	11.7±0.5	90±6	17.3±0.8	60±9	Haile et al (2014)
Tumelie (Local)	2.36±0.05	8.5±0.14	67.78±1.60	11.92±0.2	37.9±1.2	Lakew et al. (2014)
Tumelie (Local) X Dorper	3.24±0.04	14.9±0.21	129.9±2.23	20.43±0.3	64.6±1.7	Lakew et al. (2014)
Local	2.72	8.367	NA	NA	NA	Belete (2014)
Local X Dorper	2.25±1.7	17.3±0.9	NA	NA	NA	Belete (2014)

2.6. Farmers' Perception on Breed Improvement

According to Bereket et al (2017) the high diversified ethnic and cultural diversity affects the adoption of the technology in Ethiopia, especially SNNPR. However, For the success of indigenous sheep genetic improvement understanding the community breeding animal preference is important (Solomon et al, 2013)

Getachew et al (2016), farmers in Ethiopia showed keen interest to adopt and implement breeding programs when they found them working and benefitting them. However, depending on their level of experience and capacity, farmers might support either crossbreeding or pure breeding. Farmers are interested in adoption of sheep crossbreeding due to the fast growth of crossbreds compared to their local sheep breeds in the Awassi × Menz and Farta x Washera crossbreeding attempts in the highlands of the Amhara region (Taye et al., 2011; Teferra et al., 2014; Getachew et al 2016). According to Tibbo (2006) these crossbreeding programs were failed because they not meet farmer's preference. Also, Gizaw et al. (2013) reported that the existence of cross-breeding projects has a negative effect, 93% of the farmers interviewed in the Menz region expressed their preference for Awassi sheep, which were introduced into the area by the Awassi sheep cross-breeding project.

According to Haile et al (2011), if farmers participate in whole process of breed improvement program, the breeding program is success and farmer's adoption is very high. For example, according to Haile et al (2014) and Gutu et al (2015) Bonga community-based breeding program were success and the farmer's perception still high. According to the Kebede H. and Zekarias B. (2017) study on farmers' perception on performance of different disseminated breeding ram in Wolayita area show that the respondents in the area prefers breeding rams based on different traits and physical appearance, thus farmers in some areas appreciate Bonga sheep for its ability to adapt and its progeny fast growth. And also, Mekuriaw et al (2012) reported that, Washera sheep have been more preferred by the farmers for their large body size, smooth hair, fast growth, big fat tail and attractive coat color and farmers' and pastoralists' preferences are usually influenced by market forces to adopt cross-breeding (Gizaw et at., 2013).

2.7. Flock Structures and Lamb mortality

Flock composition in terms of age and sex classes has been taken as an indicator of the management objectives for the owner and the production of the flock (Ayalew et al., 2002).

Most of the time flock structure can reflect objective and strategy of the production. The study Solomon, (2007) in north western lowland of Amhara region showed that among total sampled Gumuz sheep under farmer's management condition, about 42.58% were adult females, while the proportion of rams in a flock was only 5.8 %. In Menz sheep flock breeding ewes take a major portion (46.8%) followed by lambs (19.2%) and ewe lambs (14.3%) and low proportion (5.65%) of breeding rams and castrates (3.92%). Tesfaye, (2008) also reported in Afar pastoral breeding system that ewes were dominant (49.2%) followed by lambs (23.6%) and ewe lambs (18.1%) as well as 2.83% breeding rams and 0.8% castrates.

Sheep ownership varies depending on the wealth status and the overall farm production objectives (Deribe, 2009). In the highlands, sheep are kept in small flocks of about 5 sheep per household by nearly 40 % of all smallholders. The average flock size of sheep in Alaba was 5.0 (Tsedeke, 2007). However, the average sheep flock ranges from 3.7 (Abebe, 2010) to 31.6 (Getachew et al.2010) of sheep per household.

Lamb mortality rate varies from one flock to another depending mostly on management level (Awigichew, 2000). Lamb losses during pre-weaning period due to poor milking ability of dam and poor management before one year of age vary from 6.4 % to 45% (Deribe, 2009). The study on Horrro and Menz sheep of Ethiopian highlands show that slow growth rate associated with mortality has been limiting factors for profitability of the indigenous sheep breeds (Tibbo, 2006). Gemeda et al. (2005) and Berhanu and Aynalem (2011) reported that survival rate of lamb was significantly affected by birth weight. The higher mortality rate for lambs born in dry season, compared to those born in the wet season was reported by (Deribe, 2009).

The major couses for lamb mortality in Bonga area were disease, cold stress (in wet season), predators according to Metsafe, (2015) and unknown causes Fisseha (2015). However, causes of lamb mortality are directly associated to the production and the management system (Berhanu and Aynalem, 2009). According to (Tibbo, 2006) more than half percentage of early lamb mortalities was an important losses associated to managements.

2.8. Feed sources and feeding strategy of sheep

The review of Addis (2015), show that the available feed resources of small ruminants are natural pasture, crop residue, cultivated forage and industrial by product and other by feed resources derived from herbaceous forages, trees and shrubs, food crop residues, agro-industrial by products, mineral supplements and other by products. Studies by Zewdu (2008) indicated that grazing on fallow land was the major feed resource for farmers in Adiyo Kaka district during the rainy season when most of the farm lands are cultivated. The main water source for sheep in Kafa area were river Dejene (2010). Ermias (2014) reported that 77.8%, 37.5% and 64.6% respondents use natural pasture as feed source during dry and wet seasons in Damot Gale, Damot Sore and Mirab Azernet District, respectively. On other study, natural pasture, fallow land and crop residues reported as major feed sources for sheep (Helen et al, 2015).

The main supplementary feeds practice for Bonga sheep were grains (boiled bean, pea and maize), Crop residues, home left over, non-conventional feeds like Atella (left over) of Tella, Areke and Bored, and table salt supplementation for sheep fattening also was reported by Zewdu (2008) and Dejene (2011). However, Agro-industrial by-products such as wheat bran were the only feed used as supplemented for breeding animals during the dry season in mixed crop-livestock system.

3. MATERIAL and METHODS

3.1. Description of the Study Areas

The study was conducted in selected four zones of Southern Nations Nationalities and Peoples Region (SNNPR), where improved using Bonga rams from Boka-Shuta community in Addiyo District of Kaffa Zone. The SNNPR is located in the southern and south western part of Ethiopia. The total area of the region is estimated to be 110,931.9 square km which is approximately 10% of the country's total area (Official website of SNNPR, 2012). The region has 14 zones and 8 special District.

Based on Bonga ram distribution information, four zones were selected for the current study. One district from each of these zones have been selected purposively based on accessibility of infrastructure, number of rams distributed, and Agro-ecology of the district. The details of Agro-ecology and production system of selected districts are as shown in table 6.

3.1.1. Silte Zone

The administrative center (Worabe) was located at 173 km from Addis Ababa and 177 km from the regional city Hawassa. (https://en.wikipedia.org/wiki/Silt%27e_Zone). The zone has a total area of 2537.5 sq. km and lies between 7.43 - 8.10 latitude and 37.86 to 38.53 longitudes, with an elevation ranging from 1501 to 3500 m.a.s.l. Out of the total land size 3.42% is lowland (LL), 73.57% Midland (ML) and 23.01% Highland (HL). The annual mean temperature ranges between 10.1-22.5oC and the annual mean rainfall ranges between 801- 1200 mm. The zone has 8 Districts. http://www.southinvest.gov.et/potentialSiltie.htm. The zone has twelve Districts. According to the CSA (2016/17) Livestock population of the zone are Cattle (547,666), Sheep (331,455), Goats (227,592), Horses (33,160), Mules (2,040), donkey (126,539), Poultry (805,968) and Beehives (27,869).

3.1.2. Wolayta Zone

The administrative center (Sodo) was located at 330 km to the south-west of Addis Ababa and 160 km from Hawassa. The annual average temperature of the zone is 15.1°C and the mean annual rainfall ranges from 1200 to 1300 mm. Regarding to the Agro – Ecology of the zone, out of the total land size 3% is lowland, 57% Midland and 40% Highland. The zone has twelve

Districts. According to the CSA (2016/17) Livestock population of the zone are Cattle (841,729), Sheep (240,315), Goats (159,362), Horses (1,619), Mules (874), donkey (40,672), Poultry (1,019,67) and Beehives (57,294).

3.1.3. Gurage zone

The administrative center (Welkite) was located at a distance of 158 km south -west of Addis Ababa. The zone has a land size of about 5932 sq. Km and consists 15 District. The zone has three Agro- ecological zones Highland (35%) Midland (62%) and lowland (3%). The annual average temperature of the zone ranges from 13 to 30°C and the mean annual rainfall rages from 600-1600 mm. According to the CSA (2013/14) Livestock population of the zone are Cattle (916,309), Sheep (316,600), Goats (133,689), Horses (49,608), Mules (4,383), donkey (94,357), Poultry (647,708) and Beehives (53,662).

3.1.4. Sidama zone

The zone is located 275km south of Addis Ababa and has 19 Districts. The zone covers 6972.1 square kilometer and lies between 6.14-7.18 latitude and 37.92 to 39.19 longitudes, with an elevation ranging 501-3000 meters above sea level. https://en.wikipedia.org/wiki/SidamaZone. Regarding to the Agro – Ecology of the zone, out of the total land size 26.8% is lowland, 45.49% Midland and 27.71% Highland. The annual mean temperature of the zone ranges between 10.1-27o c and the annual mean rainfall ranges 801- 1600 mm. http://www.southinvest.gov.et/potentialSidama.htm. According to the CSA (2013/14) Livestock population of the zone are Cattle (2,172,01), Sheep (519,655), Goats (338,551), Horses (46,53), Mules (9,467), donkey (99,350), Poultry (2,123,579) and Beehives (102,452). The map of the study areas is presented in figure 1.

Table 6. Agro-ecology and production system of study districts

Location	Lowland%	Midland %	Highland%	Altitude (m.a.s.l)	Longitude (North)	Latitude (East)	Production System
Arbegona	0	31.5	68.5	2985	$6^0$39'60"	$38^0$44'60"	Mixed farming
Ezha	5%	66%	29%	2930	$8^0$55'02"	38^0 6' 22"	Mixed farming
Damot Pulasa	0	100%	0	1919	$7^0$00'08"	$37^0$47'34"	Mixed farming
Alicho Worero	0	52%	48%	2295	$7^0$55'02"	$38^0$7'42"	Mixed farming

Source: GPS and Secondary sources

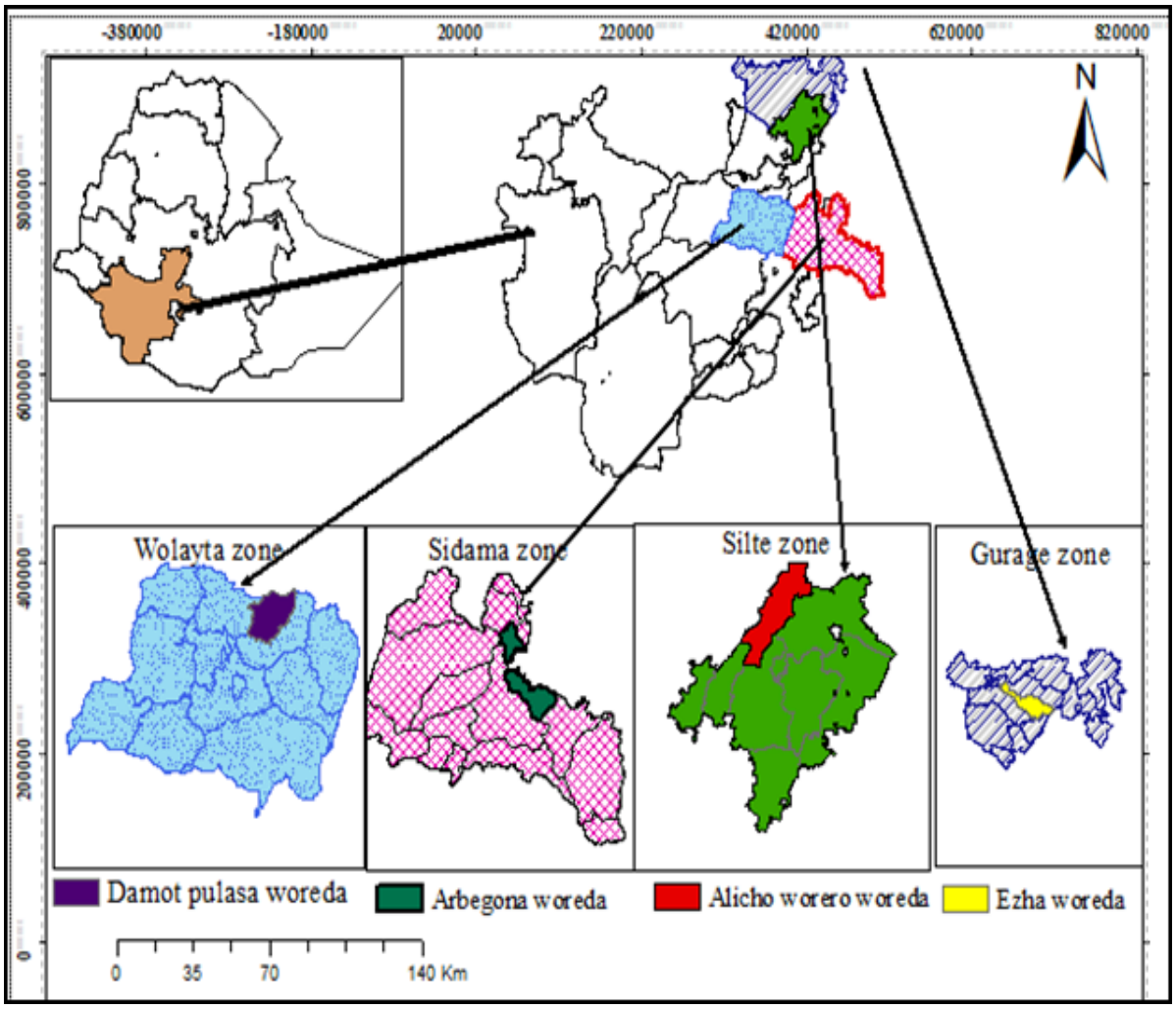


Figure 1 Map of the Study Areas

3.2. Introduction of Bonga Ram in the Study Areas

The year of introduction and number of Bonga ram introduced, year wise, up to study time (16th April, 2016) is presented in table 7. The dissemination of improved Bonga ram was started in 2012 onward. The improved Bonga ram were introduced over the years in order to improve both productive and reproductive performance of local sheep type through crossbreeding with Bonga sheep.

The Bonga rams were purchased from Bonga Sheep Community Based Breeding and Multiplication a cooperative, which is under Bonga Agriculture Research Center, by either government agencies or NGOs. The respondents in the study area reported that the beneficiary farmers contribute a potion on purchase cost on these rams and the is presented in **(**Appendix 11: **Focus Group Discussion Results**

Table 7: Number of Disseminated Bonga Rams in the Study Area

Location	Year of Bonga ram Introduction			
	2014	**2015**	**2016**	**Total**
Arbegona	0	27	33	60
Ezha	0	28	0	28
Damot Pulasa	0	27	44	71
Alicho Worero	30	75	0	105
Total	30	157	77	264

Source: Bonga Agriculture research center

3.3. Sampling Technique

The study Districts were selected purposively based on distribution of Bonga rams. The respondent farmers for survey study were selected as per details in table 8. The monitoring studies in the four selected Districts were carried on pregnant ewes (382 ewes belonging to 301 HH) mated with either Bonga or local ram.

Table 8: Sampling structures for selection respondent farmers in study districts

Stages	Activity	Sampling Technique	Sample frame	Criteria
First	Selection of Study Zone	Purposively	Gurage, Sidama, Silte and Wolayta	Distribution of Bonga ram from Boka-Shuta community
Second	Selection of Study Districts	Purposively	Ezha (Gurage), Arbegona (Sidama), Alicho (Silte), Damot-Pulasa (Wolayta)	Introduction of high number of Bonga rams from Boka-Shuta community in Districts
Third	Selection of Respondents for Survey	Randomly	320 farmers	a) 40 respondents using Bonga rams; and b) 40 respondents using local rams from each district

A total of 320 households (80 from each district i.e. 40 households from BRUs and 40 households from non-BRU) were considered purposively for the household survey. Furthermore, monitoring studies in the four selected Districts were carried on 382 pregnant ewes (Belonging to 301 HH) mated with either Bonga or local ram. These ewes were monitored for lamb growth and ram reproductive performance during the study. The details of these ewes (Monitoring study) are shown in table 9.

Table 9: Details of sampling of ewes for monitoring studies

Location	Local ewe x Local ram		Local ewe x Bonga ram		Total	
	Number of ewes	**Number of Household**	**Number of ewes**	**Number of Household**	**Number of ewes**	**Number of Household**
Alicho Worero	39	34	50	50	**89**	**65**
Ezha	53	53	56	56	**109**	**81**
Damot Pulasa	37	37	42	42	**79**	**78**
Arbegona	48	48	57	57	**105**	**77**
Pooled	**177**	**142**	**205**	**159**	**382**	**301**

3.4. Data Collection Procedure

A structured questionnaire, focus group discussion, field monitoring and secondary sources were used to gather qualitative and quantitative data on sheep breeding and production practices in the area. Structured questionnaires were prepared to collect information on the existing socio-economic characters (sex, age, education level, household size, livestock possession and major production constraints), reproductive performances (age at first lambing, lambing interval, age at first service, flock structure, major feed sources and diseases of sheep in the area, sheep production system and husbandry practices from each flock owners and key informants via interview.

Organized group discussion was held with clan or village leaders, District Agricultural Experts (Extension Agents), researchers, and sheep owners (female and male member) of the society who are known to have better knowledge on social and economic status of the area. Discussions and individual interviews were focused on the genetic potential of Bonga sheep, farmer's preference, current status of breeding strategies and major constraints of sheep production. A discussion was done by using a prepared check list. To get adequate information on the parameters like age at first lambing, lambing interval, lamb mortality, litter size, case histories of breeding females have been taken gathered.

3.5. Animal Identification and Data recording

Farmer selection, Animal identification and data records were done between October 2016 and June 2017. Thus, total of 382 pregnant ewes from 301 farmers were identified based on secondary data from the Office of livestock and fishery resource development and experts of animal husbandry consultation through house to house visiting as indicated in table 7. The development agents (DA) was trained on the method of animal identification and data recording. Training and demonstration was done before commencement of the study for enumerators (development agents).

Background /reproductive/ history of all selected ewes were identified and recorded at first by using earlier developed format (Haile et al, 2011). Data was collected during the monitoring period includes: parity of dam, genetic group of ram, date of birth, type of birth, sex of lamb, coat color and tail type of lamb, lamb birth and growth weights up to six months by using

weighing balance (50kg), and litter size/prolificacy, twinning rate, weaning rate and mortality rate by using format (Haile et al, 2011).

The breeding soundness of the disseminated rams' information were collected from each location. The data includes, libido, Body condition score, testicle circumference, mating performance and other aspects of the ram were assessed in the respected area.

3.6. Data Management and Statistical Analysis

All collected data were entered and managed into Microsoft Excel 2016. The collected survey data through questionnaire were subjected to crosstabs of descriptive statistics and compare means of Statistical Package for Social Sciences (SPSS, 2011 ver. 20). Chi square ($X^{2)}$ test was used to test the significance differences of the variables and an index was used for qualitative data ranking.

The recorded growth performance and reproductive data were subjected to General Linear Model (GLM) procedures of the Statistical Analysis System (SAS, 2012 ver. 9.3). The growth performance analyzed were birth weight, weight at 60, 90 (This is the weaning weight), 120 and 180 days and Average Daily Body Weight Gain (ADG) from 0- 90, and 90-180 days. Tukey Kramer test was used to compare more than two effects of means which were significant in the least squares analysis of variance (SAS 9.3).

The fixed effects fitted in the model of growth traits included the effects of location (Alicho Worero, Ezha, Damot Pulasa, Arbegona); breed (local, Bonga cross); sex (male, female); parity (1….6); birth type (Single, twin and multiple) and season of birth (Spring (September-November) and Dry (December- February) and the interaction effect of location by breed. The fixed effects fitted in the model of reproductive traits included the effects of location (location (Alicho Worero, Ezha, Damot Pulasa, Arbegona) and breed (local, Bonga cross).

Model 1:

The statistical model for growth performance:

$$\mathbf{Y_{hijklmno}=\mu + Bh + Li + Xj + Pk + Tl + Sm + Zn + ehijklmno,}$$

Where;

$Y_{ehijklmno}$ = Observed weight for n^{th} lamb at different age

μ = Overall population mean

B_h = Fixed effect of h^{th} genetic group (h =Local lamb; Bonga cross).

Li= Fixed effect of the i^{th} location (i= 1, …,4)

Xj = Fixed effect of j^{th} sex (j=1,2)

Pk = Fixed effect of k^{th} parity (k= 1…,6)

Tl= Fixed effect of l^{th} type of birth (l= 1….,4)

Sm= Fixed effect of m^{th} season (m = 1,2)

Sn= Fixed effect of n^{th} interaction (n = B_h, L_i)

ehijklmno= Random error

Model 2:

The statistical model for reproductive performance

$$Yijkl=\mu + B_i + L_j + I_{k+} e_{ijkl},$$

Where;

Y_{ijkl} = Observed values of the sheep reproductive performance

μ = Overall population mean

B_i = Fixed effect of i^{th} genetic group (i =Local; Bonga cross).

L_j = Fixed effect of the j^{th} location (i= 1, …,4)

I_k= Fixed effect of k^{th} interaction (k = B_i, L_j)

e_{ijkl}= Random error

Parameters like Pre-weaning and post- weaning mortality rate, twinning rate, weaning rate was computed on percentage basis using their respective formulas below.

$$\text{Multiple birth rate} = \left\{ \frac{(Number\ of\ lambs\ born\ Single\ or\ Twin\ or\ Ttriplet\ or\ Quadriplut)}{Total\ number\ of\ lambs\ born} \right\} \text{X } 10$$

$$\text{Pre-weaning mortality rate} = \left\{ \frac{\text{Number of lambs died before weaning (upto 3 months of age)}}{\text{Total number of lambs born}} \right\} \text{X } 100$$

$$\text{Post-weaning mortality rate} = \left\{ \frac{\text{Number of lambs died after weaning upto 180 days of age}}{\text{Total number of lambs born}} \right\} \text{X } 100$$

$$\text{Weaning rate} = \left\{ \frac{\text{Number of lambed weaned}}{\text{Total number of lambs born}} \right\} \text{X } 100$$

$$\text{Pre-weaning ADG (gm/day)} = \left\{ \frac{\text{Weaning weight} - \text{Birth weight}}{\text{Weaning age}} \right\}$$

$$\text{Post-weaning ADG (gm/day)} = \left\{ \frac{\text{Post-weaning weight (180 days age)} - \text{Birth weight}}{\text{Post-weaning age}} \right\}$$

4. RESULTS and DISCUSIONS

4.1 General Characteristics of households

4.1.1 General information

The result of demographic and socio-economic characteristics of the selected respondent households (HH) considered for survey study is presented in table 10. The total (Overall) proportion of male headed household is 75% and 83% for Bonga and local ram users, whereas the remainders are female headed, respectively. The overall average educational background showed that a major proportion of respondent households were able to (a) read / write (38 and 20 % for user and NBRU group); (b) up to elementary school (31 and 26 % for user and NBRU group); and (c) illiterate (27 and 33 % for user and NBRU group) in the current study. The overall average age group showed that a major proportion of respondent households were (a) 31 – 40 years' age (32 and 41 % for user and NBRU group); (b) 41-50 years' age (36 and 29 % for user and NBRU group); and (c) < 30 years' age (17 and 16 % for user and NBRU group) in the current study.

The result of family size of the respondent households (HH) in the present study is presented in table 11. The large number of family size for survey study is 7.58±3 and 6.85±2.94 from Arbegona for both Bonga and local ram users, respectively, whereas the small number of family size for survey study is 6.55±2.02 and 5.3±1.99 from Damot Pulasa for both Bonga and local ram users, respectively. The overall male family number is 3.69±1.4 & 3.06±1.39 and female family number is 3.58±1.77 & 3.17±1.49 for both Bonga and non-BRUs respectively.

Table 10. Category-wise Proportion of Sex, Educational Level and Age (Years) of Respondent Farmers

	Respondents	Alicho				Ezha				Damot Pulasa				Arbegona				Overall			
		User		Non-Users		User		Non-Users		User		Non-Users		User		Non-Users		Users		Non-Users	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Sex	Male	33	83	27	68	35	88	38	95	22	55	30	75	30	75	38	95	120	75	133	83
	Female	7	18	13	33	5	13	2	5	18	45	10	25	10	25	2	5	40	25	27	17
Educational Level	Illiterate	16	40	23	58	8	27	5	13	11	28	12	30	5	13	12	30	40	25	52	33
	Read & Write	10	25	14	35	13	43	9	23	19	48	5	13	15	38	4	10	57	35.6	32	20
	Elementary School	13	33	3	7.5	10	33	15	38	6	15	10	25	17	43	14	35	46	28.8	42	26
	Secondary School	0	0	0	0	6	20	3	7.5	2	5	1	2.5	2	5	4	10	10	6.3	8	5
	High school	1	2.5	0	0	3	10	8	18	2	5	11	28	1	2.5	2	5	7	4.4	20	13
	>High school	0	0	0	0	0	0	1	2.5	0	0	1	2.5	0	0	4	10	0	0.0	6	4
Age group	<30	2	5	5	13	6	20	3	8	11	28	7	18	6	15	11	28	25	17	26	16
	31-40	15	38	15	38	9	30	12	30	10	25	19	48	14	35	19	48	48	32	65	41
	41-50	16	40	18	45	11	37	13	33	12	30	10	25	15	38	6	15	54	36	47	29
	51-60	4	10	2	5	10	33	2	5	5	13	3	8	4	10	1	3	23	15	8	5
	>60	3	8	0	0	4	13	10	25	2	5	1	3	1	3	3	8	10	7	14	9

Table 11. Family sizes of households in the study

Location	Respondents	Male	Female	Total
		Mean ± SD	Mean ± SD	Mean ± SD
Alicho Worero	BRUs	3.4±1.4	4.2±1.9	7.57±2.3
	Local Ram Users	2.83±1	3.28±1.3	6.05±2.1
Ezha	BRUs	3.8±1.3	3.57±1.4	7.37±2.3
	Local Ram Users	3.3±1.5	3.35±1.3	6.65±2.1
Damot Pulasa	BRUs	3.6±1.4	2.97±1.5	6.55±2
	Local Ram Users	2.8±1.3	2.55±1.2	5.3±2
Arbegona	BRUs	4±1.54	3.58±1.9	7.58±3
	Local Ram Users	3.4±1.6	3.5±1.98	6.85±2.5
Overall	BRUs	**3.69±1**	**3.58±1.8**	**7.26±2.5**
	Local Ram Users	**3.06±1**	**3.17±1.5**	**6.2±2.37**

4.1.2 Sheep Flock Structures

The results of sheep flock structure of respondent farmers for both BRU group and non-BRU group is presented in tables 12 and 13, respectively. Perusal of tables showed that overall mean sheep flock size for BRUs was 4±1.8 and 3±1.6 Bonga crosses and local types sheep, respectively. The overall mean sheep flock size for non-BRUs was 4.9±2.7. The sheep flock structure reported by respondent household farmers relatively was in agreement with 3.7 (Abebe, 2010), 5 (Tsedeke, 2007) and 4 (Ermias, 2014). Large number of Bonga cross lambs were less than 6 months (2.4±1.2) of age whereas similar figure was 2.13±0.8 for local female sheep aged greater than 12 months (Table 12). Similarly, among non-BRUs respondents, the lambs less than 6 months of age and female sheep greater than 12 month of age had large number (1.14±1.2 and 1.8±0.9 for < 6 months' age and females > 12 months' age, respectively.) in the flock size (Table 13). The results reflected that use of Bonga ram for crossing with local ewes is showing increasing trend in the study area.

