BONGA UNIVERSITY

COLLEGE OF AGRICULTURE AND NATURAL RESOURCE

DEPARTMENT OF ANIMAL SCIENCE

EFFECT OF THE REPLACEMENT OF NOUG SEED CAKE WITH GRADED LEVELS OF LOCAL BREWERY RESIDUES ON REPRODUCTIVE PERFORMANCE OF BONGA SHEEP

BY

AMARE ABATE GELAW

MSc THESIS

IN PARTIAL FULFILLMENT OF THE **REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE**

June 2024

BONGA, ETHIOPIA

EFFECT OF THE REPLACEMENT OF NOUG SEED CAKE WITH GRADED LEVELS OF LOCAL BREWERY RESIDUES ON REPRODUCTIVE PERFORMANCE OF BONGA SHEEP

By

Amare Abate Gelaw

A research thesis submitted *to the Department of Animal Science, Bonga University College of Agriculture and Natural Resource: in Partial Fulfillment of the* Requirement for Degree of Master of Science in Animal Productions

Major Advisor: Professor Desie Sheferaw

Co-advisors: Dr. Jane Wamatu (Ph.D)

Muluken Zeleke (Ph.D Candidate)

February 2024

Bonga, Ethiopia

BONGA UNIVERSITY COLLEGE OF AGRICULTURE AND NATURAL RESOURCE DEPARTMENT OF ANIMAL SCIENCE.

ADVISOR APPROVAL SHEET

This is to certify that the thesis entitled "**EFFECT OF THE REPLACEMENT OF NOUG SEED CAKE WITH GRADED LEVELS OF LOCAL BREWERY RESIDUES ON REPRODUCTIVE PERFORMANCE OF BONGA SHEEP,** in Kaffa Zone, Southwestern Ethiopia" submitted in partial fulfilment of the requirements for the degree of Master's with specialization in Animal production, the Graduate Program of the Department of Animal Science, and has been carried out by Amare Abate Id. No WM0002/14, under my/our supervision. Therefore, I/we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

Desie Sheferaw (Professor)	__________	___________
Major Advisor	Signature	Date
Muluken Zeleke (Ph.D candidate, MSc)	_________	_____________
Co-Advisor	Signature	Date
Dr. Jane Wamatu (Ph.D.	____________	_____________
Co-Advisor	Signature	Date

BONGA UNIVERSITY COLLEGE OF AGRICULTURE AND NATURAL RESOURCE

DEPARTMENT OF ANIMAL SCIENCE.

EXAMINERS' APPROVAL SHEET

We, the undersigned, members of the Board of Examiners of the final open defence by Amare Abate have read and evaluated his/her thesis entitled "The effect of graded level replacement of noug seed cake with local brewery residues on reproductive performance of Bonga sheep", and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the Master of Science in Animal Science (Animal production) degree.

____________________________	_______________	__________
Name of the chairperson	Signature	Date
____________________________	_______________	__________
Name of major advisor	Signature	Date
____________________________	_______________	__________
Name of internal examiner	Signature	Date
____________________________	_______________	__________
Name of external examiner	Signature	Date
____________________________	_______________	__________
SGS Approval	Signature	Date

Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the School of Post Graduate Post (SPGP) through the Department/School Graduate Committee (DGC/SGC) of the candidate's department.

ACKNOWLEDGEMENTS

First and formost my greatest thanks go to God for his unreserved disposal to make me propose and bring up this paper to the light. Next to God, I would like to express my heartfelt thanks to my major advisor, Professor Dessie Shiferaw and co-advisors Muluken Zeleke and Jane Wamatu for their guidance, encouragement and valuable comments from the start of my research proposal up to the completion of my thesis. I would also like to thank Bonga agriculture research centre researchers and CBBP site workers for their technical support and logistics arrangement. I would like to thank CBBP smallholder farmers in Boka kebeles in the Adiyo district for allowing the use of their ewes and for their willingness for this study. Ialso want to express my sincere thanks to ICARDA for offering me financial assistance for my research work. Finally, my great and heartfelt thanks also go to my wife Emebet Jemberu and, my daughter:Haset and my sons Melcol and Nahom for their love, moral support and a great deal of help any contribution to the completion of my study.

TABLE OF CONTENTS

Content **Page**

DEDICATION

This study is dedicated to my lovely wife Emebet Jemberu and her sister Lubaba Jemberu who helped me in all logistic support and my sweet babies on understanding me when they loss fatherhood role due to my burden.

STATEMENT OF THE AUTHOR/DECLARATION

I declare and confirm that this thesis is a result of my work and that I have duly acknowledged all sources of materials used for writing it. I hereby submit this thesis to Bonga University in partial fulfillment for the Degree of Master of Science in Animal production. The thesis is deposited at the library of the University to be made available to borrowers for reference. I confirm that this thesis has not been so far submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate. Brief quotations from this thesis are allowed without requiring special permission if an accurate acknowledgement of the source is made. In all other instances, however, permission must be obtained from the author.

Name: Amare Abate Signature:______________ Date: __________________

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CBBP	Community Base - Breeding Program
CP	Crude Protein
CSA	Central statistics agency
ETB	Ethiopian Birr
FAO	Food and Agricultural Organization
FCE	Feed Conversion Efficiency
GLM	General Linear Model
ICARDA	International Center for Agricultural Research in Dry Areas
ILRI	International Livestock Research Institute
ILCA	International Livestock Center for Africa
kg	Kilo Gram
m.a.s.l.	Meter Above Sea Level
ME	Metabolizable Energy
N	North
RCBD	Randomized Complete Block Design
SPSS	Statistical Package for Social Science
SWERS	Southern West Ethiopia Regional State
TDN	Total digestible nutrient
°C	Degrees Celsius

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The study's objective was to evaluate the effect of the replacement of noug seed cake with graded levels of local brewery residues on reproductive performance of bonga ewes**.** Forty-eight Bonga ewes (2 - 3 BCS and 22 – 37 kg of body weight) grazing on natural pasture were randomly assigned to supplementary treatments consisting of combinations of 'Areke atela' and commercial concentrate (CC): T1 (0 g 'atela' + 450 g CC), T2 (45 g 'atela' + 405 g CC), T3 (90 g 'atela' + 360 g CC), T4 (135 g 'atela' + 315 g CC), T5 (180 g 'atela' + 270 g CC) and T6 (control). The experimental design was a randomized complete block design (RCBD) with eight blocks consisting of six ewes per block based on their body weight and body condition score. The sampled ewes were only targeted at Bonga agriculture institution CBBP site owned by breeding program cooperative members and the study spanned 170 days with an additional 15-day adaptation phase, conducted in the Adiyo district Boka village, Kafa zone, southwest Ethiopia region, from 10 August 2023 to January 2024. After feeding for 15 days as an adaptation period, the estrous cycle was synchronized with two intramuscular injections with 11-day intervals, 5 mg PGF2α, before artificial insemination. Semen was collected from top rams using artificial vagina at the day of ewe's estrus response and immediately inseminated. A general linear model (GLM) procedure of the statistical analysis system (SAS, version 9.3) was used to analyze body weight, body condition score, onset of estrus, duration of estrus, lambs birth weight, litter size, and gestation period. The estrus response rate, conception rate, and lambing rate was analyzed using nonparametric test. The result showed that, the replacement groups significantly increased ($p < 0.05$) at T2, and T3 demonstrated superior estrous response and pregnancy rate compared with T4,T5 and the controlled group T6. Replacement group (T2, T3) with 45 g areke atela + 405 g CC and 90 g areke atela + 360 g CC are promising economical feed replacement to increase the reproductive performance of Bonga ewes.

Key words: Bonga ewes, nutritional flushing, reproductive performance.

1. Introduction

Small ruminants in Ethiopia account on average for 40% of the cash income and 19% of the total value of subsistence food derived from all livestock production (Mengesha, 2012). Ethiopia has the largest livestock population in Africa. According to (CSA, 2021) there are about 42.9 million sheep and 52.5 million goats to be found in Ethiopia. About 42.9 million heads of sheep among which 70% of them are females and 30% are males. They are important components of the livestock subsector and are sources of cash income, milk, meat, wool, manure, and saving or risk mitigation during crop failures, property security and investment in addition to many other socioeconomic and cultural functions (Gobena,2016; Abraham *et al.,* 2017; Nwogwugwu *et al.,*2018).

FAO 2011 reported that, the annual off-take rate was 31.1% for sheep, 35.4% for goats and the potential production is estimated at 8.70 million sheep and 8.10 million goat skins. The increase in demand for meat in general and the high demand for sheep and goat meat in the Middle East are another incentive for sheep and goat production in the country (Hassen *et al.,* 2013). Farmers depend on small ruminants for much of their livelihood, often to a greater extent than cattle, because small ruminants are generally owned by the poorer sectors of the community as reviewed by Gizaw *et al.,* (2013).