Table 12. Sheep flock structure of BRUs in the study areas (Mn± SD)

Age Category (Month)	Sex	Breed Type	Alicho	Ezha	Damot Pulasa	Arbegona	Overall
Less than 6	Both	Local	0.3±0.7	0	0.1±0.6	0	0.1±0.47
		Bonga cross	2.1±1.9	3.3±1.	2.4±1.1	2.4±1.2	2.4±1.4
6 up to 12	Male	Local	0	0.5±0.6	0.1±0.3	0.18±0.5	0.17±0.5
		Bonga cross	0.7±0.9	0.5±0.7	0.3±0.5	0.48±0.7	0.5±0.7
	Female	Local	0.1±0.3	1.2±0.6	0.3±0.7	0.7±0.9	0.54±0.8
		Bonga cross	0.8±1	0.8±0.7	0.4±0.6	0.83±0.8	0.7±0.8
Greater than 12	Male	Local	0.2±0.6	0.1±0.3	0.1±0.3	0.03±0.16	0.1±0.38
		Bonga cross	0	0	0	0	0
	Female	Local	1.8±0.7	2.8±0.8	1.8±0.7	2.13±0.8	2.1±0.86
		Bonga cross	1.1±1	0	0.1±0.2	0.13±0.4	0.33±0.7
Fattened	Castrated	Local	0	0.03±0.2	0	0	0.01±0.08
		Bonga cross	0.1±0.3	0	0		0.01±0.16
	Barren	Local	0	0	0	0.05±0.32	0.01±0.16
		Bonga cross	0	0	0	0	0
Total	Local		**2.3±1.3**	**4.6±1.1**	**2.4±1.4**	**3.08±1.6**	**3±1.6**
	Bonga cross		**4.7±2.2**	**4.3±1.6**	**3.1±1.3**	**3.78±1.34**	**4±1.8**

Table 13. Sheep flock structure for non-users in the study areas (Mn± SD)

Age (Month)	Sex	Alicho	Ezha	Damot Pulasa	Arbegona	Total
Less than 6	Both	1.4±1.1	1.5±1.4	1±0.8	0.6±1.2	1.14±1.2
6 up to 12	Male	0.2±0.6	0.9±0.9	0.3±0.6	0.6±0.9	0.5±0.8
	Female	0.6±0.9	1.2±1.1	0.7±0.7	1.3±1.3	1±1.1
More than 12	Male	0.5±0.6	0.4±0.7	0.05±0.2	0.3±0.5	0.3±0.6
	Female	1.5±0.7	2.7±0.9	1.3±0.5	1.8±0.7	1.8±0.9
Unknown	Castrated	.05±0.3	0.3±0.6	0.08±0.3	0	0.1±0.4
	Barren	0	0.05±0.3	0	0	0.01±0.2
Total		**4.4±1.9**	**7.1±2.9**	**3.5±1.5**	**4.6±2.6**	**4.9±2.7**

4.2 Origins of Sheep in the Study Area

The FGD was held to identify the origin of local sheep type in the study area. The FGD in Alicho and Ezha Districts reported that local sheep presently maintained in these Districts have possibly originated from the Gummer sheep (Local name) present in the Gummer District of Gurage zone, SNNPR. This perception of the farmers may possibly be correct as to the origin of local sheep in these Districts. The local names of different sheep category assigned by different names in Silte, Gurage, Wolayta and Sidama zones have been summarized in table 15.

The origin of local sheep types in Damot Pulasa (Wolayta Zone) and Arbegona (Sidama Zone) were not from their District or Zone. The participants reported that, the local sheep type was introduced from Kambata (southern region) and Kokokisa (eastern Oromiya region) areas through marketing in Damot Pulasa and Arbegona areas respectively. The elder participants in the Arbegona told that, "during Italian occupation in Ethiopia, Italy government was introduced hairy and horned sheep type around the district and Hawassa areas". The present-day presence of small horned ewes in this area may possibly be due to this introduction. The discussions also showed that all sheep rears in the Arbegona bought sheep from Kokokisa, but reverse sale were not supported by discussions. Therefore, the origin (sources) of local sheep in Arbegona area may possibly be from Kokokisa.

The earlier workers (Gizaw et al., 2008; Galal, 1983; Mengesha and Tsega, 2011) reported that the diversified indigenous sheep types in the country reared under diverse Agro-ecology, production systems by different ethnic communities were named from their commonest niche areas.

The FGD in Damot Pulasa revealed that, in the past their local sheep was called *Kambata sheep.* This sheep types were distributed through Wolayita, Hadiya and Kambata Tambaro zones in the region. This sheep type called "*Adilo sheep"* some years ago and currently called *"Doyogena sheep".*

Table 14. Local names of sheep in the study area

Sheep Category	Location			
	Alicho (Silte)	**Ezha (Gurage)**	**Damot Pulasa (Wolayita)**	**Arbegona (Sidama)**
Sheep	*Tay*	*Tay*	*Dorsa*	*Gerecho*
Dam/Ewe	*Taynite*	*Tay*	*Uziyo*	*Gerewuama*
Ram	*Ambuli*	*Gundir*	*Orgiya*	*Gocho*
Lamb	*Giligil*	*Girangir*		*Wilile*
Ewe lamb	*Kebint*	*Noshash*		*Godane*
Ram lamb	*Korbosha*	*Korbosha*		*Wililecho*

4.3 Feed Resources and Feeding Strategy

The investigation was carried to compare the feed resources and sheep feeding strategies in each study district. Natural pasture from grazing land was the major feed source across all the studied districts and other feed resource includes crop residues, cultivated forage (Desho grass), home feed leftover, commercial by products (Frushica and Molasses) mineral (Bole) supplements. Studies by Edea, (2008) indicated that grazing on fallow land was the major feed resource for Bonga sheep rears during the rainy season. Similarly, Addis (2015), carried a review of feed resources for sheep in Ethiopia, and his findings were also comparable with present report. The details of grazing land and grazing systems are as under:

4.3.1. Type of Grazing Land

The result of type of grazing land is presented in tables 16. The farmers in all study sites use private, communal and both communal and private grazing land for sheep. Thus, 70.63%, 6.87% and 22.5% BRUs respondents use private, communal and both communal and private grazing land for their sheep respectively whereas, 66.87%, 8.13, and 22% of NBRU respondents use private, communal and both communal and private grazing respectively as shown in table. However, X^2 test showed that, there is no difference of grazing land usage trend among BRUs and NBRUs between and within (except Damot Pulasa) location. And none of farmers in Ezha and Arbegona site use Communal grazing land. In generally most of the farmers in all study site use private grazing land. During this study it was observed that farmer tether their sheep on the road and between border and they consider this as a supplementary grazing land (both

communal and private) especially in Ezha and Arbegona site. However, private farm land was the major grazing land for sheep in the study districts

The studies of Edea, (2008) and Metsafe, (2015) in Bonga area also showed that the majority of farmers were using private grazing land for grazing of sheep in Adiyo kaka (home track of Bonga sheep) area. They also reported that the area used for communal grazing is shrinking due to its use for cultivation for crops.

Table 15. Type of Grazing Land

Groups	Grazing Land	Alicho Worero	Ezha	Damot Pulasa	Arbegona	Over all Site
BRU Respondents	Private	67.5	67.5	67.5	80	70.63
	Communal	22.5	0	5	0	6.87
	Both Land	10	32.5	27.5	20	22.5
Non-BRU respondents	Private	70	80	32.5	85	66.87
	Communal	20	0	12.5	0	8.13
	Both Land	10	20	55	15	25
	X^2	**NS**	**NS**	******	**NS**	**NS**

*Note; NS = non-significant, ** = Significant at 0.01,*

4.3.2. Grazing System

The grazing system of Bonga cross lambs and local sheep practiced by BRU and NBRU respondent farmers is presented in table 17 and figure 2. The grazing system followed by BRU respondents for Bonga rams and its crossbreds showed that overall 10, 66.3 and 23.7 % of farmers practice free mixed grazing (with other Sheep), tethered grazing and free grazing alone (with other Sheep tethered), respectively. The BRU respondent farmers in Ezha (65%) Damot Pulasa (55%) and Arbegona (47.5%) practice tethered grazing of Bonga and its cross lambs whereas at Alicho Worero (87.5%) practice free grazing alone (with other Sheep tethered) for Bonga and its cross lambs.

The majority of NBRU respondents (55, and 77.5 %) practice tethered grazing in Alicho Worero and Ezha districts respectively, whereas in Arbegona districts free mixed grazing is

major practice (85 %) for local sheep. However, in Damot Pulasa district the grazing practice was uniformly 50 % under both systems.

However, the X^2 estimated showed significant differences in the grazing practice of Bonga crossbred and local lambs. The possible reason for majority of farmers tethering goats may be to avoid damage to the standing crops in and around private grazing land, which was was major source of grazing (Table 16).

Edea (2008) reported that majority (53 %) of farmers in Addiyo Kaka (Bonga) area practiced tethered grazing system and this is in agreement with present finding.

Table 16: Grazing System of Sheep

Respondent category	Type of sheep	Grazing System	Alicho Worero	Ezha	Damot Pulasa	Arbegona	Overall
BRU	Bonga and its crossbreds	Free Mixed grazing	0	2.5	22.5	15	10
		Tethered grazing	12.5	65	55	47.5	66.3
		Free grazing alone	87.5	32.5	22.5	37.5	23.7
NBRU	Local sheep	Free Mixed grazing	45	22.5	50	85	50.6
		Tethered grazing	55	77.5	50	15	49.4
		Free grazing alone	0	0	0	0	0

Figure 2: Bonga ram and its crosses grazing system in the study area

4.3.3. Supplementary Feeding Practice

The results on the supplementary feeding practiced by BRU and NBRU respondents across the four locations are presented in table 18. The overall survey results of BRU respondents showed that 19.38 % give supplementary feed for Bonga ram/ crossbreds separately, 46.25% no supplementary feed given and 34.38 % give supplementary feed without separating local sheep from Bonga ram/ crossbred sheep. The 62.5% NBRU rerspondents give supplementary feeding to local sheep which was higher than practiced for Bonga ram / crossbreds at all sites (Table 18). In Ezha (Gurage) site, results showed that none of the BRU respondents give supplementary feed to Bonga ram/ crossbreds alone. However, 20 % of BRU respondents reported that they give supplementary feed to Bonga ram/ crossbreds along with other local sheep maintained by these respondents. Edea et al., (2012) reported that Bonga sheep breed is one of known sheep breeds with high growth rate under grazing on natural pasture. The earlier study of Ermias (2008) also showed that there was little supplementary feeding practice for Dorper cross in Wolayta and Silte zones.

The BRU respondent farmers in the four locations showed that majority (70 and 72.5% in Alicho Worero and Damot Pulasa districts, respectively) of them give supplementary feeding to their sheep (Bonga crossbreds and local). The possible reason for supplementary feeding in these two districts may be to generate more income by sale of fast growing surplus stock at an early marketing age. The second important reason maybe education background of farmers in the study area was a good opportunity to learn farmers easily about sheep breeding and husbandry practices. In the other two districts (Ezha and Arbegona) the introduction of Bonga crossbreeding was only 1-2-year-old and thus farmers had less number of surplus stocks.

Table 17: Supplementary Feeding Practiced by Respondent Farmers

Supplementary feeding	Respodents	Districts				Overall	X^2 test
		Alicho Worero	Ezha	Damot Pulasa	Arbegona		
Yes	BRU	30	0	40	7.5	19.38	**
	NBRU	50	82.5	67.5	50	62.5	**
No	BRU	30	80	27.5	47.5	46.25	**
	NBRU	50	17.5	32.5	50	37.5	**
Yes (For all)	BRU	40	20	32.5	45	34.8	**

On the other hand, NBRU farmers reported that, due to low growth and high pre-weaning mortality rate of local sheep, they provide supplementary feeds to accelerate growth and reduce pre-weaning mortality.

4.3.4. Types of Supplementary Feed

The result on the type of supplementary feed along with source is presented in table 19. The results showed that Desho grass, Home leftover, Crop Residues and Frushica were common supplementary feed for sheep in all study districts. The Enset /Amicho was common supplementary feed in all districts except Ezha. Similarly, molasses is being fed as supplementary feed in Ezha district whereas sweet potato was used as supplementary feed in Damot Pulasa distinct. Bole, a mineral source, was commonly supplemented in Alicho Worero and Ezha districts.

The practice of grains (boiled bean, pea and maize), Crop residues, home left over, non-conventional feeds like Atella (left over) of Tella, Areke and Borde, and table salt supplementation for sheep fattening was reported by Edea (2008) and Dejene (2011) for Bonga sheep.

Table 18: Common Supplementary feeds and sources for sheep in the study site

Type of supplementary Feed	Source of supplement			
	Alicho Worero	Ezha	Damot Pulasa	Arbegona
Frushica	Purchased	Purchased	Purchased	Purchased
Enset/ Amicho	Farm Produce	Not Practice	Farm Produce	Farm Produce
Crop Residues	Farm Produce	Farm Produce	Farm Produce	Farm Produce
Molasses	Not Practice	Purchased	Not Practice	Not Practice
Sweet Potato	Not Practice	Not Practice	Farm Produce	Not Practice
Home leftover	Home	Home	Home	Home
Desho grass	Farm Produce	Farm Produce	Farm Produce	Farm Produce
Bole	Purchased	Purchased	Not Practice	Not Practice

4.3.5. Feed Shortage and Reasons for Feed Shortage

The survey result showed that there was feed shortage problem in all study sites (Figure 3). The results clearly revealed that more than 90 % respondents reported that feed shortage is the main problem for animal production in general and sheep production in particular in all areas studied.

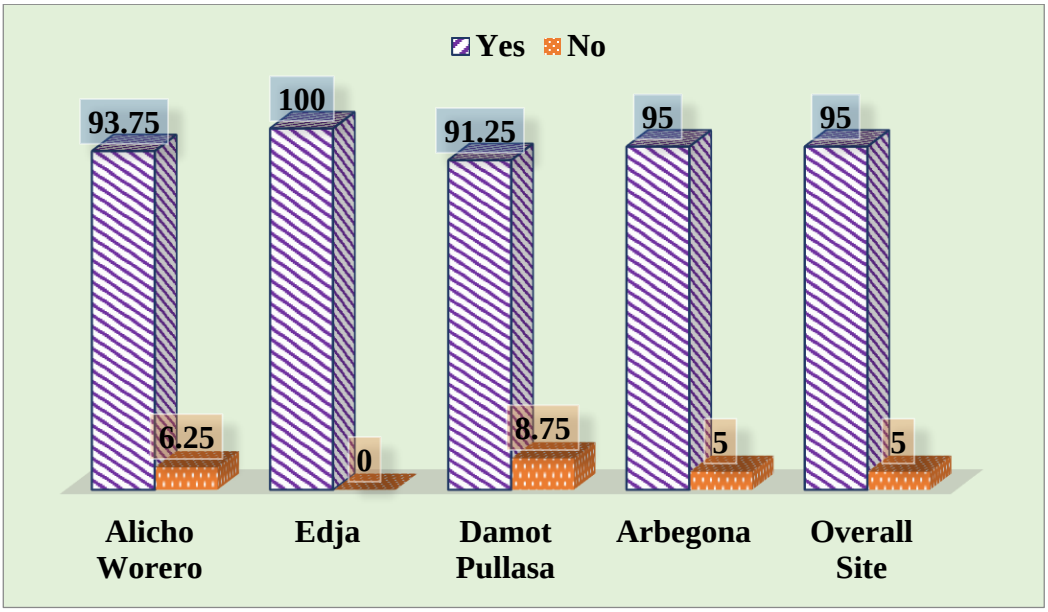


Figure 3. Feed Shortage problem

The results of respondent farmer's survey in the study area revealed three reasons as the cause for feed shortage and the same is presented in figure 4. The, the survey result (Overall) showed that 67.5, 7.5 and 25% of respondents reported that the main cause were drought, annual increasing in the area of crop cultivation and both increasing cultivation and drought, respectively.

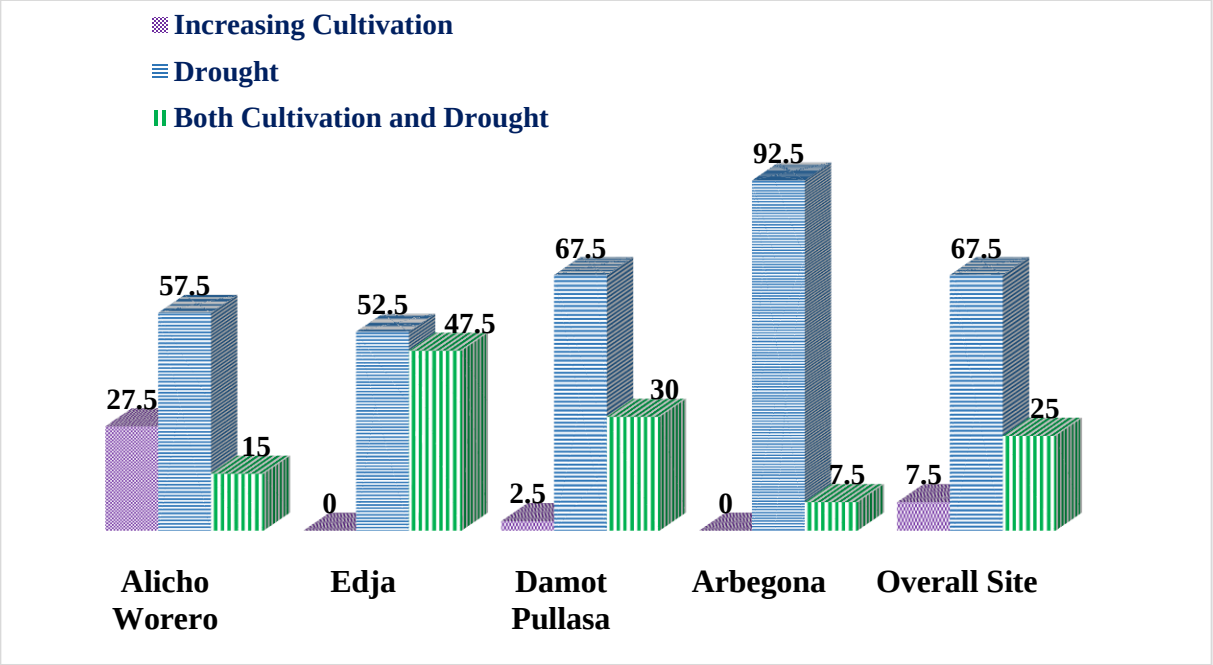


Figure 4. Reasons for feed shortage in the Study site (%)

However, in Ethiopia for last two years' climatic change was main headache in some parts of the country. Farmers in the study site correlated the causes with employees less youth focus on cultivation and last year climatic change in the country. However, there is on any report /result/ from respondents that Bonga sheep (ram and its cross) was died by feed shortage in the study site.

4.4. Watering Management

4.4.1. Sources of Water for sheep

The main water sources for sheep in the study area were presented in table 20**.** As shown in this table, that overall 68.8% and 81.6% of farmers used river and ponds as source of water for sheep during summer and dry season, respectively. In Damot Pulasa site farmer, has a pond donated by the NGO in the area, used pond water (33.75% in summer and 92.5 % in dry season) for watering sheep. The farmers in Arbegona and Damot Pulasa sites used rain water (27.55 and 15%, respectively) as watering source during summer season. Dejene (2010) reported that river was the main water source for sheep in Kafa area.

Table 19. Water sources for sheep in the study area (%)

Water Sources	Alicho Worero		Ezha		Damot Pulasa		Arbegona		Overall Site	
	Summer	Dry	Summer	Dry	Summer	Dry	Summer	Dry	Summer	Dry
River	83.75	31.3	95	6.3	23.75	5	72.5	7.5	68.8	12.5
Pond	8.75	66.3	2.5	85	33.75	92.5	0	82.5	11.3	81.6
Spring	3.75	0	2.5	0	0	0	0	0	1.6	0
River and Pond	3.75	2.4	0	8.7	27.5	2.5	0	10	7.8	5.9
Rain water	0	0	0	0	15	0	27.5	0	10.6	0

4.4.2. Shortage of Water for sheep and Reasons for Shortage

The results of the survey of respondent farmers in the study areas is presented in figure 5. The overall results revealed that 71.9% of respondents faced the problem of water shortage in the area. The results also showed that water shortage was acute in Ezha site (97.5 % respondents reported water shortage) followed by Alicho Worero (75 % respondents reported water shortage) whereas it was less acute in Damot Pulasa and Arbegona sites (58.75 and 56.25% respondents reported water shortage, respectively).

Moreover, the researcher was captured that farmers in all study site watering Bonga rams and its cross by previous trends and practices without separating local sheep. And also, Bonga cross adapted water shortage like local sheep in all study site. Thus, there were no any complains were reported during survey and Focus group discussion time about Bonga ram or its cross-adaptability problem of water shortage in all study sites.

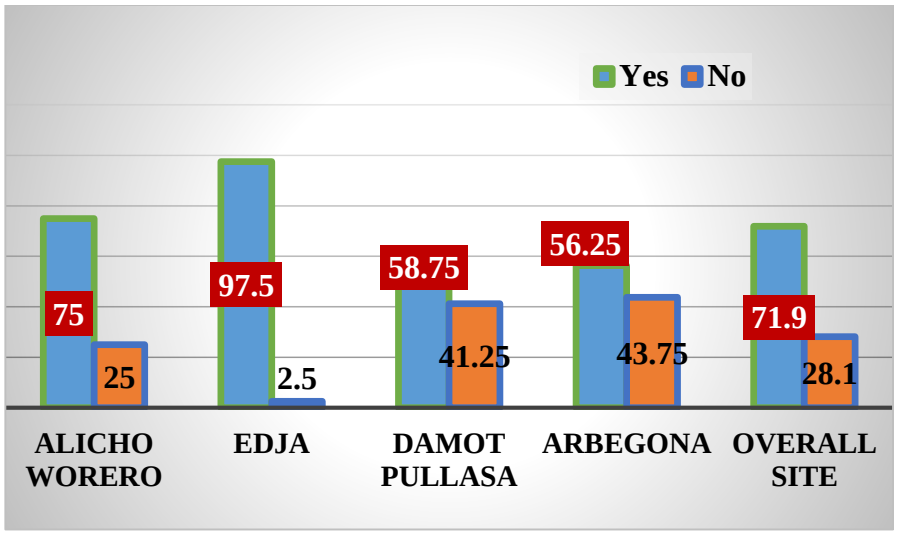


Figure 5. Shortage of Water in the study site

The survey results on the reasons of water shortage during dry season is shown in figure 6. The results revealed that drying of water sources during dry season was the main reason of shortage (60, 67.5, 55 and 46.25 % of respondents reported drying of water sources as main reason in Alicho Worero, Ezha, Damot Pulasa and Arbegona sites, respectively). A proportion of respondents (15, 30, 3.75 and 10 % respondents in Alicho Worero, Ezha, Damot Pulasa and Arbegona sites, respectively) reported that a greater distance of water source was another reason for water shortage during dry season. However, 25, 2.5, 41.25 and 43.75 % of respondents in Alicho Worero, Ezha, Damot Pulasa and Arbegona sites, respectively, reported that shortage of water during dry season was not a problem.

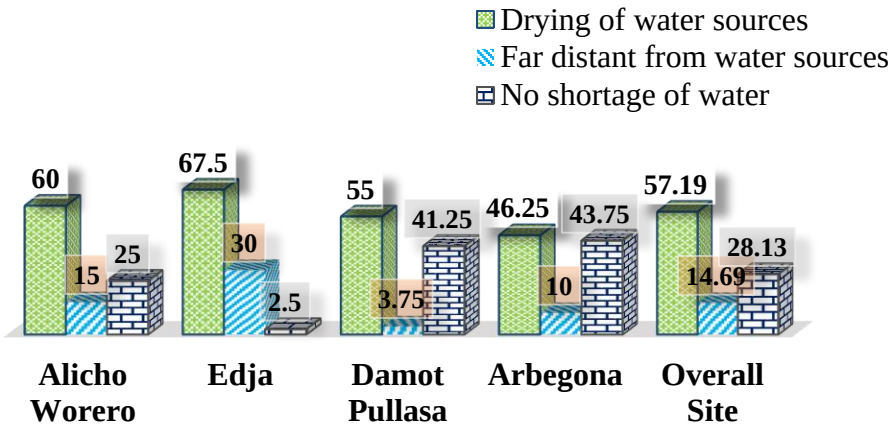


Figure 6. Reasons for Water Shortage during Dry Season in the Study Site

4.5. Breeding Practice and Objectives of farmers in the study Areas

4.5.1. Farmers Breeding objectives

The current breeding objectives and strategies in each study areas have been identified through FGD (**Appendix 11: Focus Group Discussion Results**). Farmers developed breeding objectives for enhancing sheep production and reproduction in the areas. The traits considered were growth rate, body size, coat color in all locations under present study. However, in Arbegona and Damot Pulasa districts twinning rate was also a breeding objective in addition to above objectives.

The findings w.r.t. body size and twining rate were in consonance with those of Merkena (2010), Haile et al (2011), and Gut et al. (2014) for breeding objectives of Afar, Bonga, Horro and Menz sheep. The possible reason for the above breeding objectives (Growth rate, body size, coat color) may be to generate more income by sale of surplus sheep marketed at an earlier age.