According to Edea *et al*., (2012), Bonga sheep breed is one of Ethiopia's most well-known and largest breeds, with a long and wide fat tail with a tapering and twisted end, polled males and females, short and smooth hair, a predominantly convex facial profile of males, and a predominantly light red coat color. When compared to other Ethiopian indigenous sheep breeds, it has the best litter size, high growth rate or weight gain, and nice edible quality and palatability of meat under comprehensive management, even with low feeding or natural pasture grazing. Sheep nutrition influences fertility through mechanisms such as oocyte development, ovulation and fetal survival via blood metabolites and hormones (Ahmad and Hossein 2014). The main factors impacting sheep fertility, reproduction, and productivity are energy and protein sources in the diets (McDonald *et al*., 2010).

Bonga sheep (Ovis aries) are native to Kaffa zone of Southern Ethiopia regional state and also the predominant livestock breed in the said region. They are of mutton type breed and have a higher body weight at maturity and the ewes are moderately prolific. The skeletal frame of the Bonga sheep is larger as compared to other Ethiopian sheep breeds and the sheep are generally tolerant to many of the locally prevalent diseases (Edea 2008; Haile et al. 2013). The Bonga breed was earlier considered a sub-type of Horro sheep. However, the result of Gizaw (2008) study indicated that the

Bonga sheep is distinctly different from the Horro sheep. Thus, in order to improve the body weight of Bonga sheep and also to understand the selection practices of the traditional breeders a community-based breeding program (CBBP) was launched in the year 2009. The CBBP program also aimed to identify and conserve this sheeps elite germplasm of this sheep taking into account considering both the traditional and scientific of livestock selection practices (Haile et al. 2013).

Flushing causes ewes to ovulate and supplementing actions are essential for meeting feed nutritional requirements and are also vital for improving reproductive success. It can help ewes to get more nourishment during breeding season (Michael, 2018). Flushing the ewes can help in ovulation, conception, and embryonic implantation rates. It also improves the breed's reproductive performance by increasing the proportion of females who show estrus, increasing lambing rates by 10-20% and changing the breed's reproductive performance. Estrus synchronization is the use of exogenous hormones to improve reproductive performance in sheep. It's also when the luteal or follicular phases of the estrus cycle are manipulated. Prostaglandin PGF2α hormone based procedures make the luteal phase to be shortened by lysing the corpus luteum (Dias *et al*., 2018).

Nutrition and reproduction has long been known to have important implications on the reproductive performance (Smith, 2010) which directly influences fertility through mechanisms such as the development of oocytes, ovulation, fetal survival, blood metabolites and hormones (Robinson et al., 2006). Economically speaking, fertility is considered as the most prominent characteristics in livestock breeding. Moreover, they are regarded as the most important determining factors for the efficiency of livestock breeding and genetic evidences (Fazel *et al.*, 2014).

Therefore, the study was conducted to evaluate the effect of replacing noug seed (*Guizotia abyssinica*) cake with different levels of local brewery residue on reproductive performance of Bonga breed sheep fed on day time grazing as a basal diet.

1.1. Statement of the Problem

Backward management practice may affect the performance of the sheep. Among the management practices that affect the performances of the ewes, nutritional gap takes the largest portion, but in reciprocal there are many forages feed and refusals which have high nutritive values and easily available in the area. The farmers feed their sheep some of these indigenous feeds but their nutrient compositions and their potential on ewes' reproductive performance was not studied in the study area. Such challenges makes to explore the use of reproductive technologies (estrus synchronization) with artificial insemination and alternative indigenous feed such as local brewery residue that is cheaper, locally available and of low cost which is expected to be rich sources of useful ingredients in healthy and balanced animal diets.

1.2. Objectives

1.2.1 General Objective

- The general objective of this study was to evaluate the effect of graded level replacement of noug seed cake with local brewery residues on reproductive performance of bonga breed sheep.

1.2.2. Specific Objectives

- To evaluate the reproductive performance of Bonga ewes by different level of local brewery residues
- To examine the economic efficiency of flushing ewe by local brewery residues (Kindly add this section in methodology and result, for more information discuss with Agegnehu)
- To identify the optimum level of local brewery to nutritional supplementation of ewes

2. LITERATURE REVIEW

2.1. Geographical Distribution of Sheep in Ethiopia

Ethiopian sheep breeds can endure a wide range of circumstances, including harsh environments (Edea *et al*., 2013). Numerous efforts have been undertaken to categorize the sheep breeds using traits including tail shape, wool type, and additional genetic analyses. Based on their morphological traits four main groups of sheep variety exists in Ethiopia: Short fat-tailed, long fat-tailed, thin-tailed, and fat-rumped. Ethiopian sheep were divided into six genetically diverse breed groups and nine breeds using the genetic data along with phenotypic variability. The names of the sheep species are derived from their geographic origins or from the ethnic groups that keep them. It was found that populations with various local names and historical distinction as distinct types can really share genetic traits. For instance, the short fat-tailed breed mixes the genetically close sheep breeds Bonga, Sekota, Farta, Tikur, Wollo and Menz (Gizaw *et al*., 2013).

2.2. Reproductive Performance of Sheep

The reproductive performance of animals is a vital issue for any successful livestock production program. Any successful livestock production program requires good reproductive performance. Indigenous sheep breeds range in reproductive performance, and the heterogeneity of breeds allows for the selection of acceptable breeds for a given habitat (Admasu *et al*., 2017). High reproductive performance is a significant attribute and a major component of overall production efficiency in any livestock production system. The most essential aspects of sheep production are reproductive performances such as age at first lambing, lambing interval, litter size, reproductive life duration of ewes, and breed reproduction rate (Teramaj, 2020).

Amelmal, (2011) reported that a number of factors influence sheep reproductive success, including age at first lambing, litter size, lambing interval, and the ewe's lifetime output. The number of lambs born per parturition is determined by a combination of ovulation rate and embryo survival. Ages at first lambing and lambing interval are economically important reproductive traits. They are an indication of the overall flock productivity. Age at first lambing is an important indicator of sexual maturity and lifetime productivity in ewes, the earlier the ewes' starts to lamb the more the productive life of the animal (Deribe and Mengiste, 2014). Lifetime production can be increased by decreasing age at first lambing (Zewde and Welday, 2015). On average, age at first lambing for most of the indigenous sheep in Ethiopia is between 11and 16months and most sheep breeds tend to have their first offspring before they are two years old (Ayele *et al.*, 2019).

According to Neme, (2016) the lambing interval in the west Shoa zone was stated to be 8.83 months. Litter size (LS) is mostly regulated by ovulation rate, but it is also influenced by fertilization rate, embryonic and fetal losses (Teramaj,2020) and other influencing factors such as breed, amount of nutrition, season, and age of ewes, as described by Mekuriaw *et al.*, (2013). As indicated in (Table 2) below AFL was longer in BHS sheep breed and shorter in Abera and Horro sheep breeds as compared to others. Liter size was highest in Abera sheep breeds followed by Bonga and Horro breeds.

Table 1. Reproductive Performance of sheep breeds

Breed/Ecotype	AFL (days)	LI (days)	LS (lamb)	Source
Menz	522.3±17.4	261±8.7	1.02	Mirkena *et al.*,2012 Tesfaye *et al.*, 2013
Wollo	434.1±21	227.1±9	-	Tesfaye *et al.*, 2013
Bonga	438±75	255±48	1.37	Mestafe, 2015
Horro	399±51	276±72	1.36	Edea *et al.*, 2012
Washera	457±4.76	303	1.0±0.09	Mekuriaw *et al.*, 2013,
BHS	720	420	1.06	Wilson, 2011
Abera sheep	387±7.8	288±7.2	1.5±0.00	Marufa *et al.*, 2015
Horro	491.17	264.58	1.32	Bekana, 2019

AFL = Age at first lambing; LI = Lambing interval; LS= litter size; BHS = black head Somali

2.3. Sheep Breeding Practices

To create sustainable genetic improvement plans for smallholder circumstances, it is crucial to comprehend traditional sheep breeding procedures and reproductive efficiency. Lack of this information causes sheep genetic improvement initiatives to be designed with unrealistic breeding targets, which can endanger the preservation of local animal genetic resources (Teramaj, 2020).

In the production of sheep, selection was one of the breeding practices. Different selection criteria are used by farmers to choose breeding animals. When selecting breeding ewes, they take into account the lambing interval, mothering prowess, coat color, and twining rate. When choosing breeding rams, they also take into account the body size, coat color, tail type and length, fast growth, libido, age, adaption, and lineage (Tesfaye, 2008).

Open-nucleus breeding is a technique used to improve the genetics of sheep in Ethiopia by allowing the in-flow of high-potential breeding animals from lower-tier flocks for pure-breeding to nucleus flocks in the ranches. Through development and wise application, the approach could be used to conserve genetic resources like breeds, good genes, and genotypes. The transmission of superior genetic elements through this approach, which may be used for both pure-breeding and cross-breeding, enables the preservation and advancement of the local sheep breeds (Philipsson *et al*., 2006)

Cross-breeding is an alternate strategy for bringing about genetic change in a population. It allows for faster evolutionary advancement than selection, matches genotype with environment, and capitalizes on the genetic complementarity of the involved breeds. It can be used in a variety of ways, such as continued cross-breeding (where all breeds contributing to the cross must also be kept as straight-bred populations), the creation of a new synthetic breed, or breed substitution by repeated crossing (FAO, 2010)., crossbreeding has been employed in Ethiopia to improve the genetic makeup of sheep by importing exotic breeds.

The demands of farmers as well as their perceptions and indigenous practices, have received little to no consideration. They have also had little to no input into the planning and execution of breeding projects. Additionally, the breeding programs needed breeding plans to maintain cross-breeding at the village and nucleus center levels. In the majority of the industrial systems in Ethiopia, mating behavior is largely uncontrolled (Gizaw *et al*., (2013).

2.4. Ewe fertility and Flushing

Flushing is a temporary treatment that provides significant nutritional benefits, and it is the feeding of extra grain or lush pasture two to three weeks prior to the breeding season to increase the number of ova shed from the increasing number of ova shed from the ovary for yielding twins (Banerjee, 1999). Flushing the ewes with good feeding for a short period before breeding season has improved litter size (Smith *et al*., 1983; Leury *et al*., 1990).

Flushing the ewes can improve the rate of ovulation, conception, and embryonic implantation. It also increases the proportion of females that exhibit estrus symptoms and can boost lambing rates by ten to twenty percent (10-20%) and to reduce barrenness otherwise, through increased proportion of twinning (Owen, 1976).

Blood metabolites regulate the development of oocytes, egg laying and fetal survival, making nutrition a critical influencing factor in reproduction. Fertility and reproductive behavior arethe most significant features of animal reproduction and production and they are the most important qualities in breeding. When nutrition is addressed appropriately, fertility can be obtained (Michael, 2018).

According to Shad *et al*., (2011), female sheep gaining weight in the 3-4 weeks before mating are more likely to conceive and have twins or triplets than those in poorer condition. This has led to the practice of "Flushing" ewes by transferring them from a low to a high plane of nutrition before mating. Special feeding usually begins around 2 weeks prior to breeding and continues at least 2 to 4 weeks into the breeding season. This ensures good embryo attachment to the uterus wall, reducing early embryonic death. Flushing should not be continued too long, because an extended period of high feeding is unnecessarily costly, and can reduce the survival of oocytes and embryos due to destruction of progesterone, the hormone required for the establishment and maintenance of pregnancy.

2.5. Reproduction in Indigenous Ethiopian Sheep

2.5.1. Age at First Lambing

Age at first lambing (AFL) is an important reproduction trait as greater population turnover and more rapid genetic progress can be obtained when sheep produce their first offspring at an earlier rather than later age. Early maturing females are known to have a relatively long and fruitful reproductive life. Data on average AFL for most of the indigenous sheep in Ethiopia are between 11 and 16 months (Table 3) and most sheep breeds tend to have their first offspring before they are two years old. The AFL values found in most of Ethiopian sheep are within the range of 11.2 to 22.8 months reported for sub-Sahara African sheep breeds (ILCA Working Document, 1995) but slightly lower than 18.8 to 22.6 month documented for West African Dwarf, Djallonke, sheep (Gbangboche *et al*., 2006). The AFL (10 - 11 month, Table 3) reported for BHO sheep is longer than the values documented for most of the indigenous sheep in Ethiopia. This is consistent with 24.4 month reported for Balochi sheep in different ecological zones of Balochistan, Pakistan (Jahan, *et al*., 2013) and appears to be due to the seasonal scarcity of feed resources. Among the most important parameters affecting AFL, genotype and various management components ILCA Working Document (1995) are the main one. Management, with regard to whether breeding is controlled or uncontrolled also tends to affect the age at first parturition (Wilson, 1989). The author observed delayed first parturitions in sheep that was bred in controlled breeding systems compared with those reared under uncontrolled systems. where rams are free to run with females and serve them at the earliest possible display of oestrus. Poor nutrition and disease can leads to delayed age at first lambing through limiting early animal growth. 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. The results from previous studies generally show that AFL of Ethiopian sheep seems to have wide variation within and among breeds. This implicates the presence of huge opportunity to improve this trait through improved management and selection.

Table 2. Age at First Lambing and Lambing Intervals (Month) of Ethiopian Indigenous Sheep Breeds.

Breeds	AFL(Month)	LI(Month)	Management	Source
Adilo	11.8 -14.6		on farm	Getahun, *et al.*, 2008
Adilo	12.4	7.3	on farm	Fsahatsion *et al.*, 2013
Afar	13.5	9.01	on farm	Tesfaye, (2008)
ArsiBale	12.7	7.8	on farm	Tsedeke, (2007)
Arsi-Bale	12.4	9.1	on farm	Deribe, (2009)
BHO	23.6	10.5	on farm	Fekerte, (2008)
BHO		11.2	on farm	Aden, (2003)
Bonga	14.9		on farm	Zewdu *et al.*, 2009
Gumiz	13.67	6.6	on farm	Abegaz *et al.*, 2011
Horro	13.3		on farm	Zewdu *et a*l., 2009
Horro	10_11	9_10	on farm	Dhaba *et a*l., 2013
Horro	13.5	8.7	on farm	Belay *et a*l., 2009
Menz	15.7	8.5	on farm	Tesfaye, (2008)
Menz	16.5		on station	Gautsch, (1987)
Washera	15.5	9.03	on farm	Mengistie *et a*l., 2011

AFL = age at first lambing; LI = lambing interval, BHO = Blackhead Ogaden; on farm= under farmers management, on station= in research station (relatively under good management).

2.5.2. Lambing Interval

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. Thus this breed can produce three lambing in two years even under the traditional management system. But the study done by Edea (2008) indicated that lambing interval of Bonga and Horro ewes were around 8 and 7.8 ± 2.4 months respectively. Other breeds of sheep with short lambing interval in Ethiopia include Menz (8 and a half months) and Afar sheep (9 months) (Tesfaye, 2008). Genetic and environmental differences have resulted in a large variation in LI among different sheep breeds.

2.5.3. Litter size

Litter size (LS) or prolificacy is defined as the number of progenies born per parturition (ILCA Working Document, 1995). It is one of the most important reproductive parameters affecting a dam's productivity and thereby the farm's profitability. Litter size is a trait that depends on ovulation rate and is affected by the number of fertilized oocytes. The higher the ovulation rate, the more oocytes were available for fertilization during the estrous and increase the possibility of large number of litters (Drouilhet *et al*., 2013).

2.6. Nutrient Requirement of Sheep

Nutrition, genetic makeup, and management decide the productivity of animals. The contribution of improving genetic makeup for production does not exceed 30%, but nutrition and management account for 70% share of the production of livestock (BoFED, 2006). A constant supply of feed is required for small ruminant production throughout the year. Energy, protein, minerals, vitamins, and water are the nutrients that sheep require. These nutrients are required for proper maintenance, optimal production, and the prevention of nutritional deficiency symptoms. Sheep's nutritional needs vary depending on their physiological state, breed type, age, and daily body weight gain (Mike, 2007).

The nutritional intake increases with animal size (growth) increase to fill the requirements of the rumen stomach. To express this in another way, larger animals consume more feed to maintain their body functions and productivity (Alemu, 2008). When voluntary intake is too low, the pace of production is slowed, resulting in maintenance requirements accounting for a considerable amount of the metabolizable energy consumed, resulting in poor feed conversion efficiency. Supplementation of concentrate and multipurpose fodder trees like *Erythrina brucei* leaves can boost ruminant feed intake. This suggested that the supplement's ability to give nitrogen and energy to ruminal bacteria improved DM fermentation in the rumen (Desta *et al*., 2017).

2.6.1. Protein requirements

In sheep nutrition, proteins are required for the maintenance, growth, and synthesis of new tissues in growing sheep, particularly in reproductive animals. That is, it is determined by growth, age-appropriate weight, body condition, pace of gain, and protein-to-energy ratio. In most sections of the country, green pastures and legume hay (alfalfa, clover, soybeans, and others) are great sources of protein for sheep (Asmare, 2016). High-quality legume hays can contain 12 to 20% protein and supply adequate protein for most classes of sheep. But grains generally contain 8 to 11% protein. In DM, a minimum protein level of 8% is essential for maintenance (McDonald *et al.*, 2010). Fodder trees and bushes with a CP of more than 22 percent and up to 30 percent fed as a complete ration can provide enough protein for most classes of sheep fed. The Supplemental feed may be utilized to sustain a greater rate of growth or to raise lambs to a market finish faster, depending on the amount and quality of forage available. The CP requirements of growing and fattening sheep with a 20 kg body weight, according to Ranjhan (2001), are 85 and 127 g/day, respectively. The same author has noted that the requirements for growing and fattening animals are relatively higher than the requirements for adult animals. A protein deficiency is characterized by reduced appetite, lower feed intake, and poor feed efficiency. Under extreme conditions, there are digestive disturbances, nutritional anemia, and edema. The protein produced by ruminal synthesis does not supply all of the amino acids required by animals in the quality and quantity needed (McDonald *et al*., 2010).