The FGD also showed that the breeding strategy of farmers in all study districts aimed to improve growth rate and reproductive performance of local sheep through crossing local ewes with Bonga Ram and improving income gain through sale of fast grower Bonga cross lambs at early ages. Thus, farmers followed terminal crossing breeding strategies through using Bonga rams as breeding sire and selected local and Bonga cross female sheep as breeding ewes, selling Bonga cross ram lambs before mating in the study areas currently. Moreover, farmers in Damot Pulasa exercise purchasing of best local breeding ewes from market for breeding purpose. Farmers have no complaints for present breeding strategies; rather they have interest to introduce Bonga ewe lambs in the areas.

Bereket et al (2017) reported that terminal sheep crossbreeding with Bonga sires as Best fit practice in SNNPRS, Ethiopia.

4.5.2. Farmers Selection Criteria:

The traditional selection criteria of farmers, based on FGD, in each study areas have been summarized in table 20. The study showed that body size, coat colour and mothering ability were the three traits considered for ewe selection in all the four districts. In Damot Pulasa and

Arbegona districts twining was considered as an important selection criterion However, polled (hornless) was also a characteristic considered in Arbegona district. The studies of Gameda (2010), Tadele (2010), Haile et.al. (2011) and Gutu et.al (2014) also showed that body size, coat color and mothering ability were selection criteria for Bonga sheep. However, polled as a selection criteria were in agreement with Metsafe et al (2017).

In case of breeding males, the common selection criteria were body condition, coat color in all the four districts but horn was only in three districts (Alicho Worero District is an exception) and tail in only one district (Damot Pulasa).

The possible reason for body size and/or body condition as selection criteria may be the association of this trait with growth rate as farmers were interested is fast growing lambs to generate more income.

Table 20: Farmers Selection Criteria

Traits	Districts			
	Alicho Worero	**Damot Pulasa**	**Ezha**	**Arbegona**
I. Breeding Females:				
Body Size	Good body size	Wide and Long body size with Wattle	Good body size	Big body size
Horn	No consideration	No consideration	No consideration	Polled (Hornless)
Coat colour	Red, Brown; and Dark Red with White head	Light Red with White	Dark and red with white head	Red
Mothering ability	Good milked	Wider udder	Good Mothering for her lambs	Wide udder size
Type of birth	No consideration	Twining	No consideration	Twining
II. Breeding Males:				
Body condition	Good body appearance, Big and long body size	Good body appearance, Big and long body size	Good body appearance, Big and long body size	Good body appearance, Big and long body size
Coat color	Red, Brown; and Dark Red with white head	Grey, Red, and White with Red mixture	Dark red, Red	Red
Horn	No consideration	Horned	Horned	Polled (Hornless)
Tail	No consideration	Long tail	No consideration	No consideration

4.5.3. Selection of Ewes for crossing with Bonga Rams:

The result of selection of local ewes for crossing with Bonga rams in the four study districts is presented in figure 9. These results showed that majority of BRU respondent farmers (85.0, 82.5 and 65.0 %) do not practice selection of local ewes for crossing with Bonga rams in Alicho Worero, Damot Pulasa and Arbegona districts, respectively. However, 56.7 % (More than 50 %) of BRU respondent farmers practice ewe selection for crossing with Bonga rams in Ezha district. Farmers select breeding ewes with large body size and good body condition. This finding is in agreement with the report of Haile et al. (2013) wherein large body size was used as selection criteria for Afar, Menz, Bonga and Horro ewes in Ethiopia. The possible reason for large body size of ewe as selection criteria may be attributed to the assumption of farmers that lambs born from good body condition and large body sized ewes have higher body weight. Another possible reason may be that Bonga rams being large sized, farmers assume that crossing these rams with small sized ewes may lead to reproductive problems.

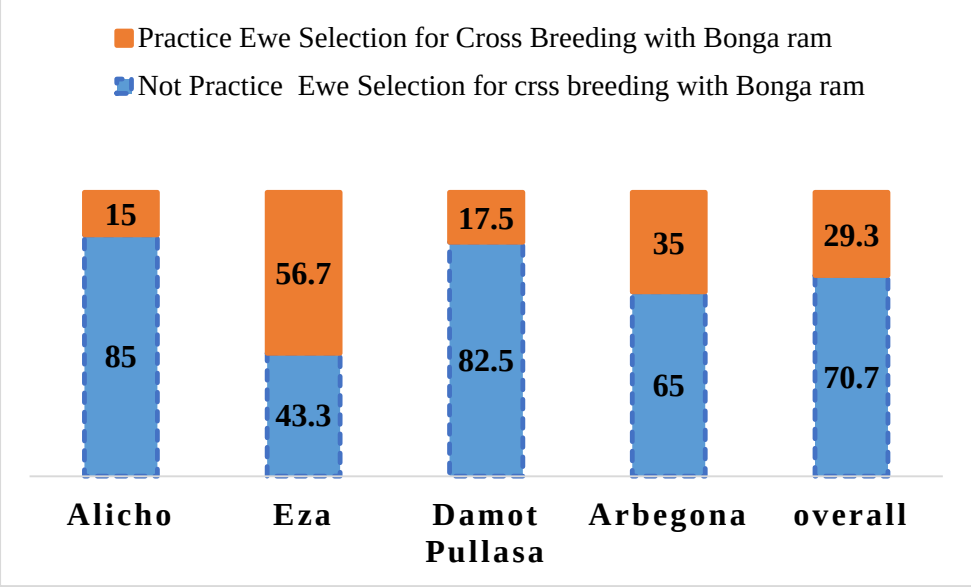


Figure 7: Selection of Ewes for Cross Breeding with Bonga ram

4.5.4. Bonga ram using Trends

The Bonga rams were introduced in these areas by either regional government or NGOs (Non-government Organization for sheep improvement about 2-3 years ago up to this study. The

wider scale distribution of improved Bonga ram in the region as was reported by Gutu et al. (20014). This introduction of Bonga rams facilitated optimum availability of breeding rams. The results on trends in Bonga ram keeping and using by BRU Farmers is presented in table 21.

Table 21: Trends of Bonga ram keeping and using by BRU Farmers

Location	Percentage of farmers (%)			
	Owning Bonga ram		Use another Breeding Ram (%)	
	Yes	No	Yes	No
Alicho Worero	0.0	100.0	7.5	92.5
Ezha	33.3	66.7	3.3	96.7
Damot Pulasa	60.0	40.0	25.0	75.0
Arbegona	30.0	70.0	17.5	82.5
Overall	30.7	69.3	14.0	86.0

Perusal of this table (Table 21) showed that 30.7 % (Overall) of respondent farmers own Bonga breed rams whereas 69.3% of respondent farmers do not own Bonga breed rams. The respondent farmers who do not own Bonga rams obtained the Bonga breeding rams from FTC and / or other community members. The FGD revealed different patterns of use of Bonga rams in the study areas.

In Alicho Worero site none of farmers own Bonga ram rather they were using Bonga rams from either FTC or "*Limat Budin"* (local sub-group). In Ezha District (Gurage zone), FGD and field observation revealed that farmers, who do not own Bonga rams, avail the facility of a Bonga ram by rotating from farmer to farmer and one farmer keep the ram for one month then shift to another farmer with the norm of good management and all farmers should use the ram freely. In Damot Pulasa site, the Bonga rams were maintained by model farmers and then other farmers (Not owning Bonga rams) use these ram for mating. The model farmer continues to maintain the Bonga ram and can dispose it off after prescribed age. However, in Arbegona area, the rams were maintained by model farmers. These rams were used by community member (A local group of farmers constituted for Bonga ram maintenance), who do not own Bonga ram, for mating in their flock free of cost but non-community members have to pay a nominal charge of 3 ET Birr / service. Haile et al (2014) reported that, the community decides how rams are

managed and how they are shared in the community-based breeding sites. However, lack of ram mating pedigree records might be difficult to manage inbreeding problem in the study areas

The results (Table 21) also showed that majority of BRU farmers (96.7, 92.5, 82.5, 75.0 % in Ezha, Alicho Worero, Arbegona and Damot Pulasa Districts, respectively) prefer only to mate their ewes with Bonga rams. However, a small proportion of BRU farmers (3.3, 7.5, 17.5, 25.0 % in Ezha, Alicho Worero, Arbegona and Damot Pulasa Districts, respectively) give first preference to mating ewes with Bonga ram but if it is not available, when ewe is in heat, they then use any other available ram, preferably local.

4.5.5. Culling of Local Rams after Introduction of Bonga Rams

The result of culling practices is presented in table 22. The overall results showed that 74.13 and 25.86 % of respondent farmers culled local rams through sale and castration, respectively. The district-wise results showed that farmers in three districts (75, 100 and 79.41% in Ezha, Damot Pulasa and Arbegona, respectively) culled local rams by sale whereas farmer in Alicho Worero culled local rams by castration (58.06 %). Similar trends were reported by Haile et al. (2014) and Metsafe (2015), who reported that farmers culled inferior breeding ram.

Table 22. Culling Practices of local ram after introduction of Bonga ram

Culling Practice	Location								Overall	
	Alicho Worero		Ezha		Damot Pulasa		Arbegona			
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Castration	18	58.06	5	25.0	0	0	7	20.58	30	25.86
By Sale	13	41.93	15	75	31	100	27	79.41	86	74.13

N number of respondent farmers possessing local breeding rams at the time of introduction of Bonga Rams.

4.5.6. Mating systems:

During FGD in all sites, it was revealed that before introduction of Bonga ram in their community, the famers were using breeding rams randomly (from rams existing in own flock/ neighbor flock / from ram brought in the market for sale). The results of the mating systems

followed by the respondent farmers before introduction of Bonga rams are presented in figure 7. Broadly the mating system followed was either controlled (Selected rams were used for mating by the farmers) or uncontrolled (Rams used for mating were not selected but depended on the rams available at mating time). The results (overall) showed 24 and 76 % of BRU respondents were exercising controlled and uncontrolled mating, respectively, before introduction of Bonga rams in their area. However, 25 and 75% of Non-BRU farmers in the area continue to exercise controlled and uncontrolled mating systems, respectively.

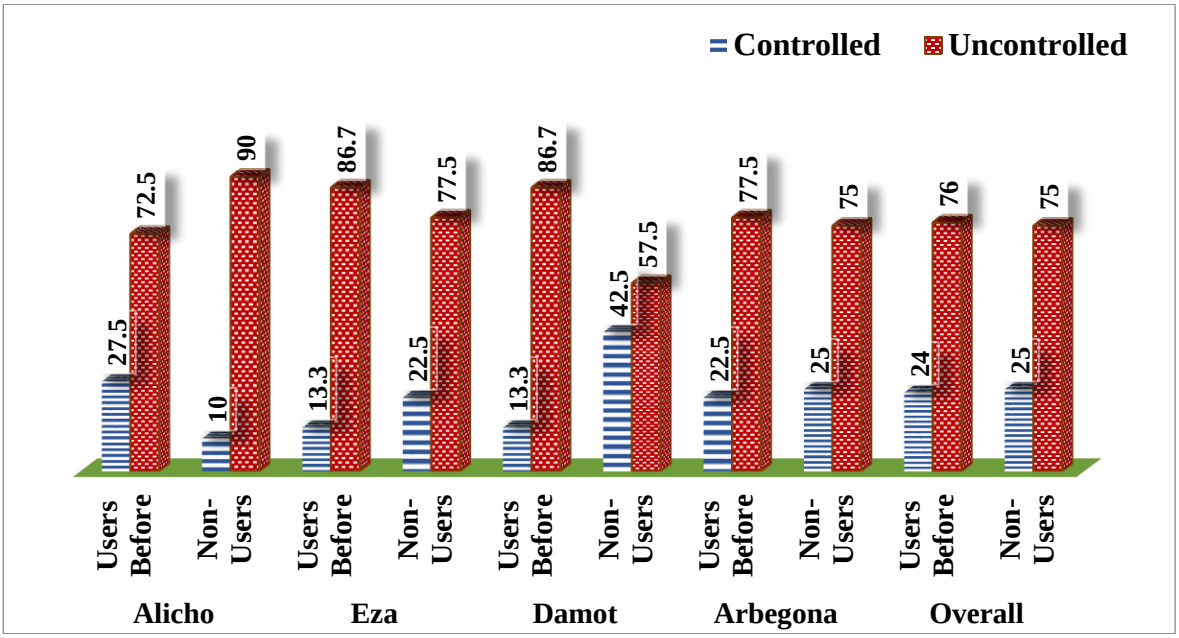


Figure 8: Mating system of sheep in the study area before introduction of Bonga rams

4.5.7. Mating season:

The results of mating season in the study areas are presented in table 23. The results (overall proportions) showed that wet season is the major mating season (77.3 and 60 % of ewes were mated in BRU and NBRU groups, respectively, during wet season) followed by dry season (16.0 and 28.8 % of ewes were mated in BRU and NBRU groups, respectively) and autumn (6.7 and 11.2 % of ewes were mated in BRU and NBRU groups, respectively). The respondents were justified that, availability of optimum feed sources for animals during wet season. However, in Ezha District breeding ewe commonly mate during dry season (52.5%). The X^2 test indicated that difference of ewes mating season between Bonga ram and Local ram was significant ($P<0.0001$). The results were in agreement with Solomon (2014).

Table 23: Ewe Mating Seasons

Location	Farmer Group	Wet Season	Dry Season	Autumn
Alicho Worero	BRU	85.0	12.5	2.5
	NBRU	57.5	30.0	12.5
Ezha	BRU	56.7	36.7	6.7
	NBRU	42.5	52.5	5.0
Damot Pulasa	BRU	62.5	20.0	17.5
	NBRU	55.0	27.5	17.5
Arbegona	BRU	100.0	0.0	0.0
	NBRU	85.0	5.0	10.0
Overall	BRU	77.3	16.0	6.7
	NBRU	60.0	28.8	11.2
	X^2 value	56.821/ < 0.0001		

4.5.8. Farmers Awareness for Inbreeding:

The farmers' perception about inbreeding problem were captured through FGD and structured questioners from BRU and from NBRU before introduction of Bonga rams in the area, the results are presented in figure 8. A majority of respondent farmers reported that they were not aware of problem of inbreeding (61.25, 70.0 and53.8 % in Alicho Worero, Ezha and Damot Pulasa, respectively) whereas 36.3 % (Small proportion) of farmers in Arbegona District were not aware of problem of inbreeding. Perusal of results further showed that among the farmers who were aware of problem of inbreeding, some farmers reported it to be critical problem (21.3, 10.0, 5.0 and 43.8 % in Alicho Worero, Ezha, Damot Pulasa and Arbegona, respectively) whereas some said that it can be managed (17.5, 20.0, 41.3 and 20.0 % in Alicho Worero, Ezha, Damot Pulasa and Arbegona, respectively). The current finding of farmer's knowledge was in agreement with Gutu et al (2014) that farmers in Bonga ram home track have better knowledge about inbreeding and measures to be taken to reduce it.

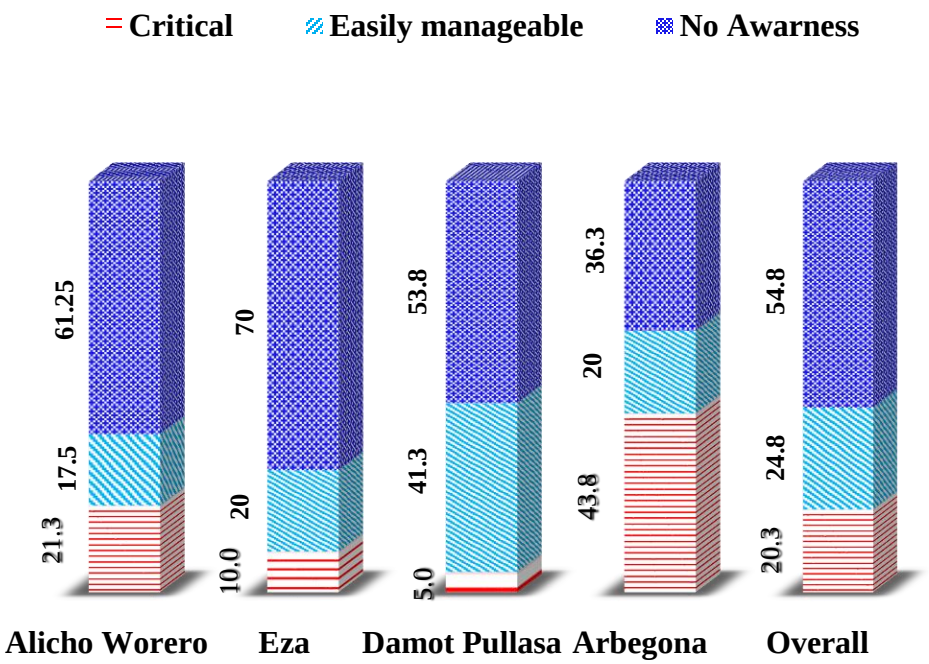


Figure 9: Farmers Awareness about Inbreeding before Bonga ram Introduction

The result of BRU farmers' perception about magnitude of inbreeding problem after introduction of Bonga rams is presented in table 23. The BRU farmers in Ezha and Arbegona districts reported that inbreeding has been avoided fully (100 %) whereas in Alicho Worero districts inbreeding was reported to have been either avoided (80.8 %) or there was no change (19.2 %). However, BRU farmers in Damot Pulasa districts opined that inbreeding has been avoided (47.5 %), minimized (5.0 %) and no change (47.5 %).

Table 24: BRU Farmers Awareness about Inbreeding After Bonga Ram Introduction

Inbreeding perception	Districts				Overall
	Alicho Worero	Ezha	D/Pulasa	Arbegona	
Avoided	80.8	100.0	47.5	100.0	75.5
Minimized	0.0	0.0	5.0	0.0	1.9
No change	19.2	0.0	47.5	0.0	22.6

4.6. Farmers Perception on Bonga ram

4.6.1. Source of Information about Improved Bonga Breed:

The results of the source of information about good attributes of Bonga type of sheep in the study area is presented in table 28. The overall results showed that 80.1, 5.63, 4.38 and 3.75 % of respondent farmers obtained information on good attributes of Bonga type sheep from Extension Experts / Public Meetings, friends, public media /FM and NGO, respectively. The district-wise results showed that 70, 85, 95 and 100 % of respondent farmers obtained information on the good attributes of Bonga rams from Extension Experts / Public Meetings in Damot Pulasa, Alicho Worero, Ezha and Arbegona districts, respectively. This indicated that extension experts play a great role in dissipation of knowledge (Good attributes of Bonga type sheep) among farmers.

Table 25. Source of information about the Performance of improved Bonga sheep

Source of Information	Location									
	Alicho Worero		Ezha		Damot Pulasa		Arbegona		Overall	
	N	%	N	%	N	%	N	%	N	%
Public Media/ FM	4	10	2	5	0	0	0	0	7	4.38
Extension & Public meeting	34	85	38	95	28	70	40	100	128	80.1
Friends	2	5	0	0	6	15	0	0	9	5.63
From NGO	0	0	0	0	6	15	0	0	6	3.75

4.6.2. Management of Bonga Rams and its Progeny

The results of special management given to Bonga rams are presented in figure 11. The overall results showed that no special management (71.25%) of Bonga rams and its progeny was carried by majority of respondent farmers in all districts. The present result was in disagreement with reports of Demeke et al. (2015) for Awassi Menz crossbred sheep in North Shoa. The respondent farmers reported that, since Bonga rams and its progeny easily adapted the

environment and consumed locally available feeds, so there was no need of special management. Similarly, the farmers in Bonga ram home track, give special feeding and managements for fattening sheep only whereas no such special management is given other Bonga rams used for mating. However, respondent farmers in Arbegona districts (45%) provided special management for Bonga rams and its progeny. This may be attributed to awareness of farmers.

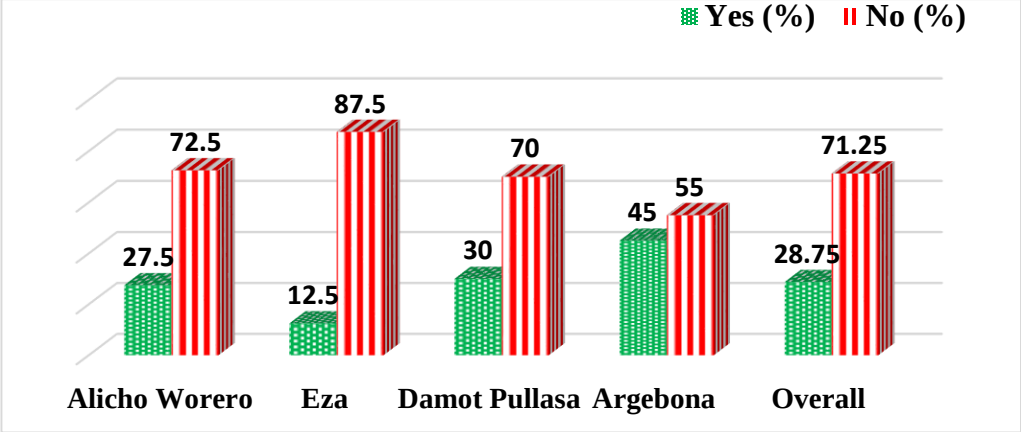


Figure 10. Special management for Bonga ram or its cross

4.6.3. Purpose of Keeping Bonga Crossbred Lambs

Farmers knew the useful features and select sheep of their choice and keep each category of them for specific purposes (breeding, home consumption, income, gifts etc.). The results of the purpose of keeping Bonga cross lambs is presented in table 26 and aAppendix 10: Purpose of Bonga sheep crossing. The overall results showed that 33% of respondent HH retain male crossbred lambs for breeding and the remainders (67 %) of HH sell these male crossbred lambs. However, 89 % of respondent HH retain female crossbred lambs for breeding/ production whereas a small proportion (11 %) of HH disposes of these lambs by sale. Th other purpose of keeping sheep (Appendix 10) were in agreement with the report of Edea, (2008) and Ermias, (2014).

Table 26. Purpose of Keeping Bonga Cross Lambs

Purpose Keeping	Sex	Alicho		Ezha		Damot Pulasa		Arbegona		Overall	
		N	%	N	%	N	%	N	%	N	%
Breeding / Production	Male	14	35	15	37.5	18	45	6	15	53	33
	Female	33	82.5	35	87.5	38	95	37	92.5	143	89
For Sale only	Male	26	65	25	62.5	22	55	34	85	107	67
	Female	7	17.5	5	12.5	2	5	3	7.5	17	11

4.6.4. Farmers Perception on Growth performance of Bonga Crossbred lambs

The farmer's perception about growth performance of Bonga crossbred and local lambs from both BRU and NBRU are presented in table 27. The overall interviewed BRU farmers (98%) in all districts were interested in new born crossbred lambs. They revealed that fast growing rate, attractive marketable coat color, large body size and early weaning characteristics and sale of these crossbred lambs at minimum age of 3- 4 months in local market against good price increased their interest to use Bonga ram. Similar results were reported by Kebede and Zekarias (2017), Demeke et al. (2015) and Mekuriaw et al (2012) for Bonga and Doyogena, Awassi Menz and Washera crossbreds, respectively. Farmers in Ethiopia showed keen interest to adopt breeding programs when they realize the higher benefits from such programs (Getachew et al., 2016).

Comparatively, among interviewed overall NBRU farmers in all districts, 58.1% respondents reported that new borne local lambs do not show any change in body size and growth rate. Perusal of results further showed, 10.6% reported that body size of new borne local lambs has shown decreasing trend.

Table 27: Farmers Perception on growth performance of Crossbreds and Local lamb

Location	Improvement in Body Size				
	BRU For Crossbred Lambs		NBRU for local Lambs		
	Yes (%)	No (%)	Yes (%)	No (%)	Decrease in body size (%)
Alicho Worero	97.5	2.5	27.5	72.5	0
Ezha	100	0	12.5	75	12.5
Damot Pulasa	95	5	60	30	10
Arbegona	100	0	25	55	20
Overall	98	2	31.3	58.1	10.6

4.6.5. Ranking of Traits by Farmers in Bonga Rams and Crossbreds

The result of farmer's preference of traits in Bonga and its crossbred rams were ranked and is presented in table 28. The results showed that among physical traits the respondent farmers uniformly ranked size, appearance and coat color as first, second and third rank (Preference) for preferring Bonga and its Crossbred Rams in all the three districts. However, among performance traits, similar uniformity observed for growth rate which was ranked as number one trait (0.48, 0.50, 0.48 and 0.48 in Alicho Worero, Ezha, Damot Pulasa and Arbegona districts, respectively.) for preferring Bonga and its Crossbred Rams in all the three districts. The traits ranked second and third were different in the four districts. The d feed adaptability ranked as second (0.18), prolificacy (and libido) and diseases tolerance ranked as third (0.17) in Alicho Worero; feed adaptability as second (0.21) and disease tolerance as third (0.17) in Ezha; feed adaptability as second (0.22) and disease tolerance third (0.16) in Damot Pulasa; and prolificacy as second (0.22) and feed adaptability as third (0.20) in Arbegona districts, respectively.

During focus group discussion in Damot Pulasa district it was reported that farmers prefer Bonga rams over the available Doyogena (Adilo) rams. These rams have been introduced from Doyogena Community Based Breeding Cooperatives operating in Doyogena district of

Table 28. Traits that farmers appreciate/like about Bonga ram and its crosses

Physical traits	Alicho Worero					Ezha					Damot Pulasa					Arbegona					Overall				
	Rank			Total	Index	Rank			Total	Index	Rank			Total	Index	Rank			Total	Index	Rank			Total	Index
	1	2	3			1	2	3			1	2	3			1	2	3			1	2	3		
Size	27	10	3	104	0.43	23	17	0	103	0.43	28	11	1	107	0.45	32	6	2	110	0.46	110	44	6	424	0.44
Appearance	10	24	0	78	0.33	17	23	0	97	0.4	11	22	6	83	0.35	6	31	3	83	0.35	44	100	9	341	0.36
Coat Color	3	2	17	30	0.13	0	0	21	21	0.09	1	4	21	32	0.13	2	1	24	32	0.13	6	7	83	115	0.12
Hornless	0	4	13	21	0.09	0	0	14	14	0.06	0	0	7	7	0.03	0	0	9	9	0.04	0	4	43	51	0.05
Temperament	0	0	7	7	0.03	0	0	5	5	0.02	0	3	5	11	0.05	0	2	2	6	0.03	0	5	19	29	0.03
Performance traits																									
Disease tolerance	0	13	15	41	0.17	0	14	12	40	0.17	0	7	24	38	0.16	0	6	12	24	0.10	0	40	63	143	0.15
Feed Adaptability	2	12	7	37	0.18	0	11	12	34	0.21	2	17	5	45	0.22	0	15	5	35	0.20	4	55	29	151	0.19
Growth Rate	38	0	2	116	0.48	40	0	0	120	0.50	38	0	0	114	0.48	36	4	0	116	0.48	152	4	2	466	0.49
Prolificacy and Libido	0	15	11	41	0.17	0	10	9	29	0.12	0	12	9	33	0.14	4	11	19	53	0.22	4	48	48	156	0.17

SNNP; due to Bonga ram's temperament, prolificacy and fast growth rate of its crossbred lambs. The Doyogena rams were reported to be aggressive. Kebede and Zekarias (2017) also reported that aggressive behavior of Doyogena ram is not preferred by farmer.