2.6.2. Energy requirements

The major sources of energy for sheep are pasture, hays, silage, by-product feeds, and grains. These energy requirements of sheep are affected by body weight (BW) extent of growth (gain), breed type, age, the environment, and protein content of the ration. Large animals require higher energy to attain their maintenance requirement than smaller animals. This is because of the increased rate of metabolism for energy in large animals. Moreover, a fast rate of growth demands energy-rich feeds or the consumption of large amounts of feed. The energy status of sheep is dependent on how much feed they are consuming, what the energy content of the feed is, and what the digestibility of the feed is. The energy content of feeds is often described by the TDN content of the feed. TDN stands for total digestible nutrients. Grains have TDN values ranging from 70 to 80%, while, forages range from 50 to 60% TDN. For example, sheep can have access to all the corn cobs that they want and still be in an energy-deficient situation. This is because they have a limited capacity to consume a bulky, poorly digested feed that lacks usable energy content. Conversely, lambs are often fed high-grain diets to finish them for the market. They are eating similar amounts of feed daily as those eating cobs; however, they would be growing quite rapidly. The difference is the digestibility and energy content of the two feedstuffs. Supplementing urea-treated crop residues with feed containing a greater energy source is more helpful than those with high protein content (Gashu *et al*., 2014).

Sheep often lack nutrients, due to poor-quality pastures and roughage or inadequate amounts of feed. Because of this, energy is the most common limiting factor in small ruminant nutrition. Lower growth or weight loss, reduced reproductive efficiency, reduced milk, meat, or fiber production, increased susceptibility to infectious disease and parasites, and increased mortality is all symptoms of energy deficiency. The percentage of TDN is the most widely used method of evaluating feed for energy. As a rule, the greater the TDN is in a ratio, the greater the rate of gain will be in the animal (Robert Spencer, 2018). Furthermore, sheep's energy status is influenced by their feed consumption, energy content, and digestibility of the feed (Mike, 2007).

2.7. Effect of Nutrient Supplementation on Live Body Weight gain of Sheep

Nutrition is the most important factor affecting sheep live weight gain and meat production (McDonald et al., 2010). The rate of weight gain for sheep can be influenced by management type and stage of growth. Similarly, the rate of growth of an animal is controlled by its nutrient intake, especially by its energy intake. As suggested by Larbi and Olaloku (2005), there is a proportional improvement in the growth performance of sheep with increasing crude protein levels in their diets. Therefore, as animal consumes more feed each day, there is a high opportunity for increasing their daily production (McDonald et al., 2002). At any given age and body weight, the higher the degree of nutrition, the more fat is accumulated in lambs. Increasing protein and energy levels in the diet improve the average daily BW gain and feed conversion efficiency of the animals.

According to the report of Abraham (2019), supplementing feed for Begait sheep showed a consistent increase in body weight, but non-supplemented tend to gain for the first 30 days and almost stabilize gain then after. Supplemented Afar rams improved more than control rams in the most carcass and non-carcass parameters (Tesfay, 2007). Moreover, Emebet (2008) also reported that blackhead Ogaden sheep supplemented with concentrate had better carcass characteristics and higher (8.2 - 10.4 cm2) rib-eye muscle area compared to that fed hay alone (6.7 cm2).

2.8. Non-Conventional Feed Resources in Cost Minimization

Non-conventional feed sources usually refer to all those feeds that have now not been traditionally used for feeding livestock and are not commercially used within the production of livestock feeds (Amata, 2014). Nonconventional feeds along with vegetable refusals, sugar cane leaves, and enset leaves are used as animal feed (Endale, 2015).

3. MATERIAL AND METHODS

3.1. Description of the Study Area

Adiyo woreda Boka destrict was an experimental area which is CBBP station of Bonga Agricultural Research Center (BARC) in Kaffa zone, Ethiopia. It is located 495 km from Addis Ababa the capital city of Ethiopia and 30 km from Bonga city Administration of Kaffa zone. Natural forest covers large area of the district, and the area is known by growing bamboo tree (Metsafe et al., 2017). The district is situated within a longitude of 36º 47‟E and a latitude of 7º 26‟N with an altitude ranging from 500 to 3500 meters. The temperature in the area can be as high as 36ºC and can also reach the lowest value of 3ºC (SUDCA, 2007). The known farming system of the area is mixed crop-livestock production. It has a livestock population of 107657, 30819, 28825, 47176, and 7699 cattle, sheep, goat, chicken, and equines, respectively (Annual report of Agricultural and rural development office of Kafa zone, 2012).

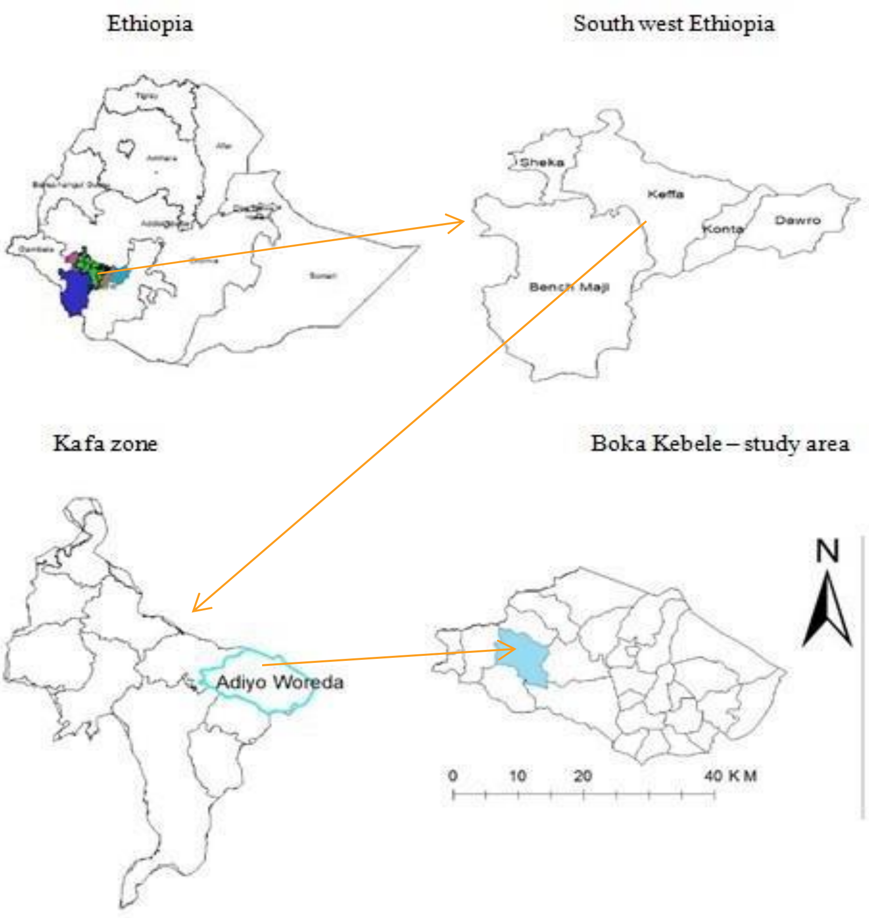

Figure 1: Map of Study Area

3.2. Sampling Methods

Forty-eight Bonga sheep ewes were purposively select from sheep breeding cooperative members based on body weight and body condition score. Mainly according to body weight and parity, the animals were divided into 6 treatment groups (T1, T2, T3, T4, T5 and T6) and eight replications. Experimental animals' selection was done with consideration of body condition score range between 2 to 3 and body weight of 22 to 37 kg. The ewes were equally distributed according to body weight in all treatment groups to avoid the weight effect. Ewes in all the groups were kept on grazing for 8 hours during daytime. In addition, flushing of ewes were provided local brewery residue feed in replacement of noug seed cake at 0%, 25%, 50%, 75% and 100%, per day to T1, T2, T3, T4, and T5, respectively and T6 left as control with only natural grass. After two weeks of adaptation period 5 mg PGF2α was injected, and additional hormone injected at 26 days for the purpose of flushing. Then after two days, the ewes were inseminated (Gootwine, 2016).

Experimental feed local brewery residue "areke atela" was collected from local producers in the surrounding of experimental area. Out of 48 Bonga breed sheep ewes except the control group 8 ewes, 40 of them feed experimental diet before flushing as adaptation period for 15 days and 11 days after flushing. The initial / total dry matter provided for ewe daily assumed 450- gram feed (local brewery and concentrate). Such experimental material was stored using plastic container to distribute for experimental sheep owners to access easily when it was required. The packaging material was plastic container and each ewe feed by plastic dish to avoid wastage and easily manage.

Figure 2: Local brewery residue / 'areke atela'

3.3. Experimental Design and Treatments

Using randomized complete block design (RCBD) the experiment was conducted with six treatments of eight replications. Experimental ewes were divided into six blocks based on body condition score and body weight. Each ewe within each block was randomly assigned to one of the six dietary treatments by using the lottery method. The body condition score and body weight information / data were collected from the most recent record book of CBBP organized cooperatives. The diet allocated in each treatment for replacement purpose in different levels as shown in table 3.

Table 3. Feeding Trial for Experiment

Treatment	Expermental feed in gram (g)			
	'Areke atela' (g)	NSC(40% 0f 450 =180 g)	WB (60% 0f 450= 270g)	Total feed in g (areke atela, WB & NSC)
T1 (8)	0	100% = 180	270	450
T2 (8)	25% = 45	75% = 135	270	450
T3 (8)	50% = 90	50% = 90	270	450
T4 (8)	75% = 135	25% = 45	270	450
T5 (8)	100% = 180	0% = 0	270	450
T6 (8) (control)	-	-	-	-

WB = wheat bran, NSC = noug seed cake, N = number of experimental animals, gr = gram

3.4. Data collection and measurement

The experiment was run of 178 days which means 15 days adaptation, 13 days feed normal treatment diet and 150 days pregnancy period. The following parameters were recorded during the trial period.

3.4.1. Reproductive performance

Reproductive and productivity parameters such as lambing rate, fertility rate, litter size, weaned rate, fecundity rate, abortion rate and pregnancy rate were calculated as;

Lambing rate (%) = (number of ewes lambing /number of ewes conceived) x 100,

Fertility rate (%) = (number of ewes pregnant / number of ewes mated) x 100,

Litter size (prolificacy) = (number of lambs / number of ewes lambing) x 100,

Weaning rate a (%) = (number of lambs weaned /number of ewes mated) x 100,

Weaned rate b (%) = (number of lambs weaning /number of lambs born) x 100, Fecundity rate (%) = (number of live births / number of ewes mated) x 100,

Abortion rate (%) = (number of ewes aborted / number of ewes mated) x 100,

Pregnancy rate a (%) = (number of ewes pregnant / ewes present to rams) x 100

(Landais and Cissoko, 1986).

3.4.2. Body weight (kg)

The body weight was recorded at the beginning, mid gestation and at lambing using a suspended spring balance of 100 kg Salter scale after thoroughly securing the animals. The weight was expressed in kilograms.

3.4.3. Body condition scoring

The BCS was evaluated by palpating the fullness of muscling and fat cover over and around the vertebrae in the loin area. The body condition score (BCS) of ewes were determined according to 1 to 5 scale (Khan et al 1992; Russel 1991) and recorded in breeding, mid pregnancy, and lambing period. To assess the body condition score of the animal with a high accuracy, body condition scoring was done in accordance with the technique described by Thompson and Meyer (1994).

3.5. Statistical Analysis

Reproductive performance data like litter size, time to onset and duration of estrus, number of twin birth, twining percentage, total number of lambs born, lambing percentage, and average birth weight of lambs were collected and entered to Microsoft Excel spreadsheet 2010. Then the data were edited and summarized by using descriptive statistics, and analyzed by using SAS 9.3 software. The data were analyzed by chi-square test subjected to analysis of variance (ANOVA) the general linear model (GLM) procedure. Analysis of variance among the treatment means, least significance difference (LSD) was used to test and locate the treatment means that significantly differ from the test. Mean differences were considered significant when ($P<0.05$). The following model was employed to analyze the data:

Models: - $Yij = \mu + ti + bj + eij$

Where Yij = response variable (an observation in i treatment and j block)

μ = the overall mean

Ti = treatment effect

Bj = block effect

eij = random error

4. RESULT AND DISCUSSION

4.1. Effect Of Flushing with Different Level of Concentrate Feeding on Reproductive Performance of Bonga Ewes.

4.1.1. Effect of Nutritional Flushing on Onset of estrus (h)

The mean time to onset and duration of estrus data recorded from Bonga ewes fed on nutritional flushing at farm level are presented in table 3 above. Onset of estrus was a significant ($p < 0.05$) and shorter in treatment groups T1, T2, T3, T4 and T5 than that of T6 (control group); where treatment groups T2 and T3 accelerates the ewes to come into heat earlier than treatment groups T4 and T5 it might be due to higher nutritional replacement. The mean time to onset of estrus in the treatment group (T2) was 40.3±1.3 hours after estrus synchronization. This result is in accordance with the previous results of Naqvi *et al*. (2012); who reported that the mean time for onset of estrus was 36.6±3.4 hours for Malpura ewes after sponge removal that ewes flushed by concentrate supplementation. On the other hand, higher intervals recorded by Naqvi *et al*. (2011) (60.0±3.0hours) for Malpura ewes that fed on concentrate supplementations. However, this result was lower than the previous results recorded by Moghaddam *et al*. (2019), (29 ±.33 hours) for Farahani ewes fed by 300 g/day/ewe concentrate and synchronized with flurogestone acetate sponges (FGA). Such differences might be attributed to the species difference and differences in the amount and type of nutritional supplementation. In the present study, onset of estrus in treatment groups (T2 and T3) was 40.3±1.340.3±1.3 and 44.3±1.2 hours, respectively. These results were big difference which is nearly (T1) 36.3±1.5 of this study the obtained by Danjuma *et al*. (2015). Also, the meantime onset of estrus was 33.48±8.6 hours for Yankasa ewes, after ewes synchronized with PGF2α when ewes supplemented on cotton seed cake. Inversely, these results were disagree with El- Shahat and Abdel-Monem (2011); who reported that the onset of estrus was 18.3±1.4 days for Baladi ewes, when the ewes fed on concentrate with selenium as basal diet supplemented with 0.3 mg of selenium per kg of diet. This difference may be due to types of feed supplemented. While in treatment group (T5) the onset of estrus in Bonga ewes was 48.3 ±1.6 hours. This result is comparatively near with (Farrag, 2019), who recorded that the ewes come into heat within 40.54
±18.28 hours for Abou-Delik ewes after synchronized with PGF2α when the ewes flushed by 300g of barley grain per day. But, this result is inconsistent with the previous findings recorded by El-Shahat and Abdel-Monem (2011); who reported that the onset of estrus was 16.4±1.4days for Baladi ewes, when the ewes fed on concentrate mixture with VitE2 as basal diet supplemented with 25mg Vit E per kg of diet. The species and time of flushing may have been contributed as such differences including nutrition type.

4.1.2. Effect of Nutritional Flushing on Duration of estrus

The mean time duration of estrus was found to be in T1 (30.5±1.7), T2 (28.6 ±1.5), T3 (28.1±1.9), T4(27±1.3), T5 (26.1±1.8) and T6(25±2.1). T2 and T3 showed the longer duration of estrus than the other treatments (Table 5). Duration of estrus recorded in the present findings in treatment groups T2 and T3 might be lower compared to T4 and T5. Also, longer duration of estrus recorded in the current investigation in treatment groups T6. Based on the current study, estrus duration of Bonga ewes ranges in between 25 to 30.5 h. This study was almost similar with the finding reported by (Montaser, 2015) in native ewe lambs (21 to 35.9 h); and Zohara et al. (2014) in indigenous ewes (30.5 to 31.6 h). Daghash et al. (2017) studied that the duration of estrus in Egyptian ewe lambs were 32.5 h in the control group and 31.62 h in flushed group.

4.1.3. Effect of Nutritional Flushing on Estrus response rate in Bonga ewes

In each treatment the mean value of estrus response results presented at table 5 below. This study revealed that treatment groups T2 and T3 had highly significant effect on percentage of estrus response ($P< 0.05$) than T4, T5 and T6 (control) group. Which means T1 (100%), T2(87.5%), T3(87.5%), T4(62.5%), T5(37.5%) and T6 (37.5%).

The estrus response rate under treatment groups T2 and T3 were 87.5% based on the current study. These results were in accordance with (Farrag, 2019) who recorded that, the estrus response rate in Abou-Delik ewes was 100%, when ewes received flushing ration (300g of barley grain/ head/ day). Also, these results were almost approaching to similar with the results of El- Shahat and Abdel Monem (2011) who reported that the estrus response rate in Baladi ewes was 100%, when using dietary supplementation of vitamin E and /or Selenium. Meanwhile, this study was in agreement with the results of *(*Daghigh *et al.,* 2019), who reported that the estrus response rate in Ghezel ewes flushed with diet containing barley grain selenium was 100%.

Based on (Huseyin *et al*., 2006) study who reported that, the current results were nearly similar with the estrus response rate in Akkaraman ewes was 98.33%, when the ewes were flushed by barley 700g/ewe/day for 35 days. On the contrary, these results were higher than the result reported by (Atsan *et al*. 2005), who found that the estrus response rate in Turkey ewes was 39% when the ewes flushed by barley grain. This difference might be attributed to differences in types of breeds and flushing diet.