4.6.6. Perception of NBRU Farmers about Bonga Rams

The non-Bonga ran user farmers' perception about Bonga ram including its crossbred progeny is presented in table 29. The overall results revealed that majority (66.9 %) of NBRU respondent farmers had seen the performance of both Bonga rams as well as their crossbred progeny. Similarly, majority (81.87 5) of NBRU respondent farmers had interest to use Bonga rams for mating with their ewes. The discussion with these respondent farmers showed that they were not aware about the good attributes of Bonga rams at the time of introduction of Bonga rams in their area. This indicated that these farmers were ready to use Bonga rams in future and thus more number of Bonga rams may be needed to meet the increasing demand.

Table 29: Perception of Bonga Rams by NBRU Farmers

	Districts								**Overall**	
	Alicho Worero		**Ezha**		**Damot Pulasa**		**Arbegona**			
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
(I) NBRU seen Bonga ram crossbred progeny:										
Yes		60		70		62.5		75		66.9
No		40		340		37.5		25		33.1
(II) NBRU had interest in using Bonga rams:										
Yes		75		75		85		90		81.87
No		25		25		15		10		18.13

The results on the perception of NBRU respondent farmers regarding faster growth performance of Bonga ram crossbred progeny is presented in figure 11. The results showed that higher proportion of (64.3, 79, 84 and 93.3 % in Ezha, Alicho Worero, Damot Pulasa and Arbegona, respectively) NBRU respondents strongly agreed that growth performance of Bonga ram progenies was better than their lambs (Local or other crosses). The reminder proportion (35.7, 21,16 and 6.7 % in Ezha, Alicho Worero, Damot Pulasa and Arbegona, respectively) of

NBRU respondents agreed that growth performance of Bonga ram progenies was better than their lambs (Local or other crosses).

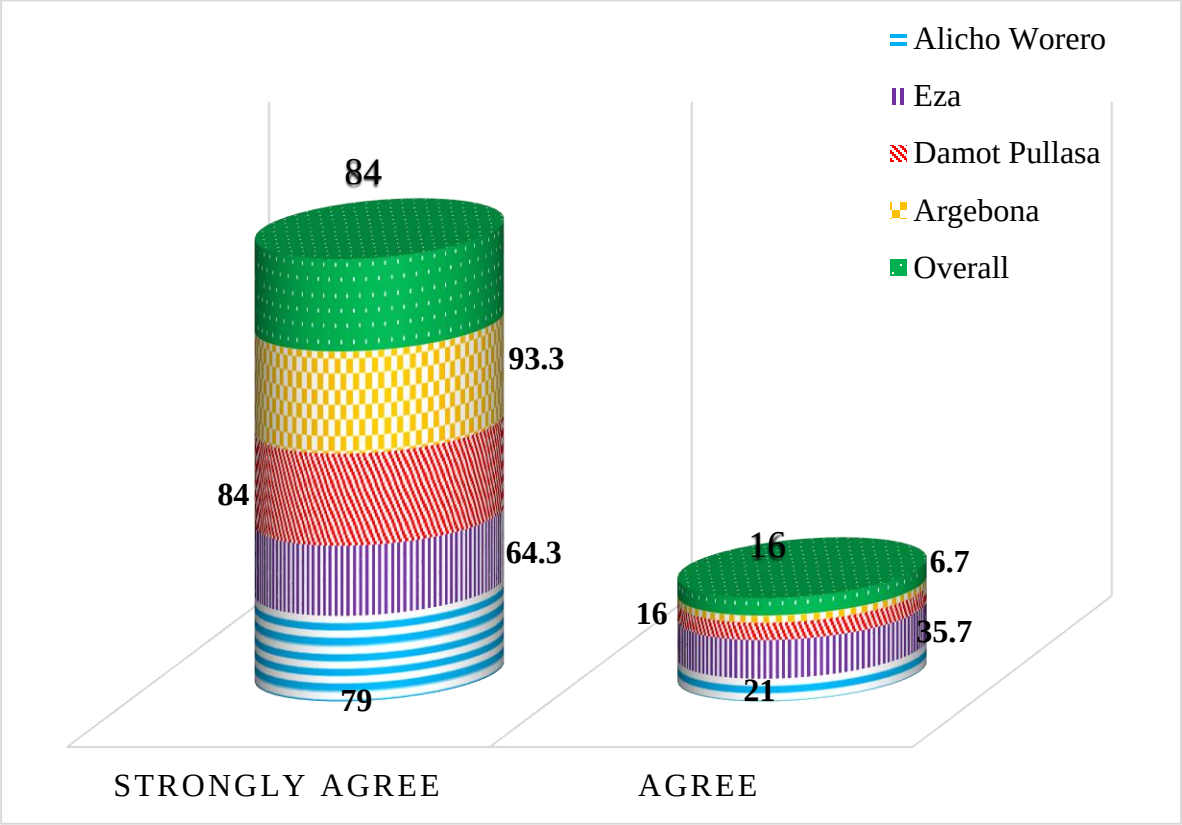


Figure 11. Perception of NBRU Farmers about growth performance of Bonga cross progeny

The FGD revealed that generally farmers in all study areas were satisfied by introduction of Bonga sheep cross breeding strategy in their areas due to improvement of their sheep flock after crossing with Bonga sheep. The FGD and documents of District Livestock and Fisheries Office indicated that in Ezha district (Gurage zone) Dorper sheep (8 rams) were introduced during 2003 E.C (2010 AD) and distributed to two villages by world vision (An NGO). However, this introduction was not successful due lack of preference by the farmers and thus has been discontinued.

4.7. Reproductive performance

The results of reproductive performance, based on interviews of BRU respondents, of sheep are presented in table 30.

4.7.1. Age at First Service (AFS):

Most of the findings revealed that age at first mating for both sexes is not fixed and sheep are left to nature to reproduce. The effect of genetic group, location and breed by location interaction on AFL was highly significant (P<0.001). The AFS for Bonga crosses were lower than local sheep in all study sites and the difference was highly significant (P<0.001). The present findings of AFS for crossbred in both sexes was lower than the reports of Edea (2008) in Bonga breed.

The AFS was estimated to be 9.12±2.3, 7.7±1.5, 7.4±1.4 and 6.8±1.4 months in Alicho Worero, Ezha, Damot Pulasa and Arbegona districts in the present study. The pair wise comparison of means showed that difference in AFS of all pairs was significant except Ezha and Damot Pulasa pair. The lowest AFS was observed in Arbegona whereas highest AFS was observed in Alicho Worero districts.

The results showed that findings of AFS in crossbred males in this study area was 6.2±0.6, 6.2±1.1, 5.8±0.3, 5.6±0.8 and 5.9±0.8 months for Alicho Worero, Ezha, Damot Pulasa, Arbegona and overall, respectively. Similarly, the AFS in local males was 10.3±1.5, 8.2±1.1, 8.0±1.2, 7.8±1.3 and 8.6±1.6 months for Alicho Worero, Ezha, Damot Pulasa, Arbegona and overall, respectively. The results of AFS in crossbred females was 6.6±0.7, 6.5±1.1, 6.2±0.6, 6.1±0.6 and 6.3±0.8 months for Alicho Worero, Ezha, Damot Pulasa, Arbegona and overall, respectively. Similarly, the AFS in local females was 9.8±1.6, 8.4±1.2, 7.8±1.2, 8.5±1.3 and 8.6±1.5 months for Alicho Worero, Ezha, Damot Pulasa, Arbegona and overall, respectively. The results showed that lowest AFS in both local and crossbred lambs was observed in Arbegona district (7.8±1.3 and 5.6±0.8 months in local and Bonga ram crossbreds, respectively) whereas the highest AFS was found among lambs of Alicho Worero (10.3±1.5 months) for local lambs and Alicho Worero (6.2±0.6), Ezha (6.2±0.6) for crossbred lambs.

The finding of breed effect was associated with fast growth and early weaning of genetic groups. Different scholars agree that, genetic as well as environmental factors, and the

interaction between these, clearly affect sexual development, i.e. earlier attainment of puberty. Besides, Younis, et al., (1978) reported that, body weight has more influence on puberty than the age. Farmers also reported that AFS in single born male lambs was lower than multiple birth lambs. This may be attributed to higher body weight of single birth lambs. The location difference may be attributed to management practice of farmers in respective areas. In general, respondent farmers reported that, after introduction of Bonga ram in the area AFS for both sexes were reduced (Appendix 11)

4.7.2. Age at First Lambing (AFL):

AFL is positively correlated with AFS (puberty). The effect of breed, location and genetic group by location interaction on AFL was significant ($P<0.001$, $P<0.01$ and $P<0.05$ respectively). The significant effect of genetic group effect was in agreement with Ermias, (2014) and Amelmal, (2011). The results showed that Bonga crossbreds lambed at an earlier age (11.5±0.9 months) compared to local (13.9±1.6 months) ewes. This may possibly be due to the heterosis between two genetic groups.

The AFL for Bonga crossbreds was 11.6±0.8, 11.5±1.2, 11.7±0.7 and 11.4±0.7 months for Alicho Worero, Ezha, Damot Pulasa and Arbegona, respectively. Similarly, the AFL for local was 14.8±1.9, 13.7±1.1, 13.4±1.4 and 13.5±1.3months for Alicho Worero, Ezha, Damot Pulasa and Arbegona, respectively. The AFL obtained in the present study revealed that, Bonga crosses had shorter AFL than Local sheep by 2.5-months of age (Overall). The pair-wise comparisons of location X genetic group (Breed) interactions showed that AFL of Bonga crossbred and local lambs were significantly ($P<0.001$) different in all locations. The AFL of local females at Alicho Worero (14.8±1.9 months) was highest indicating that these ewes lambed at very old age. This AFL at Alicho Worero location was significantly different from all other values of AFL for the other three locations (Both for Crossbred and local females). The AFL of crossbred females showed non-significant difference among themselves at the four locations. The possible reason for late AFL among local females compared to crossbred females may be due to the fast growth among crossbreds. The overall results of AFL for Bonga crosses indicated that life time lamb crop could be increased in the all study areas.

4.7.3. Lambing Interval (LI)

The shorter lambing interval gives better opportunity to increase lifetime productivity of ewes by increasing the number of lamb crop. The effect of breed and location on LI was significant ($P<0.001$) whereas effect of interaction between genetic group & location was non- significant ($P>0.05$). The LI was 7.5±0.7and 8.5±1.1 months in the crossbred and local ewes, respectively, showing that crossbred have shorter lambing interval indicating three lambing in two years could be harvested in an efficient way. However, shorter lambing intervals for Bonga crosses were reported by Bonga ram user farmers in all districts (Appendix 11)

The overall lambing interval of ewes found in this study was 8.3±1.1 month. The result was comparable with Getachew (2008), Edea (2008) and Metsafe (2015), and Marufa et al. (2017) for Menz, Bonga and Abera sheep, respectively.

4.7.4. Average Litter Size (ALS):

The reproductive performance in terms of average liter size (ALS) and type of birth percentage (single, twin, triplet and Quadruplet) from data recorded in monitoring study is presented in table 30 and 31, respectively. The ANOVA showed that the effect of breed, location and interaction between genetic group x location was significant. The overall average litter size obtained (1.62±0.5) ranged within the ALS reported for tropical sheep (Girma, 2008) and also was in agreement with reports of Gutu et al. (2014) for Bonga community-based breeding site.

The ALS was 1.75±0.3 and 1.46±0.5 for crossbred and local females, respectively, showing a higher litter size among crossbreds. The finding of current ALS for Bonga crosses was higher than that reported by Marufa et al. (2017), Deribe (2009) and Edea (2008). However, the present findings for local sheep were lower than Marufa et al. (2017) and Deribe, 2009; comparable with Getahun (2008) and Edea (2008).

The significant location effect may be attributed to differences in the ewe management practice across locations. The other findings revealed that, management system was a major source of variation in litter size (Mekuriaw et al., 2013).

Table 30: Reproductive Performance of sheep

Effects		Parameters				
		Males	Female			
		AFS (Months)	AFS (Months)	AFL (Months)	LI (Months)	ALS (LSM±SE)
Overall		7.82±1.8	7.9±1.7	13.17±1.8	8.3±1.1	1.62±0.5
Genetic Group (Breed)		**	**	**	**	**
	Local	8.6±1.6	8.6±1.5	13.9±1.6	8.5±1.1	1.46±0.5
	Bonga Cross	5.9±0.8	6.3±0.8	11.5±0.9	7.5±0.7	1.75±0.3
Location		**	**	*	**	**
	Alicho Worero	9.12±2.3^{a}	8.9±2.03^{a}	13.9±2.2^{a}	8.6±1.03^{a}	1.7±.0.05^{a}
	Ezha	7.7±1.5^{b}	7.9±1.4^{b}	13.09±1.5^{b}	8.3±1.2^{b}	1.7±0.04^{a}
	Damot Pulasa	7.4±1.4^{b}	7.4±1.3^{c}	12.9±1.4^{b}	8.3±1.1^{b}	1.5±0.05^{b}
	Arbegona	6.8±1.4^{c}	7.5±1.6^{bc}	12.6±1.6^{c}	8±1.08^{c}	1.4±0.05^{c}
Location X Breed		**	**	*	NS	*
Alicho Worero	Local	10.3±1.5^{a}	9.8±1.6^{a}	14.8±1.9^{a}	8.9±0.9	1.7±0.06^{b}
	Bonga Cross	6.2±0.6^{c}	6.6±0.7^{c}	11.6±0.8^{c}	7.7±0.5	1.9±0.07^{a}
Ezha	Local	8.2±1.1^{b}	8.4±1.2^{b}	13.7±1.1^{b}	8.2±1.2	1.6±0.06^{b}
	Bonga Cross	6.2±1.1^{c}	6.5±1.1^{c}	11.5±1.2^{c}	NA	1.8±0.06^{ac}
Damot Pulasa	Local	8.0±1.2^{b}	7.8±1.2^{b}	13.4±1.4^{b}	8.3±1.1	1.4±0.08^{b}
	Bonga Cross	5.8±0.3^{d}	6.2±0.6^{c}	11.7±0.7^{c}	NA	1.7±0.06^{ac}
Arbegona	Local	7.8±1.3^{b}	8.5±1.3^{b}	13.5±1.3^{b}	8.5±0.9	1.2±0.07^{d}
	Bonga Cross	5.6±0.8^{d}	6.1±0.6^{c}	11.4±0.7^{c}	7.3±0.8	1.6±0.06^{c}

The overall results of type birth percentage (Based on monitoring study) for ewes mated by Bonga and local ram is presented in table 31. The results revealed that, the overall twining rate of Bonga crossbreds (51.7%) was much higher than local sheep (30.5%) in this study. Twining rate of Bonga crosses was higher than the report of Edea, (2008) and lower than the report of Gutu et al. (2014), both, based on survey of respondent farmers for Bonga and Horro CBB sites. The Quadruplet type of birth was recorded at Alicho Worero only whereas triplet type of births was recorded in all districts except Arbegona district.

However, higher twining rate was observed in Ezha and Arbegona districts. The high litter size is economically important trait to improve sheep flock productivity.

Table 31: Birth type of sheep

(Based on monitoring study)

Location	Genetic Group	Type of Birth Percentage (%)			
		S	T	Trip	QP
Alicho Worero	Bonga Cross	46.0	43.6	10.0	2.0
	Local	56.4	42.0	0.0	0.0
Ezha	Bonga Cross	35.7	58.9	5.4	0.0
	Local	56.6	43.4	0.0	0.0
Arbegona	Bonga Cross	40.4	59.6	0.0	0.0
	Local	85.4	14.6	0.0	0.0
Damot Pulasa	Bonga Cross	54.8	42.9	2.4	0.0
	Local	81.1	18.9	0.0	0.0
Overall	Bonga Cross	43.4	51.7	4.4	0.5
	Local	69.5	30.5	0.0	0.0

Note: S = Single birth; T = Twin Birth; Trip= Triplet; and QP = Quadruplet

The respondent BRU farmers, based on interview (Figure 12), reported that twining rate increased after crossing local sheep with Bonga rams. Compared to this majority of NBRU respondents, based on interview (Figure 13), reported that breeding ewes give single birth (31.3%), twin birth (17.5 to 44.4%, higher values were not common), and rarely triple birth (6.9%). However triple type of birth was not reported by any of NBRU in Arbegona district.

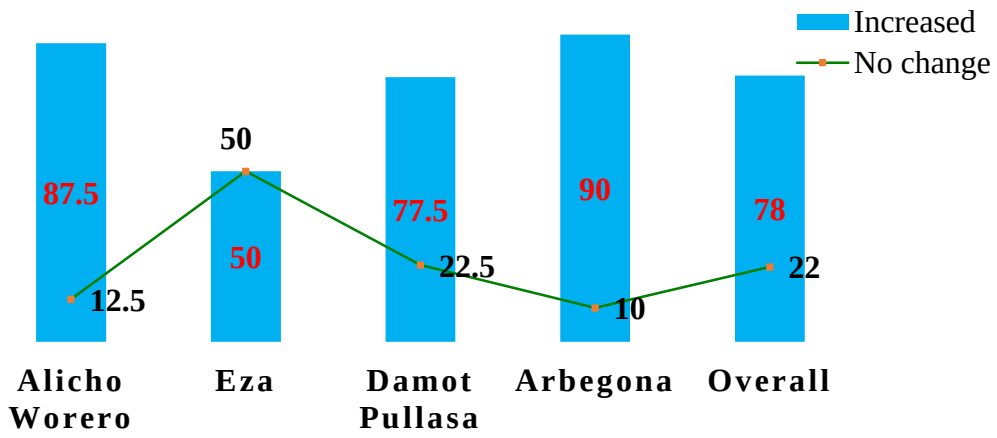


Figure 12: Occurrence of Twining after Use of Bonga Rams

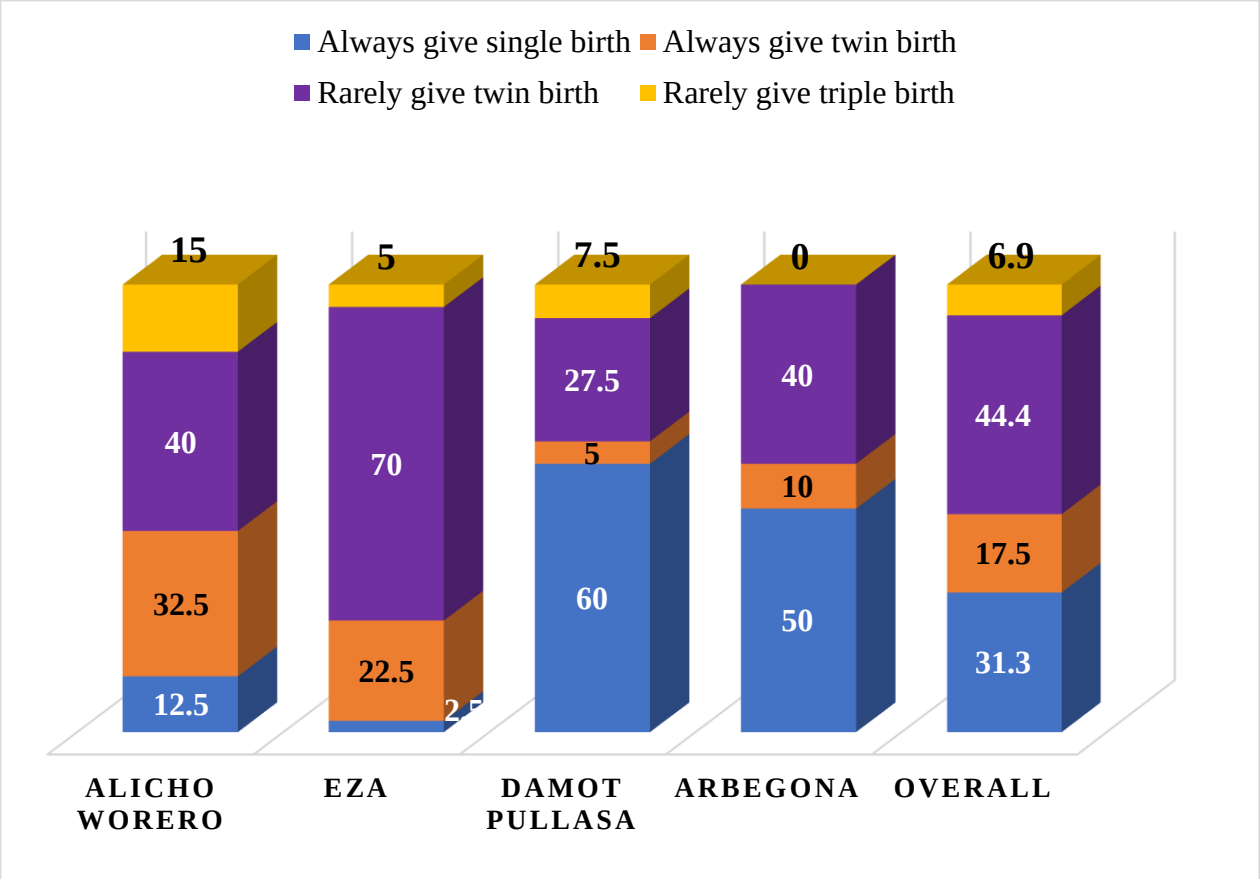


Figure 13: Prolificacy (Based on type of births) of Ewes of NBRU respondent Farmers

4.8. Growth Performance of Lambs under Monitoring Study Sites

4.8.1. Pre-weaning Body weights and Body Weight Gain

The least square ANOVA for pre-weaning body weights and body weight gain is presented in (**Appendix 7**: **ANNOVA for Pre-weaning body weights(kg) and Weight Gain (**gm), Whereas the results on least square means for pre-weaning body weights and body weight gain is presented in tables 32A and 33A.

A. Birth Weight:

The effect of location, parity, type of birth and sex was significant (P<0.05) whereas the effect of genetic group (Breed) was highly significant (P<0.001) on birth weight (Table 31A). However, the effect of season of birth and location x breed interaction were found to be non-significant (Table 33A). The overall least square mean of birth weight was 2.58 kg and the coefficient of variation (CV) was 19.61% in the present study.

The least mean squares (LSM ± SE) of birth weight for four locations were 2.62±0.2, 2.66±0.2, 2.49±0.2 and 2.74±0.2 kg in Alicho Worero, Ezha, Damot Pulasa and Arbegona respectively. The pair wise comparison of these means showed that birth weight of Damot Pulasa and Arbegona locations were significantly different whereas all other pair differences were non-significant.

The least mean squares (LSM ± SE) of birth weight for Bonga sired crossbreds and local lambs were 2.9±0.2 and 2.4±0.2 kg, respectively. The difference in the two genetic groups was highly significant (P<0.001) in which the Bonga cross lambs had heavier weight than the local lambs. The current birth weight for Bonga cross in this study, was higher than Deribe et al. (2017) for Dorper cross lambs under semi-intensive management (2.55 ± 0.63kg), Ermias (2014) for Dorper cross lambs in Wolayita and Siltie (2.25kg), and Mekuriaw et al. (2013) for Washera and Farta crossbreed lambs under farmer's management system (2.59±0.01kg). However, current birth weight was lower than pure Bonga sheep breed (3.42 kg and 3.6 kg) reported by Haile et al. (2014) and Metsafe (2015), respectively, in the breed home track.

The birth weight of the local sheep was comparable with previously reported (2.36 kg) for eastern Amhara (Lakew et al., 2014), western Ethiopia indigenous sheep (2.45±0.40kg)

(Berhanu and Aynalem, 2009) and Farta (2.50±0.02 kg). However current birth weight was lower than Washera (2.61±0.0 kg) reported by Mekuriaw et al., (2013).

The least square means of birth weight for six parities were 2.3±0.2, 2.5±0.1, 2.5±0.1, 2.4±0.1, 2.6±0.2 and 2.8±0.2 kg for 1 to 6 parities, respectively. The pair wise comparisons showed that LSM ± SE of 1-6, 3-6 and 4-6 parities were significant ($P<0.05$). The highest birth weight was observed in 6th parties and the differences in parity due to ewe age. The same effects for Dorper cross lambs was reported by Deribe et al. (2017) but non-significant effect of parity was observed in Horro and Menz sheep (Aynalem, et al.,2014).

The least square means of birth weight for single, twin, triplet and quadruplet lambs were 2.8±0.1, 2.6±0.1, 2.6±0.1 and 2.6±0.5, respectively. The difference in the LSM ± SE between single and twin lambs was significant ($P<0.05$). The same results have been reported by Deribe et al. (2017), Lakew et al. (2014) and Berhanu and Aynalem (2009) whereas non-significant effect of type of birth on birth weight was reported by Ermias, (2014) in crossbreds (Dorper x Local sheep) in Wolayta and Silte area.

The least square means of birth weight for male and female lambs was 2.7±0.2 and 2.6±0.2 kg, respectively, and these differences were significant. Similar findings have been reported by Deribe et al. (2017), Aynalem et al. (2014) for Bonga, Lakew et al. (2014) and Berhanu and Aynalem (2009) for other sheep types. In contrary to this non-significant effect of sex of lamb on birth weight was reported by Ermias (2014), Getahun (2008) for Adilo and Hassen et al. (2002).

Lamb borne with heavier weight at birth will have high weaning weight and relatively low lamb mortality. Lamb borne with Medium size at birth reduces loss of productivity. However, the increase in birth weight is also influenced by prenatal factors and thus this may not reflect true genetic merit. Similarly, the survey study conducted showed that 18.8 and 16.2% BRU and NBRU respondent farmers, respectively, reported Dystocia problem in the areas (Table 41). A very high improvement in birth weight may possibly lead to increase in Dystocia rates.

B. Two Month Body Weight:

The effect of location, genetic group (Breed), season of birth, parity, type of birth and location X genetic group (Breed) interaction on two-month body weight (Table 32A and Table 33A)

were highly significant (P<0.001) whereas the effect of sex birth was found to be non-significant (Table 32A). The overall least square mean of two-month body weight was 7.57 kg and the coefficient of variation (CV) was 21.27% in the present study.

The least mean squares (LSM ± SE) of two-month body weight for four locations were 6.7±0.5, 6.4±0.5, 7.1±0.5 and 7±0.5 kg in Alicho Worero, Ezha, Damot Pulasa and Arbegona respectively. The six-parity wise comparison of these means showed that two-month body weight of Damot Pulasa – Ezha and Ezha - Arbegona pairs means were significantly different whereas all other pair differences were non-significant.