In this study, in the treatment group four and five (T4 and T5) estrus response was (62.5 and 37.5%) respectively. This result compared with Sabra and Hassan (2008), who reported that the estrus response rate was 85%, when ewes flushed by a balanced mixture of crushed yellow corn 58% plus crushed soybean 41%. However, lower than the result that found by Sabra and Hassan (2010), who recorded that, estrus response rate was 100%, when ewes fed 0.5 kg sesban forage, compared with those fed 3 kg Egyptian clover (80%). Such differences may be due to the species difference, amounts of supplementation and management during feeding trials.

4.1.4. Effect of Nutritional Flushing on Conception rate of Bonga ewes

The present study revealed that the conception rate of ewes in treatment groups T2 (86.5%) and T3(86.5%) were significantly higher values ($p<0.05$) than that of T6(63% control group), T4(61%) and T5 (48%) treatment groups (table 5). As per the finding of the research in the present study, the conception rate, under the treatment group (T2 and T3) greater than and also (T4, T5 and T6) less than the result (Shafiullah *et al*., 2021), who reported that the conception rate was 72.72%, when Marwari ewes and (Ahmad *et al*., 2022), who reported that the conception rate was 70%, when Ossimi ewes flushed by 300gm/day and 500 concentrate supplementation for 21 days respectively. This result is also lower than the report of Huseyin et al. (2006) and Bahat (2019), they observed that the conception rates were 83.33% and 100% for Akkaraman and Abou-Delik ewes flushed by barley 700g/ewe/day for 35 days and 300g of barley grain/ewe day for 21 days, respectively. Breed used and type or time of flushing have a great impact on the result difference. In this study, T2 and T3 had higher value of conception rate, both 86%. The finding is comparable to the report of Ravindranath et al (2014) who reported conception rate was 83.3% for Nari Suwarna ewes fed ragi straw and supplemented with concentrate feed. Also, it is in a general agreement with the finding of El-Hawy et al. (2019), who reported, the conception rate of 85% in Barki ewes that fed on concentrate feed mixture and bean straw.

Table 4. Effect of nutritional flushing on estrus duration, onset of estrus, estrus response and Conception rate of Bonga ewes.

Parameters	Treatments						
	T1	T2	T3	T4	T5	T6	P-value
OE (hours)	36.3±1.5[c]	40.3±1.3[bc]	44.3±1.2[b]	48±1.4[a]	48.3±1.6[a]	48.6±1.7[a]	0.013
ED (hours)	30.5±1.7[a]	28.6 ±1.5[a]	28.1±1.9[a]	27±1.3[ab]	26.1±1.8[b]	25±2.1[b]	0.0109
ER (%)	100[a]	87.5[ab]	87.5[ab]	62.5[b]	37.5[bc]	37.5[bc]	0.0062
CR (%)	1[a]	0.86[ab]	0.86[ab]	0.61[abc]	0.48[bc]	0.36[c]	0.0288

OE: onset of estrus; ED: estrus duration; ER: estrus response; CR; conception rate

4.1.5. Effect of Nutritional flushing on Gestation period

The period elapsed from conception till parturition, which means gestation period presented of the experimental ewes were shown below (Table 6). The result showed that there was no significant change among treatment groups in gestation length ($p > 0.05$). The mean gestation periods for each treatment groups i.e.T1, T2, T3, T4, T5 and T6 were 148.7±1.6, 148.2±1.5, 148.3±1.6, 149±1.5, 150±1.6 and 150±1.3, respectively.

Mekoya, et al., (2008), reported that minimum length of gestation period as 151.8 days and the maximum was 152 days. And almost similar finding was reported by Mukasa-Mugerwa and Viviani (1992) that the length of gestation periods were 150 and 151 days in sheep supplemented with concentrated mixture and *S. sesban*. However, this result was higher than the previous findings that were recorded by (Khan et al., 2009), who obtained that the gestation period was 144.4±0.06 to 147.0±0.04 days, when the ewes fed on concentrated mixture. Based on the report Sabra and Hassan, (2010), who found that the gestation periods were 167±2.92 and 168±7.72 days ewe supplemented with 0.5 Kg sesban forage. The differences between the various studies could be due to difference in feed type, management and length of flushing days.

4.1.6. Effect of Nutritional flushing on Litter size

The mean litter size of treatment groups of T1, T2 and T3 were comparatively higher than T4, T5 and T6 (Control) (Table 6). In this study, treatment group (T1 and T3) showed highly significant ($P<0.05$) than the other treatments like T2, T4, T5 and T6. Less nutritional replacement, at T1 (0 gram) and T3 (90 gram) areke atela could be attributed the highest litter size at such treatment group. Based on the finding reported by Ribeiro et al. (2002) that the ewes supplemented with 0.5 kg per animal of ground corn was agreed with this result. In addition, with these results Marzouk et al. (2018) recorded that increasing ration during breeding period is enough to ameliorate the reproductive performance of Ossimi ewes. This study revealed that when the replacement feed (i.e. Areke atela) amount is increasing the litter size decreasing.

Table 5. **Effect of nutritional flushing on liter size and gestation period of Bonga ewes.**

Parameters	Treatments						
	T1	T2	T3	T4	T5	T6	P-value
LR (%)	1.25^{a}	1^{a}	1.25^{a}	0.875^{ab}	0.375^{b}	0.375^{b}	0.0078
GP (day)	148.7±1.6	148.2±1.5	148.3±1.6	149±1.5	150±1.6	150.6±1.3	0.2274

LS: liter size; GP: gestation period

4.2. Effects of Nutritional Flushing on Body Weight of Bonga ewes

The result of nutritional flushing effect on body weight change on Bonga breed ewes were shown in table 7. For all the treatment group, the mean body weight measured at different physiological stages, at the beginning of flushing, mid pregnancy and lambing time. The current study result showed that there was not significance difference ($P < 0.05$) in the mean body weight at the beginning of the experiment before engage/allow ewes for nutritional feeding. This insignificant difference was observed that, there was no error about sample selection or animals were appropriately distributed within each treatment. The mean body weight change at T2 and T3 consumed 45% and 90% replacement feed containing 135 % 90 % other concentrate respectively and there were significantly higher ($P<0.05$) than that of the control group in experimental ewes during flushing period at mid pregnancy period. On the other hand, at lambing period of the present study the mean body weight T2 (31.9kg) and T3 (31.6kg) attained significantly higher ($P<0.05$) than that of the other groups T4, T5 and T6 (control group). This finding is higher than the reports of Stanzaki *et al* (2021), Njoya *et al* (2002) and Vasanthakumar (2015) who reported body weight change in concentrate supplemented Marwari, Flube and Madras red ewes were 26.9-28.08 kg. But the current result also lower than the report of Zanouny *et al.* (2018), who reported 39.64 kg mean body weight for Ossimi ewes that flushed by concentrate feed mixture of 500 g/ewe/day up to 1 kg/ewe/day, for one month at mating period.

The mean body weights of Bonga ewes at lambing period in T2 and T3 treatment groups have a significance difference ($p<0.05$). In the present study, the mean body weight of ewes at lambing period was T1(32), T2(31.9), T3(31.6), T4(30.4), T5(31), T6(29.6). Marzouk *et al.* (2018), reported that the mean body weight for Ossimi ewes was 52 kg at lambing period, when ewes flushed by concentrate feed mixture of 500 g/ewe/day up to 1 kg/ewe/day, for one month. According to the present findings, a disparity exists, and it is conceivable that the timing of flushing and breeding might be contributing factors to such variations.At lambing time, the mean body weight in T2, T3, T4 and T5 treatment groups as shown in the above data, there was an increments of body weight from weight at the beginning to weight at lambing. Body weight increased at both T1 up to T5 because of nutritional supplement and replacement feeding compared to that of control group T6. The conversion of flushing supplementation into body reserves and thereby increases in the body weight of treatment groups are increase in bodyweight of ewes of Pakistan which were fed flushing diet and supplemental feeding of concentrate during breeding period (Rafiq *et al*. 2003). Islam *et al*. (2007) and Santos *et al*. (2009) stated that similar finding in Corriedale ewes supplemental feeding on concentrate. On the contrary, Kassem *et al*. (1989) and Smith (1985) reported on Awassi sheep supplemented on barely contrasted with the current findings. Generally, replacement or supplementation of concentrates feed for ewes increase body weight in each treatment level.

Table 6. The effect of nutritional flushing on body weight of Bonga ewes

Treatments	Parameters		
	BWB	BWM	BWL
T1	29.5^{ab}	33.6^{a}	32^{a}
T2	29.5^{ab}	33.4^{a}	31.9^{a}
T3	29^{b}	32.9^{ab}	31.6^{a}
T4	29.6^{a}	32.4^{b}	30.4^{b}
T5	29.5^{a}	32.2^{bc}	31^{a}
T6	29^{b}	29.5^{c}	29.6^{b}
P-value	0.0614	0.0001	0.0001

BW: Body weight; BWB: Body weight at the beginning; BWP: Body weight at mid pregnancy; BWL: Body weight at lambing.