The least mean squares (LSM ± SE) of two-month body weight for Bonga sired crossbreds and local lambs were 8±0.5 and 5.5±0.5 kg, respectively. The difference in the two genetic groups was significant (P<0.001). The crossbred lambs weighed heavier than the local sheep lambs at all ages. The current result of two-month weight of Bonga cross is 2.5kg higher than local sheep in the study areas. Lakew et al. (2014) also reported that crossbred lambs weighed heavier at two months of age than Washera and Farta types. The result obtained for Boga cross was comparable with reported two-month weight (8.72±0.18 kg) reported by Deribe et al. (2017) and 8.85 kg reported by Hassen et al. (2002). However, current two-month weight were lower than 10.9±2.54 kg reported by Berhanu and Aynalem (2009). The current results w.r.t. to local sheep were lower than that reported by Hassen et al. (2002). The improvement in two months' weight is advantageous because improving this trait will be reflected in increasing the weaning weight and thus lambs could be weaned at an earlier age.

The least square means of two-month body weight for season of birth were 7±0.5 and 6.6±0.5 kg. for autumn and winter seasons, respectively, and the difference was significant(P<0.001). Lambs borne harvest season weighted heavier than dry season. Due to crop over of the season; the surplus of the feed is available for lambs and lactating ewes. However, the birth season effect observed by Lakew et al. (2014) for Dorper × Local Crossbred was not signifiant. The least square means of two-month body weight for six parities were 5.9±0.5, 6.4±0.5, 6.2±0.5, 5.9±0.5, 6.7 ±0.5 and 7.5±0.5 kg for 1 to 6 parities, respectively. The pair wise comparisons showed that LSM of 1-6, 3-6 and 4-6 parities were significant like birth weight.

The least square means of two-month body weight for single, twin, triplet and quadruplet lambs were 8.5±0.2, 7.8±0.2, 6.9±0.4 and 4±1.7, respectively. The difference in the LSM between

single born lambs differed significantly (P<0.001) with all other type of births (Twin, Triplet and quadruplet).

The pair-wise comparisons of location X genetic group (Breed) interactions showed that LSM of two-month body weight of Bonga crossbred and local lambs were significantly (P<0.001) different in all locations. The differences in the LSM of two-month body weight of Bonga crossbred lambs in the four locations were all non-significant. Similarly, the only the local lambs of Ezha location were significantly different from local lambs in the remaining three locations whereas these lambs showed non-significant differences among themselves in the remaining locations.

C. Three Month Body Weight:

The effect of location, genetic group (Breed), season of birth, parity, type of birth and sex on three-month body weight (Table 32A) were highly significant (P<0.001) whereas the effect of location X genetic group (Breed) interaction was found to be non-significant (Table 33A). The overall least square mean of three-month body weight was 10.68 kg and the coefficient of variation (CV) was 17.43 % in the present study.

The least mean squares (LSM ± SE) of three-month body weight for Bonga sired crossbreds and local lambs were 11.4±0.6 and 8.3±0.6 kg, respectively. The difference in the two genetic groups was highly significant (P<0.001). Results obtained in the current study for Bonga cross was comparable with Mekuriaw et al. (2013) who reported 11.17±0.49kg for Washera and Farta crosses. The results were higher than that of Gizaw et al. (2012) and Hassen et al. (2002) for 50 and37% Awassi and menz crosses (10.03±0.22 and 10.47 kg, respectively) but were lower than 12.35±0.35kg for Awassi X Menz 75% cross lambs (Ayele et al.,2015), 14.95±0.21 for Dorper X local cross (Lakew et al. 2014), 14.8±0.2 and 15.5±0.08 kg for Pure Bonga reported by Aynalem et al., (2014) and Metsafe (2015), respectively, 12.42 for On-farm × crossbred (Hassen, 2004). The result of three-month weight for local sheep (8.3±0.6) group was comparable with reports of Lakew et al. (2014) but lower than that of Hassen et al. (2002) for local sheep group.

The least mean squares (LSM ± SE) of three-month body weight for four locations were 9.8±0.6, 9.4±0.6, 10.5 ±0.6 and 9.8±0.6 kg in Alicho Worero, Ezha, Damot Pulasa and Arbegona respectively. The pair wise comparison of these means showed that three-month body

weight of Damot Pulasa with other locations means were significantly different whereas all other pair differences were non-significant.

Table 32A: Least Square Means of Pre-weaning body weights(kg) and Weight Gain (gm)

Effects	Birth weight		2Month weight		3Month weight		3PrDAG
	N	LSM ± SE	N	LSM±SE	N	LSM±SE	LSM±SE
Overall	532	2.58	508	7.57	473	10.68	87.99
R2		27.58		41.55		45.25	42.30
CV (%)		19.61		21.27		17.43	20.74
Location		*		**		**	**
Alicho Worero	124	2.62 ± 0.2^{ab}	121	6.7 ± 0.5^{ab}	115	9.8 ± 0.6^{b}	77.7 ± 5.4^{b}
Ezha	170	2.66 ± 0.2^{ab}	161	6.4 ± 0.5^{b}	158	9.4 ± 0.6^{b}	70.9 ± 5.6^{c}
Damot Pulasa	105	2.49 ± 0.2^{b}	99	7.1 ± 0.5^{a}	84	10.5 ± 0.6^{a}	88.7 ± 5.6^{a}
Arbegona	133	2.74 ± 0.2^{a}	127	7 ± 0.5^{a}	116	9.8 ± 0.6^{b}	76.6 ± 5.7^{bc}
Genetic group (Breed)		**		**		**	**
Bonga-Cross	304	2.9±0.2	287	8±0.5	260	11.4±0.6	92.2±5.4
Local	228	2.4±0.2	221	5.5±0.5	213	8.3±0.6	64.8±5.5
Season		**NS**		****		**	**
Autumn/Harvest Season	255	2.6±0.2	251	7±0.5	247	10.2±0.6	82.7±5.4
Winter/Dry season	277	2.7±0.2	257	6.6±0.5	**226**	9.5±0.6	74.3±5.5
Parity		*		**		**	**NS**
1	59	2.3 ± 0.2^{b}	54	5.9 ± 0.5^{b}	49	8.8 ± 0.6^{b}	71.9±7.7
2	109	2.5 ± 0.1^{ab}	106	6.4 ± 0.5^{ab}	100	9.7 ± 0.5^{ab}	78.5±5.3
3	189	2.5 ± 0.1^{b}	185	6.2 ± 0.4^{b}	175	9.3 ± 0.5^{b}	76.1±5.2
4	117	2.4 ± 0.1^{b}	109	5.9 ± 0.5^{b}	99	9.2 ± 0.5^{b}	75.2±5.3
5	36	2.6 ± 0.2^{ab}	33	6.7 ± 0.5^{ab}	31	9.7 ± 0.6^{ab}	79.9±5.9
6	23	2.8 ± 0.2^{a}	21	7.5 ± 0.5^{a}	19	10.6 ± 0.7^{a}	82.3±6.5
Type of Birth		*		**		**	**
1	220	2.8 ± 0.1^{a}	208	8.5 ± 0.2^{a}	192	11.4 ± 0.3^{a}	93 ± 2.8^{a}
2	290	2.6 ± 0.1^{b}	282	7.8 ± 0.2^{b}	263	10.8 ± 0.3^{b}	88.2 ± 2.6^{ab}
3	21	2.6 ± 0.1^{ab}	17	6.9 ± 0.4^{b}	17	10 ± 0.5^{b}	78.4 ± 5.2^{b}
4	1	2.6 ± 0.5^{ab}	1	4 ± 1.7^{b}	1	7.2 ± 2^{ab}	54.3 ± 19.2^{ab}
Sex		*		**NS**		**	**
Male	267	2.7±0.2	258	6.93±0.46	239	10.1±0.5	81±5.3
Female	265	2.6±0.2	250	6.66±0.47	234	9.6±0.6	75.9±5.5

*Note * Significant at (P<0.05), ** Significant at (P<0.001), and SN not Significant*

Table 33A: Least Square Means of Pre-weaning body weights(kg) and Weight Gain (gm) for location x Genetic group (Breed) Interaction

Effect		Birth weight	2Month weight	3Month weight	PrDAG
Location X Genetic group (Breed)		NS	**	NS	NS
Alicho Worero	Bonga crosses	2.9±0.2	7.6±0.5[a]	11.3±0.6	91.9±5.5
	Local	2.3±0.2	6.1±0.5[b]	8.2±0.6	63.1±6
Ezha	Bonga crosses	3±0.2	8.2±0.5[a]	11.1±0.6	85.7±5.8
	Local	2.3±0.2	4.9±0.5	7.6±0.6	55.8±5.9
Damot Pulasa	Bonga crosses	2.7±0.2	8.5±0.5[a]	12.2±0.6	104.8±6.1
	Local	2.5±0.2	6.1±0.5[b]	8.8±0.6	72.4±6
Arbegona	Bonga crosses	3±0.2	8.4±0.5[a]	11±0.6	86.4±9
	Local	2.4±0.2	6±0.5[b]	8.7±0.6	67.5±6

The difference may be due to variation in the feeding management of the four locations and small flock structure of sheep (Table 12 and 13) because 40 and 67.5% of BRU and NBRU respectively provide supplementary feeds for sheep (Table 18) in the area.

The three-month weight of lambs borne during harvest season was higher than winter seasons and the difference was significant (P<0.001). The effect of season is associated with difference in feed and disease situation (Berhanu and Aynalem, 2009). The effect of parity had showed a significant effect (p<0.001) on three – month weight of lambs. The pair wise comparisons showed that LSM of 1-6, 3-6 and 4-6 parities were significant (P<0.001) and like birth and two-month weight, parity have effect on three-month weight.

The least square means of three-month body weight for single, twin, triplet and quadruplet lambs were 11.4±0.3, 10.8±0.3, 10±0.5 and 7.2±2, respectively. The difference in the LSM between single born lambs differed (P<0.001) with all other type of births (Twin, Triplet) except quadruplet. Due to individual feeding of milk during suckling, the single borne lambs weighted heavier than multi borne lambs.

The current study revealed that three months' weight of Bonga cross lamb excelled local sheep in same management practices of farmers for both sheep types in the areas. The result was in high agreement with farmers' trait preference in all study sites; thus, they ranked growth rate as first criteria (Table 28) for preference of Bonga sheep. The current findings were in agreement with Belete (2009) and Kebede et al. (2016).

D. Pre-weaning Daily Average Gain (PrDAG):

The effect of location, genetic group (Breed), season of birth, type of birth and sex on PrDAG (Table 32A) were highly significant (P<0.001) whereas the effect of parity and location X genetic group (Breed) interaction was found to be non-significant (Table 33A). The overall least square mean of PrDAG was 87.99 g/day and the coefficient of variation (CV) was 20.74 % in the present study.

The least mean squares (LSM ± SE) of PrDAG for Bonga sired crossbreds and local lambs were 92.2± 5.4 and 64.8± 5.5 g/day, respectively. The difference in the two genetic groups was significant (P<0.001). The current findings of PrDAG for Bonga cross lambs in the study areas was comparable with Deribe et al. (2017), Ayele et al. (2015), Mekuriaw et al. (2013) but lower than Aynalem et al. (2014), Lakew et al. (2014) and Hassen et al. (2004). However, daily average body weight gain of Bonga crosses was higher by 27.4 g/day than local sheep at the same management system. The possible reason for this may be the Heterotic effect of crossbreds.

The least mean squares (LSM ± SE) of PrDAG for four locations were 77.7±5.4, 70.9±5.6, 88.7 ±5.6 and 76.6±5.7 g/day in Alicho Worero, Ezha, Damot Pulasa and Arbegona, respectively. PrDAG of lambs in Damot Pulasa district were superior than the rest three districts. The pair wise comparison of these means showed that PrDAG of Damot Pulasa with Alicho Worero, Damot Pulasa with Ezha, Damot Pulasa with Arbegona, and Alicho Worero with Ezha pair means were significantly (P<0.001) different whereas all other pair differences were non-significant.

The PrDAG of lambs borne in harvest season gains 8.4 g/day more than lambs borne in dry season and the difference was significant (P<0.001). the possible reason may be that during dry season there is paucity of forage. Similarly, male lambs gain 5.1g/day more than female lambs in this study and the difference was significant (P<0.001).

The least square means of PrDAG for single, twin, triplet quadruplet lambs were 93±2.8, 88.2±2.6, 78.4±5.2 and 54.3±19.2 gm, respectively. The pre-weaning daily average gain of Triple born lambs lower than Single, Twin and quadruplet type of births and the difference was significant (P<0.05).

4.8.2. Post-weaning Body weights and Body Weight Gain

The least square ANOVA for post-weaning body weights and body weight gain is presented in (Appendix 8: ANNOVA for Post-Weaning Body Weights(kg) and Body Gains (gm**)**) whereas the results on least square means for post-weaning body weights and body weight gain is presented in tables 32A and 33A.

A. Four Month Body Weight:

The effect of location, genetic group (Breed), season of birth, type of birth and sex was highly significant (P<0.001) on four-month body weight (Table 34A), whereas the location x breed interaction effect (Table 35A) on four-month body weight was significant (P<0.05). However, the effect of parity was found to be non-significant (Table 34A). The overall least square mean of four-month body weight was 12.9 kg and the coefficient of variation (CV) was 16.28 % in the present study.

The pair wise comparison of four-month body weight means (LSM ± SE) for four locations showed that four-month body weight of Damot Pulasa with Alicho Worero and Ezha were significantly (P<0.001) different whereas all other pair differences were non-significant. The weight for location X interactions for Bonga crosses were 12.9±0.7, 12.7±0.7, 14.5±0.8 and 12.5±0.7kg for Alicho Worero, Ezha, Damot Pulasa and Arbegona for Bonga cross pair of interactions, respectively.

The weight for location X interactions for local sheep were 9.4±0.7, 8.9±0.7, 10.5±07 and 10.5±0.7 kg for Alicho Worero, Ezha, Damot Pulasa and Arbegona for local sheep pair of interactions, respectively. The pair-wise comparisons of location X genetic group (Breed) interactions showed that LSM of four-month body weight of Bonga crossbred and local lambs were significantly (P<0.05) different in all locations. The differences in the LSM of four-month body weight of Bonga crossbred lambs in the four locations were statistically non-significant.

Similarly, the local lambs in the four locations were non-significant except Ezha with Damot Pulasa which was significantly (P<0.05) different.

The least mean squares (LSM ± SE) of four-month body weight for Bonga sired crossbreds and local lambs were 13 ± 0.6 and 9.8 ± 0.7 kg, respectively. The difference in the two genetic groups was significant (P<0.001). The result obtained in this study was heavier than the report of Hassen et al. (2002) for Bonga cross and lower for local sheep. The Bonga cross in Damot Pulasa and local sheep in Arbegona sites showed higher body weight gain between three and four growths than lambs in the rest sites. The difference resulted from supplementation of feeds for sheep in the area (Table 18) and farmers in this area sell Bonga cross on average of 4.4 moths (Table 46) of age.

B. Six Month Body Weight:

The effect of genetic group (Breed), type of birth and sex was highly significant (P<0.001) on six-month body weight (Table 34A), whereas the effects of location, season of birth, parity (Table 34A) and location x breed interaction effect (Table 35A) on six-month body weight were non-significant. The overall least square mean of six-month body weight was 15.66 kg and the coefficient of variation (CV) was 19.29 % in the present study.

The least mean squares (LSM ± SE) of six-month body weight for Bonga sired crossbreds and local lambs were 17.4 ± 0.8 and 13 ± 0.8 kg, respectively. The difference in the two genetic groups was highly significant (P<0.001).

The least square means of six-month body weight for single, twin and triplet lambs were 17.1±0.7, 15.2±0.6 and 13.2±1.5 kg, respectively. The difference in the LSM between single born lambs differed significantly with all other type of births (Twin, Triplet). Similarly, least square means of six-month body weight for male and female lambs was 15.8±0.8 and14.6±0.8 kg, respectively, and these differences were significant.

The result pertaining to the body weight at six months for Bonga cross were heavier than the reports of Mekuriaw et al. (2013), Hassen et al. (2002) and Gizaw et al (2012) for Farta X Washera, Awassi X local crosses and Awassi X Menz, respectively, but lower than the reports of Haile et al. (2014) and Lakew et al. (2014) for pure Bonga sheep in its own home track and local X Dorper cross, respectively.

The high growth performance for Bonga cross observed in the current study were in close agreement with reports of Lemma et al., 2014) for Bonga x Menz crosses.

C. Post-weaning Daily Average Gain (Post-WDAG):

The effect of location, genetic group (Breed), type of birth and sex was highly significant (P<0.001) on Post-WDAG (Table 34A), whereas the effects season of birth, parity (Table 34A) and location x breed interaction effect (Tabl8e 35A) on Post-WDAG were non-significant. The overall least square mean of Post-WDAG was 76.6 gm and the coefficient of variation (CV) was 20.2 % in the present study.

The pair wise comparison of means for location showed that Post-WDAG of Damot Pulasa with Alicho Worero and Damot Pulasa with Ezha pair means were significantly (P<0.001) different whereas all other pair differences were non-significant.

The least mean squares (LSM ± SE) of Post-WDAG for Bonga sired crossbreds and local lambs were 86 ± 4 and 63.4± 4 g/day, respectively. The difference in the two genetic groups was significant (P<0.001). The acquired results of Post-WDAG for Bonga crosses was higher than findings of Lakew et al. (2014) for Dorper X local crosses and Aynalem et al. (2014) for Bonga but lower than Mekuriaw et al. (2013) for Washera x Farta crossbreds and Deribe et al. (2017) for Dorper x Local sheep in Areka area. However, the superior post weaning daily average body weight gain of Bonga crosses over local sheep attracts farmers in the study area to use Bonga sheep breed as one of the parents.

Table 34A: Least Mean squares of Post-Weaning Body Weights (Kg) and Body Gains (gm)

Effects	4Month Body Weight		6month Body Weight		6PrDAG
	N	LSM±SE	N	LSM±SE	LSM±SE
Overall	375	12.89733	190	15.66053	76.62526
R2		44.3819		48.1435	50.1916
CV (%)		16.28996		19.29102	20.24018
Location		**		NS	**
Alicho	92	11.2±0.6[b]	48	15.1±0.9	74.2±4.3[b]
Ezha	124	10.9±0.7[b]	42	13.9±1	63.7±5.2[b]
D/Pulasa	61	12.3±0.7[a]	29	16.4±0.8	85.3±4.1[a]
Arbegona	98	11.5±0.7[ab]	71	15.3±0.9	75.6±4.7[ab]
Genetic group (Breed)		**		**	**
Bonga-Cross	205	13±0.6	95	17.4±0.8	86±4
Local	170	9.8±0.7	95	13±0.8	63.4±4
Season		**		NS	NS
Autumn/Harvest	225	12±0.6	151	15.7±0.7	74.4±3.8
Winter/Dry	150	11±0.7	39	14.7±0.9	75±4.7
Parity		NS		NS	NS
1	36	10.9±0.7	19	13.5±0.9	67.2±4.5
2	80	11.4±0.6	52	14.8±0.6	72.3±3
3	147	10.8±0.6	68	14.5±0.6	72.6±2.9
4	73	11.1±0.6	33	14.6±0.7	74.8±3.3
5	23	11.7±0.7	10	16.6±1.1	80.9±5.7
6	16	12.4±0.8	8	17.4±1.9	88±9.7
Type of Birth		**		**	**
1	157	13.8±0.4[a]	78	17.1±0.7[a]	83.3±3.7[a]
2	206	12.7±0.3[b]	106	15.2±0.6[b]	76.4±3.2[b]
3	11	11.6±0.7[b]	6	13.2±1.5[b]	64.3±7.5[b]
4	1	7.8±2.2[b]			
Sex		**		**	**
Male	187	11.9±0.6	101	15.8±0.8	77.3±4.2
Female	188	11±0.7	89	14.6±0.8	72.1±4.1

*Note * Significant at (P<0.05), ** highly Significant at (P<0.001), and SN not Significant*

Table 35A: Least Mean squares for fixed effects of breed X Location Interaction for Post-Weaning Body Weight and Gain

Effect		4Month Body Weight	6month Body Weight	6PrDAG
Breed X Location Interaction		*	NS	NS
Alicho Worero	Bonga crosses	12.9±0.7 [a]	17.4±0.9	87.6±4.6
	Local	9.4±0.7 [b]	12.9±1	99.2±5.7
Ezha	Bonga crosses	12.7±0.7[a]	16.6±1.3	56.5±5.6
	Local	8.9±0.7 [b]	11.5±1.1	70.2±5
Damot Pulasa	Bonga crosses	14.1±0.8 [a]	19.7±1.1	70.2±6.5
	Local	10.5±0.7 [b]	13.5±1	82.89±5
Arbegona	Bonga crosses	12.5±0.7 [a]	17.1±1	51.3±5.4
	Local	10.5±0.7 [b]	13.8 ±1	65.5±5.2

4.9. Disease Adaptation of Bonga Crosses

4.9.1. Types of Diseases Commonly Occurring:

The FGD in the four locations revealed that there was high occurrence of Ovine Pasturolisis, Fascioliasis and tick's infestation in all locations (**Appendix 12: Major disease in the study area**). Besides Development Agents (DA) in Damot Pulasa site reported that Kerato Conjunctives and Hemoncus is a problem in the area whereas Foot & Mouth Disease (FMD) was reported to be occurring in Arbegona by DA. The Animal Health Experts at the Kebele level reported that mortality rate due Ovine Pasturolisis was medium in Alicho Worero and Damot Pulasa but low in Ezha and Arbegona sites (Personal communication). Besides the Animal Health Experts also reported that Cenorosis (Circling disease), locally called "Marto" in Arbegona, affects ram lambs and sire all over the year in Arbegona and Damot Pulasa site (Personal communication). The endo parasites, fasciollosis, eye diseases, Ector-parasites and pasteurellosis were reported by Ermias, (2014) as a major disease in the study districts of Wolayta and Silte zones. The common diseases which occur in Adiyo Kaka were pasteurellosis,

coenuruses, diarrhea and lung worm (Edea, 2008) and the prevalence of ovine pasteurellosis was high in the area (Fisseha, 2015).

4.9.3. Nature of Disease Treatment:

The nature disease treatment in the study area is presented in table 36. The respondent farmers in both groups reported that diseases were cured by using either traditional treatment or modern veterinary care or both these types. The results revealed that higher proportion (57.5, 52.2, 56.8 and 72.2 % in Alicho Worero, Ezha, Damot Pulasa and Arbegona, respectively) of NBRU respondents use modern veterinary treatment for curing of diseases. Among BRU respondents, higher proportion (37.5, 82.5 and 62.5 %, respectively) use modern veterinary care in Ezha, Damot Pulasa and Arbegona, respectively, districts whereas in Alicho Worero equal proportion (37.5 % in each case) of respondents use either traditional treatment or modern veterinary care. The same findings were reported by Ermias (2014) for farmers practice of disease treatment in Wolayta and Silte areas.

Table 36: Nature of Disease Treatment

Nature of treatment	Respondents	Districts (%)				Overall
		Alicho Worero	Ezha	Damot Pulasa	Arbegona	
Traditional practices	BRU	37.5	12.5	5	0	13.75
	NBRU	15	7.5	22.73	0	6.25
Modern Veterinary care	BRU	37.5	37.5	82.5	62.5	55
	NBRU	57.5	52.5	56.8	72.2	59.4
Both types	BRU	25	50	12.5	37.5	31.25
	NBRU	27.5	40	40.9	27.7	34.4

4.9.4. Mortality Occurrence:

The results on the occurrence of mortality in the sheep flocks in the study areas are presented in table 37. The BRU respondent in Alicho Worero, Ezha and Damot Pulasa locations reported lower occurrence of mortality in their flock ranging from 20 (Damot Pulasa), 25 (Alicho Worero) to 27.5 % (Ezha) only. However, the BRU respondents in Arbegona reported 55 %

occurrence of mortality in their flock. Contrary to this the NBRU respondents in Alicho Worero, Ezha and Arbegona locations reported higher occurrence of mortality ranging from 52.5 (Ezha), 77.8 (Arbegona) to 82.5 % (Alicho Worero) locations. However, NBRU respondents of Damot Pulasa site reported lower occurrence (36.4 %) of mortality. The X^2 test showed significant difference in the occurrence of mortality between BRU and NBRU respondents in all locations except Damot Pulasa. The highest mortality rate of NBRU in Alicho Worero and Arbegona district was maybe attributed to free mixed grazing of sheep (Table 16). Free mixed grazing with other animals maybe create opportunity to diseases transmissions.

Table 37: Mortality Occurrence in Sheep flocks

Respondent category	Mortality Occurrence	Districts (%)				Overall
		Alicho Worero	Ezha	Damot Pulasa	Arbegona	
BRUs	**Yes**	25	27.5	20	55	31.9
	No	75	72.5	80	45	68.1
NBRUs	**Yes**	82.5	52.5	36.4	77.8	61.2
	No	17.5	47.5	63.6	22.2	38.8
	P-Value	0.000	0.02	0.07	0.32	0.000
	Sign. level	**	*	ns	*	**

4.9.5. Mortality Occurrence in Different Age Groups:

A. From Survey Study

The results on the occurrence of age-wise mortality in the sheep flocks in the study areas are presented in table 38**.** According to BRU respondent the mortality rate in crossbred lambs < 3 months' age was 15, 17.5, 20 and 45 % in Ezha, Alicho Worero, Damot Pulasa and Arbegona locations whereas similar figures for crossbreed lambs aged > 3 months was reported to be 0 (Damot Pulasa), 10 (Ezha and Arbegona) and 12.5 % (Alicho Worero) locations.

According to NBRU respondent the mortality rate in local lambs < 3 months' age was 33 (Arbegona), 34 (Damot Pulasa), 37.5 (Ezha) and 55 % (Alicho Worero) whereas similar figures for local lambs aged > 3 months was reported to be 2 (Damot Pulasa), 2.5 (Ezha), 15 (Alicho Worero) and 28 % (Arbegona) locations. The age-wise mortality pattern in both BRU and

NBRU respondents showed that mortality is higher in lambs < 3 months' age compared to lambs > 3 months' age.

Table 38: Age-wise Occurrence of Mortality

Category of respondents	Age group	Districts				
		Alicho Worero	Ezha	Damot Pulasa	Arbegona	Overall
BRUs	Lambs < 3 months	17.5	15	20	45	24
	Lambs >3 months	10	12.5	0	10	8
	No lamb Death	72.5	72.5	80	45	68
NBRUs	Lambs < 3 months	55	37.5	34	33	40
	Lambs > 3 months	15	2.5	2	28	11
	Local adult Rams	10	2.5	0	0	3
	Local adult Ewes	12.5	10	5	17	11
	No mortality	7.5	47.5	59	22	35
Sign. Level		**	**	ns	**	**

B. Monitoring Study

The mortality (pre-weaning and post-weaning) and weaning rate of lambs from data recorded in monitoring study is presented in figure 16 and 17 respectively.

The pre and post weaning mortality rate was 4.8 and 2.5 % for Bonga cross lambs at Alicho Worero, 2.1 and 0 % for Ezha, 1.1 and 1.1 % for Arbegona and 1.6 and 0 % for Damot Pulasa in the present study. The pre and post weaning mortality rate for local lambs at Alicho Worero (7.1 and 3.8), Ezha (5.3 and 0), Arbegona (1.8 and 0) and Damot Pulasa (2.3 and 0) recorded during monitoring study (Figure 16). The results showed that, more mortality rate was observed in pre-weaning than post-weaning age. The low rate of post-mortality for both lamb groups were observed at Alicho Worero and Damot Pulasa sites. However, the monitoring data showed that, the pre and post weaning mortality rate of local lamb groups were higher than Bonga cross lambs in all study areas. The possible reason was that pre weaning body weight of Bonga cross lambs were significantly higher than local lambs and this possibly contributed to less mortality

in crossbreds compared to local lambs. Both Gemeda et al. (2005) and Berhanu and Aynalem (2011) too reported that survival rate of lamb was significantly affected by birth weight.

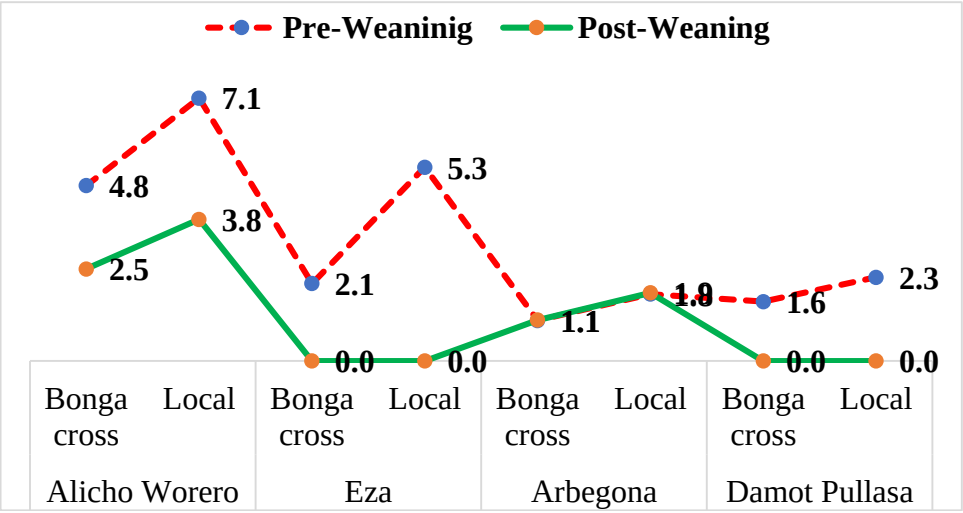


Figure 14 : Pre and Post Weaning Mortality (from monitored study)

The weaning rate of Bonga crossbreed and local lambs presented in figure 16. The results showed that, the proportion of Bonga crossbreed weaning rate was higher than local lambs. However, the weaning rate of both groups of lamb was greater than 90 % in all study areas.

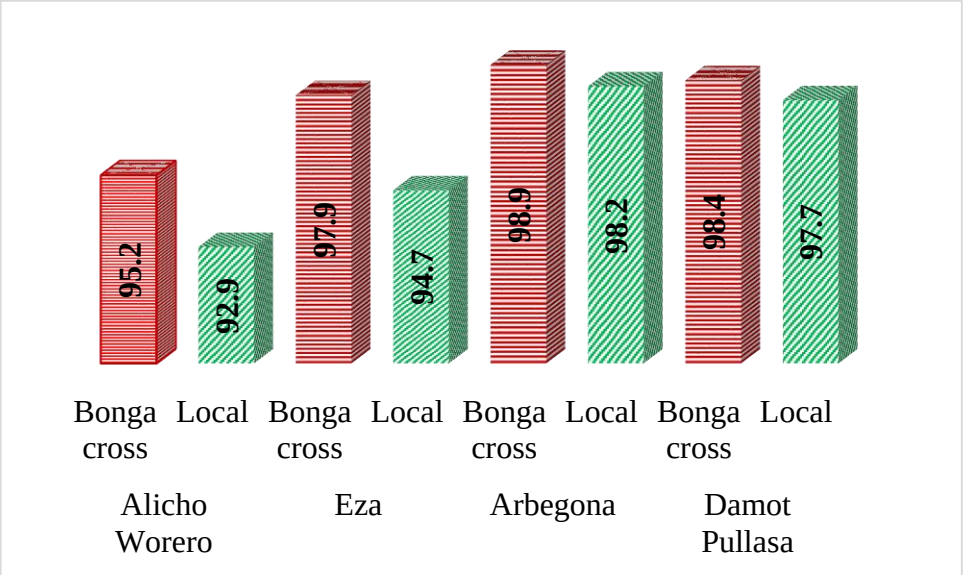


Figure 15: Lamb Weaning rate from monitored data

4.9.6. Pre-weaning Lamb Mortality in different Seasons:

The seasons-wise pre-weaning lamb mortality, based on respondent interviews, is presented in table 39. The results showed that overall pre-weaning lamb mortality was higher in dry season (54 %) compared to wet season (47.5%). Among the four locations similar trend was observed Alicho Worero (45% in wet and 70% in dry season) and Damot Pulasa (15.9% in wet and 47.3% in dry season) locations. The current finding in these two location (Alicho Worero and Damot Pulasa) was in agreement with Deribe, (2009) around Alaba area. However, in the other two locations higher mortality was observed in wet season (57.5 and 75 % in Ezha and Arbegona sites, respectively) compared to dry season (50 and 53.3 % in Ezha and Arbegona sites, respectively). This result, also, was in agreement with Berhanu and Aynalem (2011) and Metsafe (2015) for Bonga lambs. The X^2 test showed significant difference in the occurrence of pre-weaning lamb mortality (Based on pooled data) between two seasons across all locations. Berhanu and Aynalem (2011) also, reported that season has significant effect on mortality. The possible reason for higher mortality in wet season may be high humidity accompanied with heat, which provided favorable atmosphere for microbial growth.

Table 39: Season-wise Pre-weaning Lamb Mortality

Season	Respondent category	Districts				Overall
		Alicho Worero	Ezha	Damot Pulasa	Arbegona	
Wet season (%)	BRU	10	20	0	25	13.75
	NBRU	35	37.5	15.9	50	33.75
	Pooled	**45**	**57.5**	**15.9**	**75**	**47.50**
Dry season (%)	BRU	12.5	0	20	20	13.2
	NBRU	57.5	50	27.3	33.3	41.8
	Pooled	**70**	**50**	**47.3**	**53.3**	**54**
P-Value for pooled differences		**0.000**	**0.000**	**0.014**	**0.002**	**0.000**
Sign. Level for pooled differences		**	**	*	**	**

4.9.7. Causes of Lamb Mortality:

The causes of lamb mortality in the study area were presented in table 40. The overall survey results of BRUs and NBRUs respondent farmers showed that diseases (11.9 and 35 % in BRUs and NBRU, respectively) and unknown causes (10 and 28.6 % of BRUs and NBRU, respectively) were the major causes of lamb mortality in all study areas. The results of BRUs respondents at Damot Pulasa (5%), Alicho Worero (7.5%) and Arbegona (7.5%) showed that a small proportion of Bonga crossbreed lamb died accidently or suddenly. However, none of BRU respondents reported that poisoning is the causes of lamb mortality in all study areas except Damot Pulasa (2.5%). The major couses for lamb mortality in Bonga area were disease, cold stress (in wet season), predators according to Metsafe, (2015) whereas sudden or unknown causes of mortality observed in present study was in agreement with Fisseha (2015). However, causes of lamb mortality are directly associated to the production and the management system (Berhanu and Aynalem, 2009). Thus, more than half percentage of early lamb mortalities was an important losses associated to managements (Tibbo, 2006).

Table 40: Causes of Lamb Mortality in the study site

Respondent category	Cause of mortality	Districts				Overall
		Alicho Worero	Ezha	Damot Pulasa	Arbegona	
BRU	**Poisoning**	0	0	2.5	0	0.6
	Disease	15	5	0	27.5	11.9
	Accident	7.5	5	5	7.5	6
	Unknown cause	7.5	10	12.5	10	10
	No mortality	70	80	80	55	71.5
	Pooled	**100**	**100**	**100**	**100**	**100**
NBRU	**Poisoning**	5	2.5	6.8	0	3.8
	Disease	55	20	22.8	44.4	35
	Accident	0	32.5	0	0	8.2
	Unknown cause	32.5	32.5	13.6	38.9	28.6
	No mortality	7.5	12.5	56.8	16.7	24.4
	Pooled	**100**	**100**	**100**	**100**	**100**

4.9.8. Occurrence of Abortion and Dystocia:

The survey result of reproductive related problems of the ewe (Abortion and Dystocia) from both categories of respondent farmers is described in table 41**.** The overall percentage of BRU and NBRU respondents reported 34.4 % and 20.6% of abortions, respectively, in their ewes. Similarly, overall percentage of BRU and NBRU respondents reported 18.8 % and 16.2 % of dystocia, respectively, in their ewes. Furthermore, FGD revealed that both abortion and Dystocia problems occurs mostly in dry season than other seasons. Farmers reported that toxic grass (plant), mounting by aggressive ram lambs and striking of children/neighbor suddenly was the major cause. Haftom (2015) reported that, toxic plant and brucellosis were the main causes of abortion for small ruminant in Tigray region.

Table 41: Occurrence of Abortion and Dystocia in Ewes in the Study area

Nature of Problem	Respondent category	Response	Alicho Worero	Ezha	Damot Pulasa	Arbegona	Overall
Abortion (%)	**BRU**	Yes	25	40	30	42.5	34.4
		No	75	60	70	57.5	65.6
	NBRU	Yes	15	32.5	13.6	22.2	20.6
		No	85	67.5	86.4	77.8	79.4
Dystocia (%)	**BRU**	Yes	22.5	27.5	5	20	18.8
		No	77.5	72.5	95	80	81.2
	NBRU	Yes	15	15	9.1	27.8	16.2
		No	85	85	90.9	72.2	83.8

4.10. Adaptation of Disseminated Bonga Rams in the Study Area

Adaptive fitness is characterized by survival, health and reproductive related traits (Mirkena, et al.,2010). The survival rate of disseminated Bonga rams in the study areas is presented in table 42. The results revealed that, the survival rate of Bonga rams at Arbegona, Ezha, Damot Pulasa, Alicho Worero and Overall study areas were 93.3, 89.3, 97.2, 95.2 and 94.7% respectively.

According to farmer's performance traits preference for Bonga rams (Table 28), the growth rate of its progenies ranked first followed by feed adaptability, disease tolerance and libido (mating performance) of Bonga rams ranked as second, third and fourth in all study areas, respectively, except Arbegona (libido (mating performance, feed adaptability and disease tolerance ranked

as second, third and fourth). The current finding was in agreement with the report of Mirkena et al, (2010) that adaptive performance particularly disease resistance, survival and reproductive trait. However, high mortality of 36% was reported for Washera ram distributed in North Shewa (Getachew et al, 2010).

The results of FGD and personal communication with respondent farmers in the study areas revealed that good quality body size and its appearance, attractive marketable coat color and temperament (Table 28) attracted farmers to use Bonga ram in the study area. The farmers interest accompanied with good adaptability of Bonga ram in the area possibly convinced regional as well as district government to introduce Bonga crossbreeding followed by further expansion in the area.

Table 42: Survival rate of disseminated Bonga rams in the study districts.

	Arbegona	**Ezha**	**Damot Pulasa**	**Alicho Worero**	**Overall**
Introduced Rams	60	28	71	105	264
Died Rams	4	3	2	5	14
Survival Rate	93.3	89.3	97.2	95.2	94.7

4.11. Physical Breeding Soundness of Bonga rams in disseminated areas

The physical breeding soundness (body condition score, scrotal circumference, libido and other reproductive related defects) of disseminated Bonga rams were observed under monitoring study (Figure 16). The average body condition score (BCS), scrotal circumference (SC) and body weight of Bonga sires in the disseminated areas is presented in table 43. The average body condition score (BCS), scrotal circumference (SC) and body weight of Bonga sires was Alicho Worero (4, 31.8 and 57.8), Ezha (3.4, 30.4, and 48.6, Damot Pulasa (3.6, 30.7 and 50.7), Arbegona (3.6, 31 and 50) and Overall (3.7, 31 and 51.8), respectively, in study areas. The scrotal circumference and BCS of disseminated Bonga ram in all study sites were satisfactory (BCS > 3 and SC > 30cms). According to Gizaw and Thwaites, (1997) the mating weight and SC varied from 30 kg - 40 kg (Mating weight) and 27 cm - 31 cm (SC) in a study on Horro rams. The SC in the present study is higher than this report.

Table 43: Disseminated Bonga Ram Physical Breeding Soundness in the Study area (Assessment based on monitoring study)

Location	BCS	SC (Cm)	BW (kg)	Libido	Teeth	Prepuce	Sheath	Testicles
Alicho Worero	4.0	31.8	57.8	High	Normal	Normal	Normal	Normal
Ezha	3.4	30.4	48.6	High	Normal	Normal	Normal	Normal
Damot Pulasa	3.6	30.7	50.7	High	Normal	Normal	Normal	Normal
Arbegona	3.6	31.0	50.0	High	Normal	Normal	Normal	Normal
Overall	3.7	31.0	51.8	High	Normal	Normal	Normal	Normal

The BRU respondents reported that mating performance (Libido) of Bonga rams was higher than local rams in the study area (table 43). The earlier observation of farmer's traits preference for Bonga rams (Table 28) also showed that libido was considered as an important trait by BRU respondents. However, during the study time none of reproductive related defects, fertility, and mating depression problems were reported for disseminated Bonga rams in the study districts. The report of Mukasa-Mugarwa and Lahlou-Kassi, (1995) showing a depression in rams' fertility during the rainy season of Ethiopian sheep breeds was in disagreement with current finding for disseminated Bonga rams.

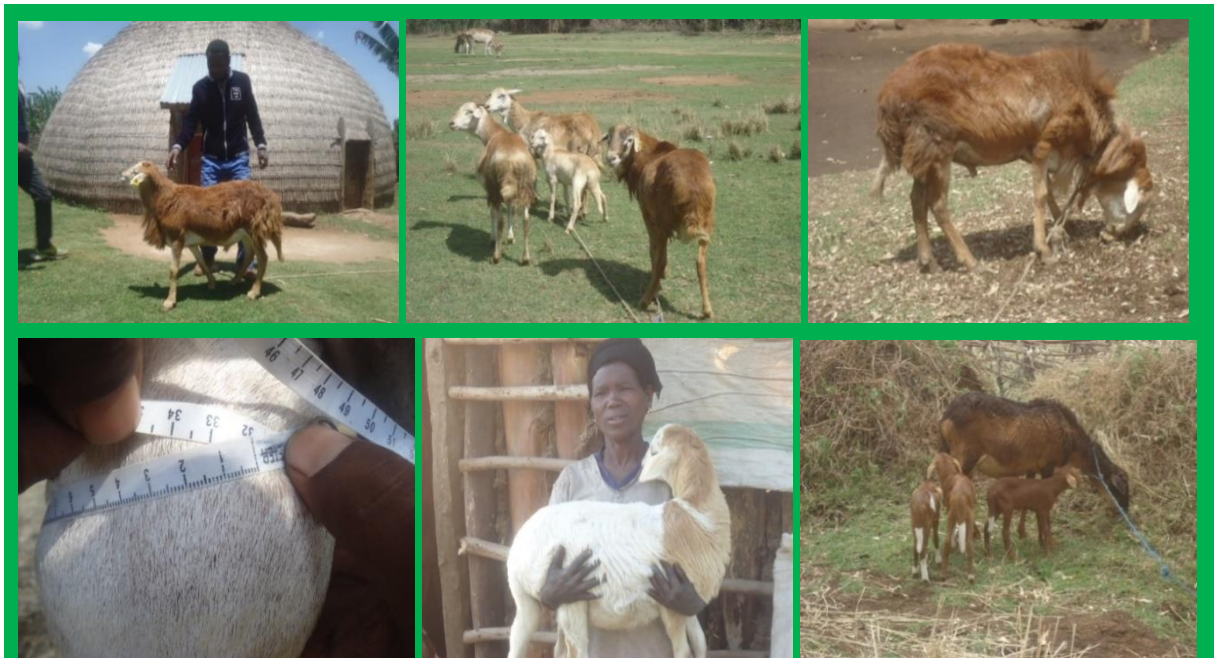


Figure 16: Bonga ram Adaptive performance

4.12. Socio-Economics of Bonga Sheep Crossbreeding in the Study Areas.

4.12.1. Sheep Flocks Before and After Bonga Sheep Crossbreeding

The sheep flock structure of BRU respondents before and after Bonga sheep crossbreeding is presented in figure 17. The results uniformly showed an increasing trend in the number of ewes, ewe lambs and ram lambs of the respondent farmers after Bonga sheep crossbreeding in all the locations. The X^2 test showed that changes in the flock structures were significant for all three categories of sheep (Ewes, Ewe lambs and ram lambs) in all the districts except for ewes in Alicho Worero. The average flock size was increased due to mixed genotypes, with the majority of farmers indicating their desire to keep only cross-bred sheep. The main reason for this was the cross-breeds' potential for fast growing, prolificacy and marketable body size and coat color compared to local sheep. For the majority of the farmers interviewed, this trait was the reason (Table 28).

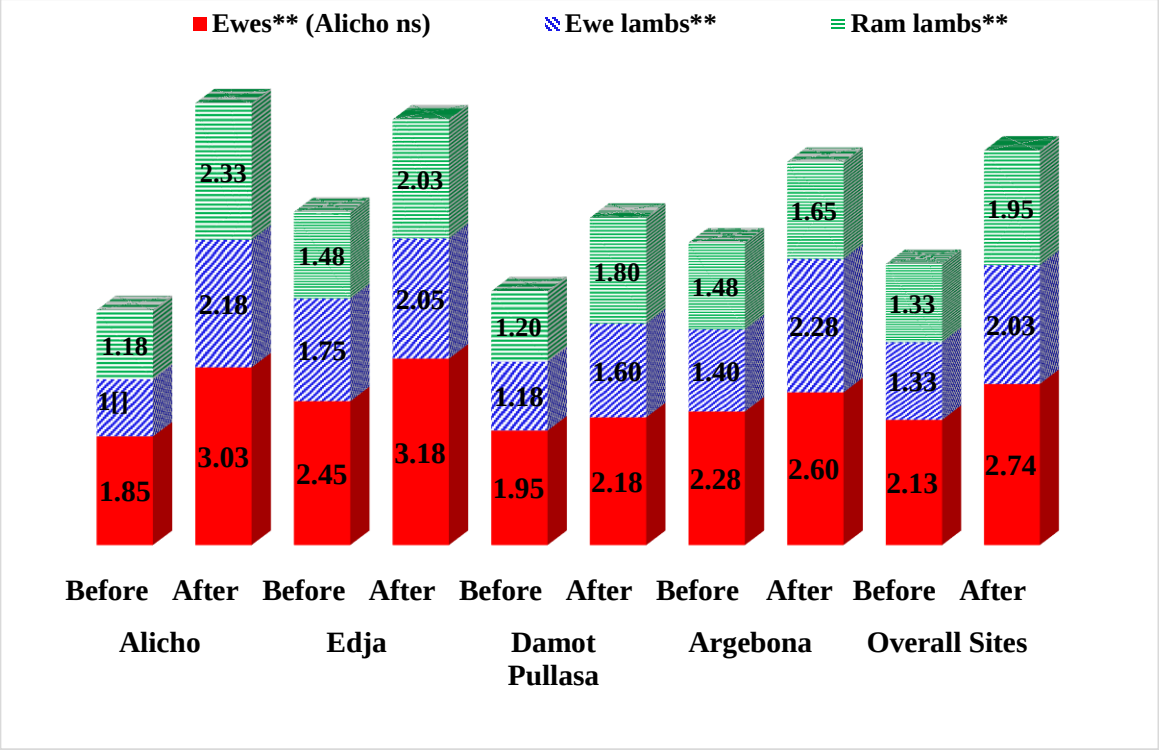


Figure 17: Sheep flock structure of respondents before and after Bonga sheep crossing

4.12.2. Sale of Sheep and Income generated after introduction of Bonga Rams:

The Bonga crossbreed sheep selling and income generating trends of BRU respondent farmers after crossbreeding is presented in table 44. The overall survey result indicates that 93.8% respondents sold sheep during last three years whereas 6.2 % did not sell any sheep during this period. The result also showed that, BRU respondent farmers sold more number of Bonga cross (2±1.5) than their local sheep (1.7± 1.4). The overall results showed that majority (80.2%) of BRU respondents reported that the trend of sheep sale increased after use of Bonga rams (crossbreeding) and the income of 96% respondents increased after Bonga sheep crossbreeding in the study sites.

Table 44: Number of Sheep Sold and Income Generated after Crossing

(*Based on BRU Respondent farmers*)

Location	Sheep sold after introduction of Bonga Rams				Trend in sale of sheep after introduction of Bonga Rams		Trend in income generated after crossing	
	Response (%)		Number sold (Mean ± SD)		Response (%)		Response (%)	
	Yes	No	Local	Bonga Crossbred	Increased	Not sure	Increased	No Change
Alicho Worero	90	10	0.95± 1.6	2.9± 2.2	80.0	20.0	100	0
Ezha	100	0	1.95± 1.2	1.73± 1.2	68.8	31.3	84.4	15.6
Damot Pulasa	92.5	7.5	1.5± 1.2	2± 1.2	92.9	7.1	100	0
Arbegona	92.5	7.5	1.7± 1.1	1.8± 1.4	80.6	19.4	100	0
Overall	93.8	6.2	1.7± 1.4	2± 1.5	80.2	19.8	96	4

4.12.3. Sale Price and Market Age of Sheep:

The results of average sale price and market age of sheep are represented in table 45. The BRU respondent farmers in the study areas sell local and Bonga cross sheep at local market with average prices of 560 and 912.7 Et. Birr. at an average age of 7.7 and 5.6 months, respectively. Location wise average sale price and age for Bonga cross were 1168.8, 674.8, 731.8, and 935.5

Et. Birr at the age of 7.3, 4.2, 4.4, and 5.8 months, respectively in Alicho Worero, Ezha, Damot Pulasa, and Arbegona districts. BRU respondent farmers in Ezha and Damot Pulasa sites sale Bonga crosses at earlier age (4.2 and 4.4 months) than Alicho Worero and Arbegona sites (7.3 and 5.8 months). The overall result showed that Bonga crosses were sold at high price of 352.3 Et. Birr than local sheep and at 2.1 month earlier ages. Based on current result Bonga cross selling trend and highest prices were observed in Alicho Worero districts (Table 44, Appendix 11.). BRU farmers reported that the price difference and earlier age selling of Bonga Cross breeds over local sheep in the study areas created good opportunity to increase their HH income. The significant difference of market price between the local and Awassi cross breed sheep breeds at all ages was reported by Solomon T. et al, (2015). The current result of average Bonga cross prices at 5.6 month ages was higher than that of Solomon T. et al, (2015) for Awassi cross (1081.4 at more than 12 month ages).

Table 45: Average Sale Price and Market Age of sheep **(***Based on BRU farmers***)**

Location	Average sale Price (ET Birr)		Average Market Age (Months)		Bonga cross Differences	
	Local	Bonga Cross	Local	Bonga Cross	Price	Age
Alicho Worero	588.9	1168.8	9.2	7.3	+579.9	-1.9
Ezha	498.8	674.8	6.4	4.2	+176	-2.2
Damot Pulasa	394.3	731.8	5.2	4.4	+337.5	-0.8
Arbegona	727.2	935.5	9	5.8	+208.3	-3.2
Overall	560.4	912.7	7.7	5.6	+352.3	-2.1

"+" indicates over than local sheep price and "– "indicated at lower age

4.12.4. Trend in Slaughter of Sheep and consumption of Mutton (Sheep meat):

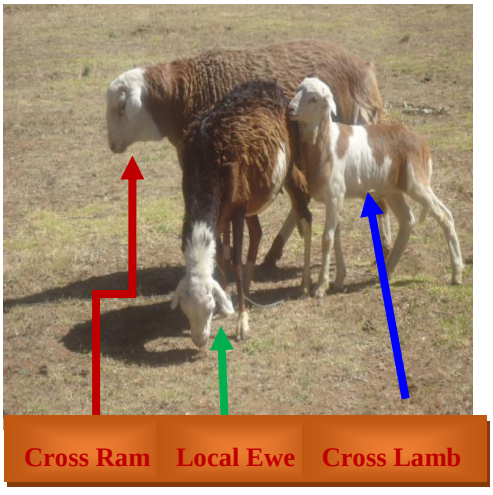
The results of trends in slaughter and consumption of meat in the study area is presented in table 46. The results showed that BRU respondent farmers slaughter (for home consumption) Bonga cross sheep in all locations but the percentage of sheep slaughtered differs among the districts. The percent slaughter was Alicho Worero (57.5%), Ezha (52.5%), Damot Pulasa (22.5%) and Arbegona (35%) indicating that percent slaughter is higher in first two locations compared latter two. The overall result showed that on an average 0.6±1 Bonga cross lambs

were slaughtered by BRU respondents slaughtered for home consumption. The X^2 test showed that the differences in the percentage of slaughter and number of sheep slaughtered across locations were significant. The results further showed that there was no change (55.6 %) followed by increased (30.6 % and decreased (13.8 %) percent in the home meat consumption among BRU respondents but the differences were not statistically significant. The main reason that farmers focus on selling of Bonga cross lambs with good price than slaughter for home consumption.

Table 46: Status and sheep meat consumption after Bonga sheep crossing

Parameters		Districts				Overall Site	P value
		Alicho Worero	Ezha	Damot Pulasa	Arbegona		
(I) Do you slaughter Bonga Crossbreed?							
Response (%)	Yes	57.5	52.5	22.5	35	42	0.04
	No	42.5	47.5	77.5	65	58	
(II) Bonga Crossbreds Slaughtered:							
Number	Mean ± SD	1.1±1.4	0.8±0.8	0.3±0.6	0.4±0.5	0.64±1	0.003
(III) Consumption of mutton (Sheep meat):							
Response (%)	Increased	60.0	45.0	20.0	7.5	30.6	0.1
	Decreased	0.0	5.0	0.0	47.5	13.8	
	No change	40.0	50.0	80.0	45.0	55.6	

4.12.5. Success Story of BRU Respondent:



W/ro Ormo Kalili is a 50-year-old and Lives Silte Zone Alicho Worero district Wezir one Kebele. Her house is around FTC and lives with her husband.

After introduction of Bonga Ram in her village she never used Local breeding Ram. Up to this study she crossed 9 local ewes with Bonga ram and got 22 lambs. From 22 cross sheep, she sold 9, slaughter 5 for home consumption and 4 given to relatives as gift and celebration support (Pledge/dowry).