4.3. Chemical composition of feed

Chemical composition / DM, CP, and ME / of representative feed sample were analyzed at International Livestock Research Institute (ILRI) nutrition laboratory. The chemical analysis of experimental feeds was carried out for their chemical composition using representative samples. Samples of experimental feeds were dried at 65^{0}C in a forced draft oven for 72 hours. The dried sub-samples of feed were ground to pass through a 1 mm sieve mesh and kept in airtight plastic bags pending analysis. Samples of feed offer was dried at 105^0C overnight in a forced draft oven for DM determination, while the ash content was determined by burning/igniting the feed samples in a muffle furnace at 550^0C for 5h in the oven according to the procedures of (AOAC, 2005). The nitrogen content of the samples was determined according to the Keldjhal method, and the crude protein (CP) was calculated as nitrogen by multiplying the nitrogen (N) content of the sample with a conversion factor of N×6.25. According to the procedures of (Van Soest and Robertson, 1985) Neutral detergent fiber, acid detergent fiber and acid detergent lignin were analyzed. The organic matter content was calculated as the difference of ash from 100. The energy value of feed was estimated according to McDonald *et al*. (2010). The nutrient composition of the supplemented feed showed in Table 4.

Table 7. Chemical composition of the treatment diets feed to Bonga sheep.

Nutrient	Areke Atela	NSC	WB	Natural grass???
DM (%)	93.9	93.3	91.8	
ASH	7.9	5.7	4.7	
CP	20.1	31.4	15	
NDF	29.8	35.7	50	
ADF	17	30.9	17	
ADL	5.7	11.9	3	
IVOMD	59.1	58.8	70.8	
ME	8.6	7.8	10.4	

Where; DM= dry matter; ASH = ash; CP=crude protein; NDF=neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin; IVOMD = in vitro organic matter digestibility; ME = Metabolizable energy

5. CONCLUSION AND RECOMMENDATIONS

Nutrition was a major limiting factor in the reproductive performance of ewes in the study area. Nutritional fed replacement for ewes in breeding season had great advantages compared with herder's usual practice. Therefore, the current study was conducted to evaluate the effect of graded level replacement of noug seed cake with local brewery residues on reproductive performance of bonga sheep. The replacement nutrition provided to Bonga ewes appears necessary to maintain a high level of ewe reproductive performance. To concluded, noug seed cake was replaced by "areke atela" as a short-term nutritional flushing for Bonga breed ewes increase different reproductive parameters and body weight. Such parameters are the onset of estrus, duration of estrus, estrus response, lambing rate, litter size, gestation period and conception rate including body weight at mid-gestation and body weight at lambing. Generally, the result showed that, the replacement groups significantly increased ($p < 0.05$) at T2, and T3 demonstrated superior estrous response and pregnancy rate compared with T4, T5 and the controlled group T6. Replacement group (T2, T3) with 45 g areke atela + 405 g CC and 90 g areke atela + 360 g CC are promising economical feed replacement to increase the reproductive performance of Bonga ewes. The long-term nutritional flushing demonstrated superior performance when compared to short-term flushing in relation to the reproductive performance of ewes. Therefore, it is advisable to implement long-term flushing practices to achieve the desired results. Furthermore, prior to scaling up the findings, further research conducted at the station level is warranted to ensure the validity and applicability of the results in broader contexts.

5.2

6 REFERENCES

Abegaz, S., Hegde, B.P. and Taye, M. (2011) Growth and Physical Body Characteristics of Gumuz Sheep under Traditional Management Systems in Amhara Regional State, Ethiopia. Livestock Research for Rural Development, 23. http://www.lrrd.org/lrrd23/5/abeg23117.htm

Abraham, H., Gizaw, S., and Urge, M. (2017). Begait goat production systems and breeding practices in Western Tigray, North Ethiopia Open Journal of Animal Sciences, 7 (2), 198-212

Abraham, T., 2019. Feed intake, digestibility and growth performance of Begait sheep fed hay basal diet and supplemented with Tsara (Pterocarpus lucens), Pigeon pea (Cajanus cajan) leaves and concentrate mixture. International Journal of Livestock Production, 10(9), 204-212.

Aden, T. (2003) Evaluation of Local Sheep Breed under Traditional Management around Rural Areas of Dire Dawa. MSc Thesis, Alemaya University, Alemaya.

Admasu L., Aberra M. and Sandip B. (2017) Traditional sheep production systems and breeding practice in Wolayita Zone of Southern Ethiopia. African Journal of Agricultural Research, Vol. 12(20), 1689-1701

Ahmad F. and Hossein D. (2014) Effect of Flushing Ration on the Sexual and Breeding Behaviors in Ghezel Sheep M.Sc. Students of Animal Physiology, Faculty of Agriculture, University of Tabriz, Iran. Department of Animal Science, Faculty of Agriculture, University of Tabriz, Iran.52-85

Ahmad F., Daghigh k., Hosseinkhani A., Moghaddam G., Alijani S., and Olfati A. (2014) Investigating the Effectiveness of Nutrition on the Sexual and Breeding Behaviors in Ghezel Sheep. International journal of Advanced Biological and Biomedical Research, 2(3), 715-722.

Alemu (2008) Short-term intensive fattening of sheep and goats before slaughter for rapid improvement in weight and condition and also producer incomes. Technical Bulletin number 11, Addis Ababa, Ethiopia.

Amata, I.A., 2014. The use of non-conventional feed resources (NCFR) for livestock feeding in the tropics: A review. Journal of Global Biosciences, 3(2), 604-613.

Amelmal, A., (2011): phenotypic characterization of indigenous sheep types of Dawuro zone and Konta special woreda of SNNPR, Ethiopia. MSc Thesis. Haromaya University, Haromaya, Ethiopia, 25-30

Annual report of Agricultural and rural development office of Kafa zone, 2012.

Asmare, B., 2016. Evaluation of the agronomic, utilization, the nutritive and feeding value of desho grass (pennisetum pedicellatum). PhD Dissertation submitted to the School of Graduate Studies College of Agriculture and Veterinary Medicine Department of Animal Sciences, Jimma University, 41.

Ayele, S. and Urge, M. (2019) Productive and Reproductive Performances of Indigenous Sheep in Ethiopia. Open Journal of Animal Sciences. 9(1):97-120.

Bahat, P. N. and Arona, C. L. (2019): (Eds.), sheep production, Chapter 7, Reproduction, female Reproduction, Studium Press Publisher, 150-164.

Banerjee, G.C.(1999). Sheep. In: A text Book of Animal Husbandry, 8th edition, Oxford & IBH Publishing Co., Pvt. Ltd., Calcutta, 997.

Bekana, K. (2019). Performance progeny of Horro sheep managed under community-based breeding in Horro district compared to on-station performance at Bako Agricultural Research center. MSc thesis, Wollegra University, Nekemte, Ethiopia 28-56

Bela, B. and Haile, A., 2009. Factors affecting growth performance of sheep under village management conditions in the south western part of Ethiopia. Development, 21, 11.

Belay, B. and Haile, A. (2009) Reproductive Performance of Traditionally Managed Sheep in the South Western Part of Ethiopia. Livestock Research for Rural Development, 21-30. http://www.lrrd.org/lrrd21/9/bela21154.htm

BoFED (Bureau of Finance and Economic Development). 2006. Development indicators of Amhara region. 4th ed. Bahir Dar, Ethiopia.

CSA (221) Ethiopian Agricultural Sample Survey, Volume ii, Report on Livestock and Livestock Characteristics.

Daghash H, Fahmy S, Hassan T and Ali M (2017). Impact of GnRH,PMSG and hCG treatments on follicular diameter, conception and lambing rates of Egyptian ewe lambs using intravaginal sponges. Egyptian Journal of Sheep and Goat Sciences, 12 (1): 1-8. DOI: https://10.12816/0035353

Daghigh Kia, H.; Saedi, S. and Hosseinkhani, A. (2019). Effects of organic and inorganic selenium supplementation with vitamin E during the flushing period on reproductive performance of Ghezel Ewes. Iranian Journal of Applied Animal Science (2019) 9(3), 433-441.

Danjuma, F.A., Bawa, É. K., Nwannenna, A.I. and Aluwong,T. 2015.Prostaglandin versus progestagen protocols in oestrus synchronization in the Yankasa ewe. Scientific Journal of Animal Science (2015) 4(9) 97-102.

Deribe, B., and Mengiste, T. (2014). Reproductive performance of Abergelle goats raised under traditional management systems in Sekota district, Ethiopia. Iranian Journal of Applied Animal Science,4 (1),59 -63.