During researcher's observation in her flock, except local breeding ewes no local sheep types was seen rather than Bonga cross.

She sold Bonga cross fattened ram to local market, farmers and relatives with minimum 2500 and maximum 7000-8000 Et. Birr. According to her, they were live in grass sheltered house before selling of Bonga cross sheep and now they changed their house to thin shelter.

Her husband said that the meat and fat composition on ribs is higher in Bonga crossbreds than local sheep. Due to this and good meat test they prefer Bonga cross for home meat consumption.

In general, W/ro Ormo and her husband were happy by introduction of Bonga Ram in their community and principles of crossbreeding with Bonga ram. Thus, they believe that crossing with Bonga rams increase income and keep food security (sheep meat consumption).

4.13. Constraints of Bonga sheep breed cross breeding effort

The constraints related to sheep production and genetic improvement is presented in table 47. The overall results showed that shortage of Bonga sires, diseases, shortage of feeds & water and shortage of technical support were ranked as first, second, third and fourth constraints in all study districts. Among location shortage of Bonga ram ranked first in Alicho Worero and Ezha districts, shortage of feed and water first, second and third in Damot Pulasa, Alicho Worero and Ezha districts, respectively. However, disease problem was ranked as first in Arbegona districts. According to Ermias (2014) the marketing was reported as major problem for Dorper crosses in Wolayta zone but no such response was reported in the present study. Besides he also reported that feed shortage was a major constraint in Silte zone and this observation was in agreement with the present study.

Table 47: Constraints of Bonga Sheep Crossbreeding

Constraints	Alicho Worero		Ezha		Damot Pulasa		Arbegona		Overall	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Diseases	0.26	2	0.29	2	0.26	3	0.35	1	0.29	2
Feeds & Water Shortage	0.26	2	0.26	3	0.32	1	0.23	3	0.27	3
Shortage of Bonga Sire	0.29	1	0.35	1	0.27	2	0.29	2	0.30	1
Lack of Technical Support	0.18	3	0.10	4	0.15	4	0.13	4	0.14	4

5. CONCLUSIONS AND RECOMMENDATIONS

5.1.Conclusions

The improved Bonga rams were distributed from Bonga sheep community-based breeding communities for genetic improvement in the local sheep of southern regions of Ethiopia and different parts of the country. Monitoring study was conducted from October 2016 and June 2017 from sampled households in Siltie, Gurage, Wolayita and Sidama zones of selected districts to evaluate the performances of Bonga rams and its progenies.

Promising results were seen on growth performance, reproductive performances, feed and disease adaptability, farmer's perception and socio-economics on Bonga rams and its progenies in all study sites. Significantly higher values ($P < 0.001$) of all the growth performance attributes were observed in Bonga cross lambs compared local lambs. The growth performances of Bonga crosses were 2.9±0.2, 8±0.5, 11.4±0.6, 13±0.6 and 17.4±0.8 kg for birth, two-month, three-month, four months and six-month weights respectively. The average daily gain for pre-weaning and post-weaning ADG weights was 92.2±5.4 and 86±4 gm respectively. Comparatively, the growth performances of local sheep were 2.4±0.2, 5.5±0.5, 8.3±0.6, 9.8±0.7, and 13±0.8 kg for birth, two-month, three-month, four months and six-month weights respectively. The average daily gain for pre-weaning and post-weaning ADG weights was 64.8±5.5 and 63.4±4 gm respectively. Location, genetic group, parity (except, 3, 4, 6-month weights and post-ADG), season of birth (except,6-month weight and post-ADG), birth type and sex had significant effect on pre-weaning and post- weaning weights.

The improvements in reproductive performance of sheep after Bonga sheep crossbreeding were observed in all study sites. The AFS for male, AFS for female, AFL and LI for Bonga crosses were 5.9±0.8, 6.3±0.8, 11.5±0.9, and 7.5±0.7 months respectively. However, AFS for male, AFS for female, AFL and LI for local sheep were 8.6±1.6, 8.6±1.5, 13.9±1.6 and 8.5±1.1 months respectively. ALS of ewe mated by Bonga and local ram were 1.75±0.3 and 1.46±0.5 respectively.

The Bonga rams and its crossbred progeny showed high adaptation to locally available feeds and waters and tolerance to disease and parasite load in the areas. The pre and post weaning mortality rate for Bonga cross lambs at Alicho Worero (4.8 and 2.5 %), Ezha (2.1 and 0 %), Arbegona (1.1 and 1.1%) and Damot Pulasa (1.6 and 0 %), respectively, which was

significantly lower than local sheep in the areas. The survival rate of Bonga rams at Arbegona, Ezha, Damot Pulasa and Alicho Worero were 93.3, 89.3, 97.2 and 95.2% respectively.

After use of Bonga sheep breed as one of the parents in all sites, sheep flock structure of farmers increased from 4.79 to 6.72, farmers sold cross lambs at earlier ages and incomes from sheep sold increased (96%). Due to attractive and promising physical traits (Body size and appearance; Coat Color) and performance traits (fast growth rate, feed adaptability, prolificacy and disease tolerance) of Bonga rams and its progenies, more farmers were adopting Bonga sheep crossbreeding and there is no any farmer's preference, social, cultural and religious antagonisms on crossbreeding of Bonga rams in all study sites. However, the overall result showed that the sheep crossbreeding efforts were constrained by shortage of improved breed, feeds & water shortage, diseases and limitation of technical support which was ranked as first, second, second, third and fourth.

5.2. Recommendations

Based on above views, the following recommendations were forwarded;

i. The shortage of Bonga breeding ram in the areas should be addressed on priority so that all local flocks in the study area are improved;
ii. The Bonga cross breeding programme in the study area has shown improvements in growth rate, reproductive performance and survival rate in all study areas. Thus this programme needs to be expanded to cover more areas;
iii. To sustain current cross breeding efforts in the areas and increase the net income of farmers, complementary interventions (improved forages, periodic vaccinating/ deworming and other management aspects) should be incorporated in the program;
iv. Awareness/ training to farmers concerning breeding management (inbreeding, merit and demerits of crossbreeding, cross lamb breeding lines and culling) along with other aspects of improved feeding managements needs to be organized on sustainable basis;
v. The strategy of using sires of other breeds (Other than Bonga) needs to be relooked after comparative studies of different crossbreds;
vi. Further study is needed to develop value chain analysis and characterize carcass yield percentages and meat quality of Bonga sheep crosses in the region

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7. Appendix

Appendix 1. Questioners Format for Bonga Ram Users

A. Remainder to enumerators

- Briefly introduce yourself to each farmer before starting any questions, i.e., get introduced to farmers (greet them by local way), tell your name and get his/her name, and make the purpose and objectives of your question clear.
- Please ask each question in local language, so clearly and patiently until the farmer understands.
- Please fill up the questionnaire according to the farmer's replay (do not put your opinion).
- Please try not to use technical terms while discussing with farmers and do not forget the local unit.
- Farmers may answer more than one question so, try to avoid repeating.

B. General Information

- Enumerator's name: _____
- Date: _____
- Questionnaire code: _____
- Zone_____District _____ kebele _____ village/gote _____

1. General Information of the Respondents

S/N	Description	Name (Response)
1	Name of the respondents	
2	Age	
3	Sex	
4	Marital status	
5	Education status of respondents	
6	Family number	Male_____Female_____Total_____
7	Total land size (hectare)	
8	Grazing land (hectare)	Farm land_____Follow land_____

For Education status of respondents use 1= Illiterate 2= Read & write 3= Elementary school 4= Secondary school 5= High school 6= other

2. How long is your sheep rearing experience? _____(year)
3. Do you have Bonga breed or its crosses? 1. Yes 2. No

If yes, fill the following table

S/n	Breed type	Sources of Sheep	Purpose of keeping
1	Local		
2	Bonga cross		
3	Pure Bonga		
4	Others (specify		

For sources of sheep 1= Home born, 2= Inherited, 3= Purchased, 4= BoA, 6= others
For purpose of keeping 1=Sale (income source), 2= Meat (home consumption) 3=Social and cultural functions, 4= Saving 5= others Specify

4. Flock structure of the Respondents

Age Category	Local	Bonga cross	Pure Bonga	Others (specify)	Total
Male 6 months to 1yr					
Female 6 months to 1yr					
Male > 1 year					
Female > 1 year					
Male lambs < 6 months'					
female lambs < 6 months'					
Castrated male					
Fattened Female					
Total					

C. Breeding Practice and Performance of Sheep

1. What type of Breeding/mating system you use before introduction of Bonga Ram?

   1. Controlled 2. Uncontrolled

2. Do you use another breeding ram by your own rather than Bonga/its cross?

   1. Yes 2. No

3. If yes, what is the source of this ram?

   1. Born in the flock 2. Purchased from market 3. Gift from relatives

   4. Rent 5.

   Others(Specify)_____

4. And for how many years this ram served in your flock? _____

5. Did you receive improved Bonga ram from any source?

   1. Yes 2. No

6. If yes, from which Sources? 1. Credit from government 2. Gift from NGOs

   3. Gift from government 4. Share arrangements

7. If No, from where you use Bonga Ram? _____So, what is your interest for future? _____

8. In which season crossing with Bonga takes place mostly?

   1. Wet Season 2. Dry season 3. Winter 4. Autumn

9. If so, what is the reason? _____

10. What is the level of conception (getting pregnant) in your ewes by using Bonga ram?

Number of	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Mated Ewes						
Ewes that received / got pregnant						

11. Do you practice selection of ewes for breeding/mating with Bonga Ram? 1. Yes 2. No

12. If yes,

    why_____

    What are your criteria?

    1. _____

    2. _____

    3. _____

13. How you compare mating performance of Bonga ram and its Cross with your local sheep? And with other breeds if you have?

Ram	**Bonga**	**Bonga Cross**	**Local**	**Others (Specify)**
Bonga				
Bonga Cross				
Local				

14. Lambing interval of your ewes after use of Bonga ram?
    1. Minimized 2. Maximized 3. No change

15. Did you observe inbreeding problem in your sheep flock before introduction of Bonga Ram?
    1. Yes 2. No

16. If yes, what are the symptoms_____? how sever is the problem?
    1. Very Critical 2. Critical 3. Bearable 4. Easily manageable

17. What is the level of this problem after introduction of Bonga Ram?
    1. Avoided 2. Minimized 3. No change

18. How much do you agree or disagree if I say that Bonga rams are genetically Best rams for sheep breed improvement? Or for Cross breeding?
    1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree

19. Body size of new born sheep in your flock after the crossing with Bonga ram:
    1. Showed improvement 2. No change 3. Decreased in body size

20. Number of twin born lambs in your sheep flock after the crossing with Bonga ram:
    1. Increased 2. No change 3. Decreased

21. In Generally, how is the reproductive performance of sheep in your flock? Fill in the table

S/n	**Particulars**	**Indigenous/Before Crossing**	**Bonga Cross/ After crossing**	**Others (Specify)**
1	Age at first lambing (months)			
2	Age of first mating for females (months)			
3	Age of first mating for males (months)			
4	Lambing interval ewes (month)			
5	Average litter sizes			
6	Estimated weaning age of lamb in your flock (months)			
7	Estimated age of lamb reaching for market (months)	M____ F____	M____ F____	M____ F____

D. Farmers Preference of Bonga Rams

1. From where you get information about improved Bonga sheep at first time?
    1. Public Media /EBC/ 2. Public Media/ FM? 3. Extension experts 4. Friends

5. Public meeting 6. Others (specify)_____

2. What did you do to your local ram after introduction of Bonga ram in your area?

   1. Castrated immediately 2. Sold to market 3. Continued keeping 4. Others (specify)

3. Is there any special management for Bonga ram? 1. Yes 2. No

   If yes, specify type of management_____

   _____

4. How do you compare the actual performance of improved Bonga ram and information you heard about the breed?

   1. Agree very much 2. Relatively agree 3. Disagree very much 4. Relatively disagree

5. Is there any livestock cooperative in your area? 1. Yes 2. No
6. If yes, in what sector? And specify animal type 1. Fattening (_____)

   2. Breed improvement (_____) 3. Production (_____) 4. All

7. What do you do if your ewe gave lambs from Bonga ram? Tick if one or more

Lamb category	**Keep for breeding**	**Keep for fattening**	**Give gift for others**
Ram lambs			
Ewe lambs			

8. Have you practiced castration of Bonga ram lamb/ram's crosses? 1. Yes 2. No
9. If yes, how many ram lambs/rams? You still castrate _____and at what age____(month)
10. Do you practice sheep fattening before starting of Bonga Crossbreeding?

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

11. Do you buy in some local sheep to your flock for fattening purpose currently?

    1. Yes 2. No

12. Do you believe the crossing with Bonga rams would improve your flock sustainably in future? 1. Yes 2. No
13. If No, Why_____
14. Are you satisfied with the demonstration of Bonga sheep crossbreeding strategy in your area? 1. Yes 2. No

If you are not satisfied, mention the reasons_____

15. Which physical appearances or traits you appreciate/like about improved Bonga ram? Tick & rank each

Parameters	**Tick**	**Rank**	**Justify**
Size			which size /big or small
Appearance			
Color			which color
Hornless			
Temperament			
Others (specify)			

16. Which performance or traits you appreciate/like about improved Bonga ram? Tick & rank each

Parameters	**Tick**	**Rank**	**Justify**
Disease tolerance			
Drought tolerance			
Feed adaptability			
Growth rate/fast growth			
Prolificacy			
Fertility/libido			
Others (specify)			

17. For what purpose, do you keep Bonga sheep/Its cross? Select one or more, then rank

Purpose	**Tick**	**Rank**	**Justify**
Meat			
Milk			
Cash income only			
Skin			
Manure			
Wealth			
Insurance			
Others (specify)			

18. Do you allow your ram/cross lamb to serve ewe other than yours?

    1. Yes, why? _____

    2. No, why? _____

19. Do you allow your ewe to be served by anyone else ram rather Bonga/ its crosses?

    1. Yes, why? _____

    2. No, why? _____

20. Do you want to increase sheep flock sizes and production in the future? 1. Yes 2. No

21. If yes, which breed you want? ---------- and what is your reason to select this breed----------

E. Socio-Economic Characteristics of Bonga Sheep Crossbreeding

1. How long have you been use a Bonga Ram? _____years.
2. Flock structure before and after the use of Bonga Ram

Average flock size before the use of Bonga ram		**Average flock size after the use of Bonga Ram**	
Sheep category	Number owned	Sheep category	Number owned
Ewes		Ewes	
Ewe lamb		Ewe lamb	
Rams		Rams	
Ram lambs		Ram lambs	

3. Have you sold sheep in the past three years? 1. Yes 2. No
4. If yes, for what purpose? And how many sheep you sold and get total price (fill the following table)

Purpose	**Local**		**Bonga cross**		**Others (Specify)**	
	#sold animal	Total Price	#sold animal	Total Price	#sold animal	Total Price
Cash for farm inputs (fertilizer, seed, etc.)						
Cash income for children school						
Cash for family health treatments						
Shortage of grazing land and feeds						
Cash to purchase foods (HH expense)						
To pay back credit						
Others, specify						

5. To whom you usually sell Bonga cross?

    1. Merchants 2. Relatives 3. Governments 4. NGO 5. Farmers in the same

6. Which sheep category would you usually target when you have to sell? (Tick)

S/n	Sheep Category	Local	Bonga cross	Others (Specify)
1	Breeding ram			
2	Ewes			
3	Ram (matured for meat/market)			
4	Ram lambs (young)			
5	Ewe lambs (young)			
6	Old ewes			

7. Do you think number of sheep sold from your sheep stock increased after the use of Bonga ram?

    1. Yes 2. No 3. Not sure

8. Average price your local sheep fetched in market? Max _____Birr; Min _____Birr

9. Average price your Bonga cross fetched in market? Max _____Birr; Min _____ Birr

10. What would you say about income gained from sell of sheep after the use of Bonga sheep?

    1. Improved significantly 2. No change 3. Decreased

11. If your income from sheep keeping increased over the last years, it is

    1. completely due to improvement in the sheep breed by crossing

    2. Just due to increase in demand and price of sheep over years

    3. Other reasons_____

12. Have you ever slaughtered Bonga cross from the flock for household consumption over the last years?

    1. Yes 2. No

13. If yes, how many sheep each year on average? _____sheep.

14. How you compare consumption of sheep meat in the household after the crossbreeding.

    1. Increased 2. Decreased 3. No change

15. If increased, why consumption has increased? _____

16. If decreased, why consumption has decreased? _____

17. Financial benefit from Bonga sheep cross breeding

Year	Number of borne Bonga cross	Number of sold Bonga cross		Average Price		Expenditures		
		Fattened	Non-fattened	Fattened	Non-fattened	Feed	Medication	labor

F. Feed Resources and Feeding Strategy of Sheep

1.What are the basic sheep feed sources for your Flock? _____

2. Do you graze your sheep? 1. Yes 2. No
3. If Yes, which type of grazing land you use? 1. Farm land 2. Follow land 3. Both
4. How you graze Bonga ram and also its cross?
   1. Free grazing with other Sheep 2. tethered grazing with other Sheep
   3. Free grazing with other Sheep tethered 4. Cut and carry
5. Do you provide supplementary feeds for Bonga ram or its cross Separately than your local sheep? 1. Yes 2. No

If yes, please fill the following Table

S/n	Supplementary feed type	Frequency of feeding	Estimated Amount in gram per day/sheep	Source of feed
1				
2				
3				
4				
5				

For source of feed; Use 1 = Produced, 2=Purchased, 3= Others (specify

6. Is there feed shortage in your area? 1. Yes 2. No
7. If yes, when? 1. Dry season 2. Wet season 3. Both
8. If feed shortage in your locality, why? (rank)
   1. Increase of animal population 2. Increasing Cultivation
   3. Increase of human population 4. Drought 6. Others, specify
9. What are the common water sources for your sheep?
   1. Rainy season _____
   2. Wet season _____
10. Is there any water shortage or problem to sheep? 1. Yes 2. No

11. If yes, when? 1. Dry season 2. Wet season 3. Both
12. Why shortage of water? 1. Drying of water sources 2. Far distant from water sources
    3. Not allowed to use sources 4. Provide other livestock than sheep
    5. others, specify _____

G. Sheep Health Management

1. Is there any common diseases and parasites that affect health and production of sheep in your flock?
   1. Yes 2. No
2. If Yes, what are those common diseases and parasites that affect health and production of sheep

S/n	**Local name**	**Which sheep group it Affects**				**Seasons or months, it occurs/ Affects**	**Symptoms**
		Ram	Ewe	Lamb	all		
1							
2							
3							
4							
5							

3. So, what would you do when these sheep sick? 1. Treat with traditional practices 2. Sales immediately 3. Slaughters immediately 4. Takes to veterinary center 5. Treat with treatments of local traders 6. Others, specify_____
4. Do you access to veterinary services in your locality/near distance?
   1.Yes 2. No
5. From where you usually obtain this service? 1. BoA 2. DA offices 3. NGOs
   4. Farm land institutions 5. Others, Specify_____
6. Has there been any death of Bonga crosses? 1. yes 2. No
7. If Yes, which sheep category mostly died?
   1. Lambs less than 3 months 2. Lambs more than 3 months 3. Rams 4. Ewes
8. Do all Bonga cross lambs born in your flock survive up to weaning? 1. Yes 2. No
9. If No, when do you experience most of the pre-weaning deaths? 1. wet season 2. dry season

10. Do your ewes face the following problems in your flock?

Parameters	Abortion	Dystocia	Others (specify)
Yes/No			
In which parity, it occurs			
In which season, it is common			
What are the reasons			
If there is Dystocia, in which lamb sex mostly occur (M /F)			
If there is Dystocia, in which birth type mostly it occurs (1,2,3,4,5,6,7)			

11. If So, what measures you take for;

A. Abortion;

_____

B. Dystocia;

_____

_____

Appendix 2. Questioners Format for Non-Bonga Ram Users

A. Remainder to enumerators

- Briefly introduce yourself to each farmer before starting any questions, i.e., get introduced to farmers (greet them by local way), tell your name and get his/her name, and make the purpose and objectives of your question clear.
- Please ask each question in local language, so clearly and patiently until the farmer understands.
- Please fill up the questionnaire according to the farmer's replay (do not put your opinion).
- Please try not to use technical terms while discussing with farmers and do not forget the local unit.
- Farmers may answer more than one question so, try to avoid repeating.

B. General Information

- Enumerator's name: _____
- Date: _____
- Questionnaire code: _____
- Zone_____ District_____ kebele _____ village/gote _____

1. General Information of the Respondents

S/N	Description	Name (Response)
1	Name of the respondents	
2	Age	
3	Sex	
4	Marital status	
5	Education status of respondents	
6	Family number	Male _____ Female_____ Total_____
7	Total land size (hectare)	
8	Grazing land (hectare)	Farm land_____Follow land_____.

For Education status of respondents use 1= Illiterate 2= Read & write 3= Elementary school 4= Secondary school 5= High school 6= other

2. How long is your sheep rearing experience? _____(year)

3.

Do you keep other breed/ its crosses? 1. Yes 2. No

S/n	Breed type	Sources of Sheep	Purpose of keeping
1	Local		
2	Others (specify		

4. Flock structure of the Respondents

Age Category	Local	Others (specify)	Total
Male 6 months to 1 year			
Female 6 months to 1 year			
Male > 1 year			
Female > 1 year			
Male lambs < 6 months'			
female lambs < 6 months'			
Castrated male			
Fattened ewe			

C. Breeding Practice and Performance of Sheep

1. What type of Breeding/mating system you use? 1. Controlled 2. Uncontrolled

2. Do you have breeding ram by your own? 1. Yes 2. No

If yes, how many_____?

3. If yes, what is the source of your breeding ram?

1. Born in the flock 2. Purchased from market 3. Gift from relatives

4. Rent 5.

Others(Specify)_____

4. And for how many years on the average is the same breeding ram serving in your flock? ____

5. If No, from where you use breeding ram: 1. From neighbors 2. From FTC

3. Others (specify) ----------

6. In which season do you think mating take place in your flock mostly?

1. Wet season 2. Dry season 3. Winter 4. Autumn

7. If so, what is the reason? _____

8. Do you think negative selection has impacted performance of productivity in your own sheep flock? 1.Yes 2. No 3. Not sure

9. Do you practice Selection of male and female for breeding purpose?

Male; 1. Yes 2. No, If yes, at what age _____ months

Female; 1. Yes 2. No, If yes, at what age _____ months

10.

What are your selection criteria? (rank)

S/n	For Breeding Ram	Rank	For Breeding Ewe	Rank
1				
2				
3				
4				
5				
6				

11. How you compare mating performance of your ram with another ram you seen in your neighbor or listen? 1. High 2. Medium 3. Low

12. What is the lambing performance of your Ewes?

1. Always give single birth 2. Always give twin birth

3. Rarely give twin birth 4. Rarely give triple birth

13. In Generally, how is the reproductive performance of sheep in your flock? Fill in table

S/n	Parameters	Indigenous	Others (Specify)
1	Age at first lambing (months)		
2	Age of first mating for females (months)		
3	Age of first mating for males (months)		
4	Lambing interval (month)		
5	Average litter sizes		
6	Estimated weaning age of lamb in your flock (months)	Max____Min_	
7	Estimated age of lamb for market (months)	M____ F____	
	Estimated age to mature (years)	M____F____	
8	lifetime production (longevity) of ewe	Max__Min___ _	
9	Total number of lambing of ewe in her life time production?	Max__ Min____	
10	Total number of lamb born by ewe in her life time production?	Max__Min___ _	

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

15. If yes, what is the symptoms _____ how sever is the problem?

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

16. Body size of new born sheep in your flock within a year:

1. Showed improvement 2. No change 3. Decreased in body size

17. If ___, how/why? _____

18. Did you have information about improved Bonga sheep/ram?

1. Yes 2. No

19. If yes, from which Sources?

1. Public Media /EBC/ 2. Public Media/ FM? 3. Extension experts 4. Friends

5. Public meeting 6. Others (specify)_____

20. Have you seen cross lambs of Bonga in your area? 1. Yes 2. No

21. How You agree if I say, the performance of Bonga cross lambs that you see higher than yours? 1. Agree very much 2. Relatively agree 3. Disagree very much 4. Relatively disagree

22. If so, why you not use Bonga Ram? 1. Lack of access for Bonga ram

2. Cost of ram for mating 3. lack of awareness

4. Others (specify_____

23. What is your interest for future? _____

24. Which sheep category would you usually target when you have to sell and bought? (tick)

Sheep category	Sell	Bought	Reason
Breeding ram			
Ewes			
Ram lambs			
Ewe lambs			
Ram (matured for meat/market)			
Old ewes			

25. Have you ever slaughtered sheep from the flock for household consumption over the last years? 1. Yes 2. No

26. If yes, how many sheep in a year time? _____sheep.

27. Consumption of sheep meat in the household in every year:

1. Increased 2. Decreased 3. No change

28. If increased, why consumption has increased? _____

29. If decreased, why consumption has decreased? _____

30. Do you accept if Bonga rams will be introduced in your got/village?

1. Yes 2. No

31. If No, Why_____

D. Feed Resources and Feeding Strategy of Sheep

1. What are the basic sheep feed sources in your area? _____

_____

2. Do you graze your sheep? 1. Yes 2. No

3. Which type of grazing land you use? 1. Farm land 2. Follow land 3. Both

4. How you practiced grazing your sheep in the dry season?

1. Free grazing 2. Tethered grazing 3. Cut and carry

5. How you practiced grazing your sheep in the wet season?

1. Free grazing 2. Tethered grazing 3. Cut and carry

6. Do you provide supplementary feeds for your sheep? 1. Yes 2. No

If yes, please fill the following Table

S/n	Supplementary feed type	Frequency of feeding	Estimated Amount in gram per day/sheep	Source of feed	Remark
1					
2					
3					
4					
5					
6					

For source of feed; Use 1 = Produced, 2=Purchased, 3= Others (specify

7. Is there feed shortage for your sheep? 1. Yes 2. No

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

10. What are the common water sources for your sheep?

1. Rainy season _____

2. Wet season _____

11. Is there any water shortage or problem to sheep? 1. Yes 2. No

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

E. Sheep Health Management

1.What are the common diseases and parasites that affect health and production of your sheep

S/n	Local name	Which sheep group it Affects				Seasons or months, it occurs/ Affects	Symptoms
		Ram	Ewe	Lamb	all		
1							
2							
3							
4							
5							

2. What would you do when your sheep sick?

1. Treat with traditional practices 2. Sales immediately 3. Slaughters immediately

4. Takes to veterinary center 5. Take to or treat with treatments of local traders

6. Others, specify_____

3. Are you accessible to veterinary services in your locality/near distance?

1.Yes 2. No

4. From where you usually obtain veterinary services?

1. BoA 2. DA offices 3. NGOs 4. Farm land institutions

5. Others, Specify_____

5. Has there been any death of sheep over the last 12 months? 1. yes 2. No

6. Which sheep category mostly died over the last 12 months?

1. Lambs less than 3 months 2. Lambs more than 3 months 3. Rams 4. Ewes

7. Are all lambs born in your flock survive up to weaning? 1. Yes 2. No

8. If no, when do you experience most of the pre-weaning deaths?

1. wet season 2. dry season

9. What do you think the reason for death of lambs? (Tick one or more blanks)

1. Predators ---------- 2. Poisoning ----------3. Disease ----------

4. Accident ---------- 5. Unknown ----------

10. Do you have separate pen for sheep? 1. Yes 2. No

11. If yes, what type of house is it?

1. Concrete wall 2. Earthen wall 3. Wooden wall 4. other, specify _____

12. Do your ewes face the following problems in your flock?

Parameters	Abortion	Dystocia	Others (specify)
Yes/No			
In which parity, it occurs			
In which season, it is common			
What are the reasons			
If there is Dystocia, in which lamb sex mostly occur (M /F)			
If there is Dystocia, in which birth type mostly it occurs (1,2,3 & 4)			
What measures you take			

13. What are the common problems of sheep production in this area? Tick and rank them

Problems	Yes/No	Rank	Remark
Diseases and parasites			
Shortage of feeds & water			
Type of Breed			
Lack of supporting technical institution/experts			

Appendix 3: Check List for Focal Group Discussion

Zone _____

District_____

1. Can you tell me the origin/history of local sheep in this area?
2. How was Sheep population and production trends in the last five years and current?
3. How was the breeding strategy of sheep in the past?
4. What are the breeding objectives and breeding practice of sheep currently?
5. Do you practice Ram and ewe Selection for genetic improvement?
6. If so, what are the Farmer traits preference/selection criteria and rank them?
7. What is the practice/experience of rams sharing within the community in this area?
8. Do you have experience of sheep crossing in the past? If so with which breed?
9. If Bonga Breed, How You get/introduce/ this breeding ram
10. What are your/local community contributions to introduce Bonga ram in this area?
11. Are there any social, religious and cultural complains concerning Bonga ram/sheep introduction?
12. What are the benefits/advantages of Bonga ram introduction in your area? (Related to food security, Income contribution…etc.)
13. How is the level of farmers' preference of Bonga Ram in your area?
14. How is the Adaptability and survivable rate of the Bonga Rams and its crosses?
15. Compare performance of sheep flock before and after the introduction of Bonga sheep in this area (body size, lamb survival to weaning, twining (prolificacy), tail type, coat color, lambing interval, Age at puberty, libido).
16. Do you think the Bonga crosses from improved Bonga ram would fetch higher premium compared to the other local breeds?
17. Have you sold any of your Bonga cross rams/ram lambs to other community (or individual) for breeding purpose? The price difference Bonga cross ram's/ram lambs and other ram's/ram lambs?
18. How is the attitude of Bonga ram non-user farmers in the village about Bonga ram?
19. What are the major constraints of sheep improvement in this area?
20. In this area who is/are mostly do sheep Keeping activities (women, man, son)

21. What are the common diseases and parasites that affect health and production of sheep in your Area?

S/n	Local name	Which sheep group it Affects				In which Seasons or months, it occurs/ Affects	Symptoms
		Ram	Ewe	Lamb	all		
1							
2							
3							
4							
5							

Appendix 4: Secondary Data Collection Checklist

Zone _____District_____

1. Human population:
    1. Male_____
    2. Female_____
    3. Total_____
2. Livestock population:

Animal	Male	Female	Total
Cattle			
Sheep			
Goats			
Donkey			
Mule			
Horse			
Poultry			

3. Average land holding per household (in ha) _____
4. Season of the year
    1. Main rainy season from _____to_____2. Short rain season from _____to_____3.Dry season from _____to _____

6. Climatic data (distribution and amount)

1. Annual average temperature _____Maximum _____Minimum_____

2. Annual average rain fall (mm) _____Max. (mm)_____Min.(mm)_____

7. Agro-ecological zone of the district (%)

1. Lowland_____3. Midland_____3. Highland_____

8. Production system/farming system_____

9. Introduction of Improved Bonga Rams in the Areas

Year	#Introduced Rams in to zone/district	# Died Ram after introduction
2005		
2006		
2007		
2008		

10. What are the contributions of Government, NGOs and Farmers during the introduction of the Bonga rams (fill the table and rank according to their contribution)

Stakeholders	**Technically**	**Financially (amount)**	**Rank**
Government			
NGOs			
Farmers			

11. How many FTCs zone/District have and number of Bonga Rams distributed

- Total Number of FTC_____
- Number of FTC Bonga ram Introduced _____
- Average number of Bonga ram per FTC_____

12. Opinion on relative importance of Bonga Sheep in the farmers' livelihood (income contribution of the activity in percent) _____

13. Major sheep production constraints at district level_____

S/n	**Constraints**	**Rank**	**Remark**
1			
2			
3			

14. Major Sheep Health Problems that influence reproductive and productive performance in the zone/district

S/n	Major disease	Occurrence/cont./sometimes	Mortality/high/low	Type of treatment
1				
2				
3				
4				

15. What is your plan for future concerning Bonga sheep in General?

_____

_____

Appendix 5: Lamb Monitoring Format

Zone: _____ District: _____ Kebele/got: _____

Farmers Name	Ewe code	Breeding ram	Mating Date	lambing date	Birth type	Sex	Parity	Lamb Coat	Tail type	Lamb code	Weight					
											PPWT	Birth	At 60	At 90	At 120	At 180 day

Appendix 6: Disseminated Bonga Ram Physical Breeding Soundness assessment format

S/n	Ram Id	Age	Libido	BCS	SC	Teeth	Prepuce	Sheath	Testicles

USE:

- Libido [1=high, 2= Medium, 3= Low]
- Teeth [1= Normal dentition, 2= Broken teeth (number: …), 3= abnormal dentition]
- Sheath [1= Normal, 2= Pus and abscesses, 3= Abnormal, 4= Other (……)]
- Testicles [1= Normal, 2= Small, 3=Big 4=Scar tissue, 5= Cryptorchidism, 6= Adhesions, 7= Other……]
- BSC (Body condition score) 1= Emaciated, 2 = Thin, 3 = Average, 4= Fat & 5 = Obese

Appendix 7: **ANNOVA for Pre-weaning body weights(kg) and Weight Gain (gm)**

Source of Variation		Birth	2Month	3Month	3PrDAG
	MS	0.98	11.55	18.40	4598.79
Location	F-Value	3.80	4.45	5.31	13.81
	P-Value	*	**	**	***
	MS	37.84	720.42	1021.09	79759.51
Breed	F-Value	147.25	277.47	294.72	239.50
	P-Value	***	***	***	***
	MS	0.62	7.56	11.51	509.65
Parity	F-Value	2.42	2.91	3.32	1.53
	P-Value	*	**	**	NS
	MS	0.38	20.24	52.25	6600.13
Season	F-Value	1.48	7.80	15.08	19.82
	P-Value	NS	**	***	***
	MS	0.82	26.48	20.65	1658.61
Birth Type	F-Value	3.20	10.20	5.96	4.98
	P-Value	*	***	***	**
	MS	1.60	9.51	37.97	3119.96
Sex	F-Value	6.22	3.66	10.96	9.37
	P-Value	*	NS	**	**
R2		**27.58**	**41.55**	45.25	42.30
CV%		**19.61**	**21.27**	**17.43**	**20.74**
Error MS		0.26	**2.60**	3.46	333.03
Mean		**2.58**	**7.57**	**10.68**	**87.99**

*Note * Significant at (P<0.05), ** Significant at (P<0.001), *** Significant at (P<0.0001) and SN not Significant*

Appendix 8: ANNOVA for Post-Weaning Body Weights(kg) and Body Gains (gm)

Source of Variation		4Month	6month	6PrDAG
Location	MS	23.60	22.86	1748.56
	F-Value	5.35	2.50	7.27
	P-Value	***	NS	***
Breed	MS	912.35	689.68	18605.69
	F-Value	206.69	75.57	77.35
	P-Value	***	***	***
Parity	MS	7.09	14.62	274.98
	F-Value	1.61	1.60	1.14
	P-Value	NS	NS	NS
Season	MS	81.31	17.04	8.58
	F-Value	18.42	1.87	0.04
	P-Value	***	NS	NS
Birth Type	MS	47.51	85.13	1412.78
	F-Value	10.76	9.33	5.87
	P-Value	***	***	**
Sex	MS	53.79	64.70	1199.21
	F-Value	12.19	7.09	4.99
	P-Value	***	**	**
R2		**44.38**	**48.14**	**50.19**
CV%		**16.29**	**19.29**	**20.24**
Error MS		**4.41**	**9.13**	**240.53**
Mean		**12.90**	**15.66**	**76.63**

*Note * Significant at (P<0.05), ** Significant at (P<0.001), *** Significant at (P<0.0001) and SN not Significant*

Appendix 9: **ANNOVA for Location X Genetic groups**

	Birth	**2Month**	**3Month**	**Pre-DAG**	**4Month**	**6month**	**Post-DAG**
MS	0.38	18.58	6.42	897.68	14.84	15.08	485.13
F-Value	**1.5**	7.4	1.9	2.7	3.4	1.7	2.1
P-Value	0.22	<.0001	0.13	0.04	0.02	0.18	0.11
R2	0.28	0.44	0.46	0.43	0.46	0.50	0.52
CV%	19.58	20.87	17.38	20.62	16.13	19.18	20.06
Significances	NS	***	NS	*	*	NS	NS

Appendix 10: Purpose of Bonga sheep crossing

Purpose	Alicho Worero					Ezha					Damot Pulasa					Arbegona					Overall				
	Rank			Total	Index	Rank			Total	Index	Rank			Total	Index	Rank			Total	Index	Rank			Total	Index
	1	2	3			1	2	3			1	2	3			1	2	3			1	2	3		
Meat	3	21	16	67	**0.28**	10	30	0	90	**0.38**	0	31	9	71	**0.3**	4	28	8	76	**0.32**	17	110	33	304	**0.32**
Cash income	37	3	0	117	**0.49**	30	10	0	110	**0.46**	40	0	0	120	**0.5**	36	4	0	116	**0.48**	143	17	0	463	**0.48**
Manure	0	0	0	0	**0**	0	0	23	23	**0.1**	0	3	16	22	**0.1**	0	5	20	30	**0.13**	0	8	59	75	**0.08**
Wealth	0	10	8	28	**0.12**	0	0	8	8	**0.03**	0	6	15	27	**0.1**	0	0	0	0	**0.00**	0	16	31	63	**0.07**
Insurance	0	6	16	28	**0.12**	0	0	9	9	**0.04**	0	0	0	0	**0.0**	0	3	12	18	**0.08**	0	9	37	55	**0.06**

Appendix 11: Focus Group Discussion Results

Sn	Parameters	Alicho	D/Pulasa	Ezha	Arbegona
1	Origin/history of local sheep	➢ From **Bole** i.e. **Gummer, Gurage zone**	➢ From **Kambata** through marketing (Shichicho market)	➢ From **Gummer, Gurage zone.** ➢ i.e. The origin of local sheep was Gurage, not from other zones ➢ The market chain was Bole (Gumer) – Shamena (study site) --- Agena—other zones	➢ The origin of their local sheep is unknown, they inherited from their parents. ➢ However, during deep discussion most of the time their parents bought from **Kokokisa** District (Oromiya region eastern/misirak/ Oromiya) and keep for production, ➢ One elder thought as, some years ago, Awassi sheep/haired type/ was introduced in the area through Italian government.

					➢ Finally, they agreed that the origin of their local sheep was from **Oromiya/Kokokisa**
	Local Name	• Sheep = • Dam/Ewe = Tay • Ram = Tindir /korbosha • Lamb = Girangir • Ewe lamb = Noshash • Ram lamb = Korbesha	•	Sheep = Tay Dam/Ewe = Tay Ram = Gundir/Korbesha Lamb = Girangir Ewe lamb = Ram lamb = Korbesha	Sheep = Gerecho Dam/Ewe = Gerewuama Ram = Gocho Lamb = Wilile Ewe lamb = Godane Ram lamb = Wililecho
2	Sheep population and production trends	• Population decreasing due to grazing land • Productivity increasing due to Bonga sheep crossing program	• Population were decreased due to decreasing grazing land in the area. • Production trends relatively increased due to market demand increasing every year.	• Population were decreased due to decreasing grazing land and shortage of feed resources in the area.	• Population decreasing due to Feed shortage in the area • Production trends increased modernization and introduction of improved Bonga breeds in the area

3	Breeding strategy in the past	• Traditional mating system, i.e. ✓ Randomly mating system/uncontrolled ✓ Don't care about pedigree information of their sheep ✓ Don't care about mating performance of ram/ they look only maleness ✓ They didn't care for inbreeding	➢ They haven't breeding strategy ✓ They didn't use improved ram ✓ Uncontrolled breeding system ✓ Inbreeding ✓ Farmers were killed their time by searching serving ram around urban and long distances of village	➢ They haven't any breeding strategy ✓ They follow random mating (uncontrolled) mating, because they use free grazing in the past. ✓ There is no selected breeding ewe and ram ✓ Farmers in the area follow hand weaning for their local lambs	➢ No Breeding strategy in the past ➢ Random mating ➢ No improvement ➢ Farmers use ram from anywhere
4	Breeding objectives of sheep currently	• Improving growth performance of local lambs/sheep • Improving income gain through selling Bonga cross sheep	○ **Breeding objectives of farmers in the area includes;** • Improvement of growth performance of lambs through crossbreeding	➢ Improving growth performance of local sheep by crossing Bonga ram ➢ Improving income through selling fast	➢ Improving body size of sheep by crossing Bonga ram ➢ Improving growth performance of local sheep

		• Generally, improving local sheep through Bonga sheep crossing strategy	• Improving their income through selling of cross sheep • Improving marketable colors such as, red, light red and white red (" Dalecha")	growth Bonga cross lambs at early age	➢ Improving income gain through selling Bonga cross sheep ➢ Increasing twinning rate ➢ Improving milk production ➢ Improving local sheep color (red
5	Breeding practice of sheep currently	➢ **Breeding practices of farmers in the area includes:** ✓ Replacing local sheep by Bonga cross ✓ Using Bonga ram and cross ram lambs within community to control inbreeding/ ✓ Selling ram lambs at less than 6 months and	➢ **Breeding practices of farmers in the area includes:** ✓ Selection of breeding Ram and female o Purchasing of best female from market and crossing with Bonga ram o Farmers who keep local ram in the immediately sold their local ram o Their sheep production or breeding were dual purpose i.e. improving their local sheep type and improving soil fertility	➢ Using Bonga ram by rotating within community ➢ Crossing local sheep with improved bonga ram ➢ Due to fast growth rate of Bonga sheep farmers in the community focus on Bonga ram	✓ Replacing local sheep by Bonga cross ✓ Following terminal crossing ✓ Castrating both Bonga cross lamb and local ram/ram lambs/ before start mating ✓ Using only pure Bonga ram for breeding purpose

		keeping ewe lambs for replacement	around their home through using sheep manure (compose).		
6	Practice Ram and ewe Selection for genetic improvement?	➢ Yes ✓ There was wool sheep in the past in the area ✓ Also meat type Peoples in the area called big sheep ***"American sheep"*** Currently also they called Bonga sheep as ***"Fereng Beg"*** or ***French*** sheep	✓ Locally they practice selection of sheep. ✓ Elders told as, they know that, selecting of both male and female for breeding purpose improve their local sheep type. But they didn't practice	✓ Some farmers in the area practice selection ✓ Not usual	➢ Yes; ✓ Most of their local sheep are recessive horned (i.e. Horns are not either big or hornless) ✓ Farmers believed that horned ewes were introduced from Oromiya region ✓ So, they didn't happy for this futurity of local sheep in the area.
	Farmer traits preference/selection criteria	**For Male;** ✓ Body condition (good body appearance, big and long body size)	❖ **For Females** o Long tail o Wide body size o Long body length o Wattle o Wider udder ❖ **For Male**	❖ **For Females** o Good body condition (Body appearance) o Color (dark red with white head, red with white head) o Good Mothering ability	**For Male;** ✓ Body length ✓ Color (red) ✓ Hornless **For Female;** ✓ Big body size ✓ Wide udder size ✓ Twinning

		✓ Color (red , Dalecha & dark red with head) ✓ Horn (hornless) **For Female;** ✓ Body condition (good body appearance, big and long body size) ✓ Color (red, Dalecha & dark red with head) ✓ Mothering ability (milk for her lambs)	o Color (Grey, white with red, red) o Horned (for market preference) o Long tail	❖ **For Male** o Color (dark red , red o Appearance o Health condition o Horned	✓ Hornless
8	Practice/experience of rams sharing within the community	Before introduction of Bonga ram, ✓ There is no common norm ✓ They use randomly, as	➢ Before introduction of Bonga ram Farmers in the area use Breeding Rams randomly. o i.e. they didn't care about breeding ram's mating performance, age and its	Before introduction of Bonga ram, ✓ They use randomly, as rams exist in the neighbor	➢ Before introduction of Bonga ram, they use ram from everywhere that ram access ➢ Currently, there is Bonga ram user cooperative

		rams exist in the neighbor ✓ They don't care rams mating/ breeding performance ✓ Currently, there is bonga ram using norms ✓ Any farmer can use the ram either from FTC or From "limat Budin" /sub community group/	background information (pedigree information), Just only, they focus on maleness, that who keep/have mature male, o then, they take female ewe that show heat and search those ram in the community o During the discussion farmers also use market as an opportunity instead of searching ram within community. ➢ After introduction of Bonga ram in the area, they have a norm that; ✓ Any farmer should be use Bonga ram according to NGO (Bonga ram introducer) ✓ Accordingly, o Without any payment o Ram holders must keep ram until end of service time Then at the end of the service farmers take the ram as their own.	✓ There was no any common norm to use local ✓ Currently, there is common norm for using Bonga ram ✓ Thus, they use Bonga ram by rotating ✓ i.e. one farmer keep ram for one month then shift to another farmer ✓ Ram must be kept in a good management ✓ Any farmer in the community can use Bonga ram	village with 80 males and 8 female ➢ This cooperative was established by lives/ILRI in the area ✓ Thus, cooperative members use ram by free charge and non-members use ram by paying 3 birr/ewe/single service. ➢ In other village rams are kept by Model farmers and this model farmer give a service like above non-members of mentioned village

8	How You get/introduce/ Bonga breeding ram	▪ Through government efforts (by the help of government)	▪ Through BOA By the help of NGO called SRG, Introduction of ram in the area was dual purpose; 1) To improve soil fertility by their manure 2) To improve local sheep by crossbreeding	▪ Through government, farmers and Gurage developmental Association (GDA) effort	➢ Bonga rams was introduced in the area by Government, Lives/ILRI, CASCAPE project, AGP and SLMP in the District ➢ However, in FGD site it was introduced by LIVES/ILRI.
9	Contribution of local community during Bonga ram Introduction	There was no any contribution except accepting	No contribution, but the farmers participate other activities such as water shade management, crop activities	▪ Farmers in the community individually contribute **30** birr for ram bought	No any contribution except establishing cooperative
10	Is there any social, religious and cultural complains concerning Bonga ram?	No	No Acceptable in any direction	No!	No, they acceptable in any direction
11	Benefits/advantages of Bonga	➢ Reduces Ram problem	➢ Income generation	➢ After introduction of Bonga ram in the area	➢ Due to fast growth rate of Bonga cross, they are

	ram introduction in the area?	➢ lamb growth performance Improved ➢ Income from bonga cross sheep was high as compare from local sheep sold. ➢ Good/attractive lambs seen in the flock/ ➢ New borne lambs body size was improved ➢ Reduced market problem ex. One cross fattened ram sold by 6000 Et.birr	✓ According to ***Alango Kusa*** a farmer ✓ His two ewes gave 8 lambs/2year ✓ He sold 6 ram lambs for thin house construction by **5500** at age of four month ➢ Manure /compose ➢ Improve food security, since cross lambs are fast grower; ➢ Reduces Ram problem in the community. ➢ For example, in the past Farmers killed their time by searching serving ram around urban and long distances of village (e.g. from Damot Pulasa (Olola) to Bodit (administrative city of Damot Gale) and they pay up to 3 Et. birr per ewe for ram owners.	✓ Good performed Lambs where seen in the flock ✓ EX. Large body sized, Lang and fat tailed, red and white colored, hornless lambs are seen in the community ✓ Lambs are reach at early age to market even at 2 & 3 months ✓ Ewes mated by Bonga ram gives more twins and rarely triplet than ewes mated by local ram ✓ Lambs growth rate is fast ✓ Meat quality and quantity is greater than local (especially, meat deposition on backbone)	good source of income for, ➢ Students ➢ Agriculture input (DAP, Urea and others ➢ Due to introduction of Bonga ram farmers practice selection of ewe ➢ Reduce ram problem ➢ Pre-weaning mortality reduced ➢ In generally, a lot of benefit/advantage they got
12	Level of farmers'	➢ High	➢ High,	➢ High;	

	preference of Bonga Ram in your area?	✓ Not only father and mother their sons know the advantage of Bonga ram ✓ Farmers travel long distance to use Bonga ram	They didn't use other ram except Bonga, but NGO was introduced Doyogena, Dorper and Bonga, "IF you bring three rams for me I will use/ prefer Bonga, because Bonga is best ram for me" thought from one elder/key informant.	✓ But, during the study time the introduction of Bonga ram was not exceeded more than 1 year, ✓ Thus, using of Bonga ram is late in the area ✓ However, farmers in the area seen Bonga cross lambs and Bonga ram user's acceptance was high	
13	Compare performance of sheep flock before and after the introduction of Bonga sheep in this area	➢ AF mating for both sexes was improve ex. Local lams not reach a year, Bonga cross reach by 4-5 months ➢ LI interval reduced by 2-3 month	➢ Body size improved ➢ Mortality reduced/new borne lambs survive up to weaning ➢ LI interval relatively reduced ➢ Growth rate of lambs improved ➢ Weaning age reduced/ Bonga cross is 3-4 month whereas for local 5-6 months	➢ Growth rate of lamb is improved ➢ Large body size and tail type is improving ➢ Color is improved ➢ Twin and triplet increased ➢ AFS for both sex is improved. EX. Local	➢ Twinning rate increased ➢ Body size improved ➢ Tail type and color improved ➢ AFS and lambing improved ➢ Growth rate of lambs improved

		➢ Cross lambs reach for slaughter by 6 months local not at year ➢ Fast growth performance ➢ Twinning rate increased	➢ AFS was reduced 5 and 7 for Bonga cross and local lambs respectively.	lambs are mate/mated at 7-10 months whereas Bonga cross is 5-7 months ➢ Due to access of Bonga Ram LI is minimized ➢ Weaning age reduced, thus Bonga cross weaned at 3-4 months whereas local up to 7 months	➢ In generally, a lot of benefit/advantage they got
14	The price difference of Bonga cross rams/ram lambs and other rams/ram lambs?	➢ There is great difference b/n Bonga cross and local sheep ➢ Ex. 6 month Bonga cross can sold by 800-1500 birr But 6 months local cannot exceed 300-500 birr	➢ Due to high market preference farmers in the area focus on selling rather than meat. ➢ Since, Bonga ram/ewe lambs attract merchants and got premium in the market. ➢ For example, 5 & 7 month Bonga cross lamb sold at 900 & and 1200 birr in local market while, local lambs at the same age sold	➢ Due to fast growth rate of cross lambs, there is great difference b/n Bonga cross and local sheep ➢ Ex. Bonga cross lamb can sell by 350-400 birr but any one cannot sell/bought local lambs	➢ Due to fast growth rate and attractive appearance of Bonga cross ✓ merchants and farmers prefers Bonga cross ✓ For Ex, local 4 month labs not sold at market whereas, Bonga cross

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<td>not more than 500 and 600 birr respectively.</td>
<td>at 3 months in local market
➢</td>
<td>lambs sold at 600-800 birr
<table><tr><td>age</td><td>Local Price</td><td>Bonga cro</td></tr><tr><td>4</td><td>Not sell</td><td>700-800</td></tr><tr><td>6</td><td>200-300</td><td>800-1000</td></tr><tr><td>12</td><td>500-800</td><td>1500-2500</td></tr></table></td>
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<tr>
<td>15</td>
<td>Attitude of Bonga ram non-user farmers in the village about Bonga ram?</td>
<td>➢ They have positive attitude
➢ They show interest every day
➢ Even model farmers show interest to buy by one their own</td>
<td>➢ They have positive attitude
➢ Even farmers from Areka and Damot Gale District Still use Bonga ram from Damot Pulasa</td>
<td>➢ Have positive altitude
➢ Even kebele livestock experts aimed to introduce additional Bonga rams to those farmers no access ram in the kebele</td>
<td>➢ They have positive
➢ Bonga ram farmers No. increased
➢ Even they need female Bonga rams will be introduce.</td>
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<tr>
<td>16</td>
<td>Major constraints of sheep improvement in this area?</td>
<td>1. Disease
2. Feed shortage
3.</td>
<td>1. Feed shortage
2. Disease</td>
<td>1. Feed shortage
2. Low body performance of local ewe
3. Disease
✓ Wattle bottle</td>
<td>4. Disease Kenkema, Dawa and Shombe
5. Feed shortage
6. Poor management</td>
</tr>
</table>

				✓ Skin disease ✓ Faciola ✓ Foot root	
Future Plan about Bonga Breed		Introducing for all 23 kebele	Introducing for all 23 kebeles	Introducing additional Bonga rams in the area	Introducing more Bonga rams in the area

Appendix 12: Major disease in the study area

Common Disease	Alicho Worero		Ezha		Damot Pulasa		Arbegona	
	Mortality	Severity	Mortality	Severity	Mortality	Severity	Mortality	Severity
O.Pasturoliss	Medium	High	Low	Low	Medium	High	Low	High
Pneumonia	Low	High	Low	Medium	Low	High	Low	High
Kerato Conjunctives	No	No	No	No	Low	Medium	No	No
Hemoncus	No	No	No	No	Low	Medium	Low	Medium
Cenorosis	No	No	No	No	Low	Medium	Low	Medium
Faciloa	Low	High	Low	High	Low	High	Low	High
FMD	No	No	No	No	Low	Medium	Low	High
Salmonella	No	No	No	No	Medium	Medium	Low	Medium
Magnesites	No	Low	No	Low	No	Low	No	High
Ticks	No	High	No	High	No	High	No	High
Lies	No	No	No	No	No	High	No	High
Hoof Root	No	No	No	Medium	No	Medium	No	Medium
Bottle jaw	No	No	No	Medium	No	Medium	No	Medium