Deribe, G. (2009) On-Farm Performance Evaluation of Indigenous Sheep and Goats in Alaba, Southern Ethiopia. MSc Thesis, Hawassa University, Awassa, 55-68.

Desta, T.G., Yadav, R.K. and Teferi, A.T., 2017. Substitution of dried mulberry (Morus indica L.) leaf meal for concentrate mix on feed intake, digestibility, body weight gain and carcass characteristics of Abergelle sheep. International Journal of Livestock Production, 8(4), 48-56.

Dhaba, U., Belay, D., Solomon, D. and Taye, T. (2013) Breeding Practices and Reproductive Performance of Traditionally Managed Indigenous Sheep and Goat in Ilu Abba Bora Zone of Oromia Regional State, Ethiopia. Global Veterinaria, 10, 676-680.

Dias, L. M. K., Sales, J. N. S., Viau, P., Barros, M. B. P., Nicolau, S.S., Simões, L. M. S., & Oliveira, C. A. (2018). Although it induces synchronized ovulation, hCG reduces the fertility of Santa Ines ewes submitted to TAI. Arquivo Brasileiro de Medicina Veterinária e Zootecnia, 70(1), 122-130

Drouilhet, L., Mansanet, C., Sarry, J., Tabet, K., Bardou, P., Woloszyn, F., Lluch, J., Harichaux, G., Viguie, C., Monniaux, D., Bodin, L., Mulsant, P. and Fabre, S. (2013) The Highly Prolific Phenotype of Lacaune Sheep Is Associated with an Ectopic Expression of the B4GALNT2 Gene within the Ovary. PLoS Genetics, 9, e1003809. https://doi.org/10.1371/journal.pgen.1003809.\

Edea Z. 2008. Characterization of Bonga and Horro Indigenous Sheep breeds of smallholders for designing community based breeding strategies in Ethiopia. MSc thesis, submitted to the School of Graduate Studies of Haramaya Univ. Dire Dawa, Ethiopia, 55-77.

Edea, Z., Haile, A., Tibbo, M., Sharma, A. K., Solkner, J. and Wurzinger, M. (2012) Sheep production systems and breeding practices of smallholders in western and south-western Ethiopia Addis Ababa: ICARDA

Edea,Z., Dadi, H., Kim, S.W., Dessie, T., Lee, T., Kim, H., et al. (2013). Genetic diversity, population structure and relationships in indigenous cattle populations of Ethiopia and Koran Hanwoo breeding using SNP markers. Front.Genet. 4:35. *Doi:10.3389/fgene.2013.00035*

El-Hawy AS, El-Bassiony MF, Abo Bakr S, Gawish HA, Badawy MT and Gado HM (2019). Productive and Reproductive Performance and Metabolic Profile of Barki Ewes Supplemented with Two Forms of Probiotics as Feed Additives. *World Vet. J.* 9(2): 135-145. www.wvj.science-line.com

El-Shahat K. and Abdel Monem U. (2011). Effects of dietary supplementation with vitamin E and/or selenium on metabolic and reproductive performance of Egyptian Baladi ewes under subtropical conditions. J. World Appl. Sci. 12, 1492-1499.

Emebet, L., 2008. Supplementation of Blackhead Ogaden sheep fed haricot bean (Phaseolus vulgaris) haulms with mixtures of wheat bran and brewers dried grain: effects on feed utilization, live weight gain and carcass parameters. Haramaya, Ethiopia: Haramaya University, 28-35.

Endale, A., Erko, B., Weldegebreal, F. and Legesse, M., 2015. Predictors of compliance with community-directed treatment with ivermectin for onchocerciasis control in Kabo area, southwestern Ethiopia. Parasites and vectors, 8(1), 1-8.

F. I. Shad, N. A. Tufani1, A. M. Ganie and H. A. Ahmed (2011) Flushing in Ewes for Higher Fecundity and Fertility Division of Animal Nutrition F.V.Sc. and A.H. (SKUAST-K)Shuhama Alusteng Srinagar-160006 (J and K) Livestock international,. 15 (2): 10-11….14

FAO (2010), Breeding Strategies for Sustainable Management of Animal Genetic Resources.FAO Animal Production and Health Guide lines.No. 3. Rome. ISBN 978-92-5-106391-0.

FAO (2011) Livestock and livestock characteristics, Report 2.Addis Ababa the Federal democratic republic of Ethiopia, 113-125

Farrag, B. 2019. Productive characteristics and reproductive responses to estrus synchronization and flushing in Abou-Delik ewes grazing in arid rangelands in Halaieb Shalateen - Abouramad Triangle of Egypt. World Veterinary Journal 9: 201-
210.

Fekerte, F. (2008) On-Farm Characterization of Blackhead Somali Sheep Breed and Its Production System in Shinile and Erer Districts of Shinile Zone. MSc Thesis, Haramaya University, 67-78.

Fsahatsion, H., Aberra, M. and Sandip, B. (2013) Traditional Sheep Production and Breeding Practice in Gamogofa Zone, Southern Ethiopia. International Journal of Livestock Production Research, 1, 26-43.

Gashu, M., Tamir, B. and Urge, M., 2014. Effect of supplementation with non-conventional feeds on feed intake and body weight change of Washera sheep fed urea treated finger millet straw. Greener Journal of Agricultural Sciences, 4(2), 067-074.

Gautsch, K.D. (1987) Comparative Productivity of Indigenous Sheep in the Highland Areas of Ethiopia and Rwanda. SRCG Working Document No 14, ILCA, Addis Ababa, 55-65.

Gbangboche, A.B., Adamou-Ndiaye, M., Youssao, A.K., Farnir, I.F., Detilleux, J., Abiola, F.A. and Leroy, P.L. (2006) Non-Genetic Factors Affecting the Reproduction Performance, Lamb Growth and Productivity Indices of Djallonke Sheep. Small Ruminant Research, 64, 133-142. https://doi.org/10.1016/j.smallrumres.2005.04.006

Getahun, L., Girma, A., Siegmund-Schultze, M., Valle, A. and Arate, Z. (2008) Small Ruminant Production in Two Mixed-Farming Systems of Southern Ethiopia: Status and Prospects for Improvement. Experimental Agriculture, 44, 399-412.

Gizaw, S. 2008. Sheep resources of Ethiopia: genetic diversity and breeding strategy. Ph.D. thesis, Wageningen University, The Netherlands, 123-130.

Gizaw, S. Abegaz, S., Rischkowsky, B., Haile, A., Mwai, A.O. and Dessie, T. (2013). Review of sheep research and development projects in Ethiopia. Nairobi, Kenya: International Livestock Research Institute ILRI, 56-58.

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

Gobena, M. M. (2016). Review on Small Ruminant Production, Marketing, and Constraints in Ethiopia. Advances in Life Science and Technology, 48, 28-34.

Gootwine E. Sheep: Reproductive Management. Ref Modul Food Sci. 2016; (December 2016). doi:10.1016/b978-0-08-100596-5.21239-0.

Haile, A., T. Mirkena, G. Duguma, M. Wurzinger, B. Rischkowsky, M. Tibbo, M. Okeyo, and J. So¨lkner. 2013. Community based sheep breeding programs: Tapping into indigenous knowledge. Livestock Research for Rural Development 25: 219.

Hassen, A., Ismail, A., Haile, A. and Legese, G. (2013), Analysis of sheep and goat value chains in Shinelle district, Somali Region, Ethiopia. Addis Ababa: ICARDA.35 pp.

Huseyin, N.; Orhan, Y. and Huseyin, D. (2006): Effects of flushing during normal breeding season on reproductive performance and birth weights of lambs in Akkaraman ewes. Saglik Bilimleri Dergisi, cilt 9, Sayi 1, Sayfa 92-99, 2006.

ILCA Working Document (1995) Reproductive Losses in Small Ruminants in Sub-Saharan Africa: A Review, 45-47.

Islam R., Bhat A.S., Sarkar T.K., Singh P.K. and Khan M.Z. (2007). Effect of flushing on reproductive performance of Corriedale ewes. Indian J. Small Rumin. 13, 1-7.

Jahan, M., Tariq, M.M., Kakar, M.A. and Waheed, A. (2013) Reproductive Performance of Balochi Sheep in Different Ecological Zones of Balochistan, Pakistan. Pakistan Veterinary Journal, 33, 37-40.

Kassem R., Owen J.B., Fadel I. and Whitaker C.J. (1989). Aspects of fertility and survival of Awassi sheep under semi-arid conditions. Res. Dev. Agric. 6, 161-168.

Khan, T. H.; Becka, N. F. G. and Khalid, M. (2009): The effect of hCG treatment on Day 12 post-mating on ovarian function and reproductive performance of ewes and ewe lambs. Animal Reproduction Science. 116:162-168.

Larbi, A. and Olaloku, E.A., 2005. Influence of plane of nutrition on productivity of ruminants in the sub-humid zone of West Africa. Coping with feed scarcity in smallholder livestock systems in developing countries. International Livestock Research Institute, Nairobi, Kenya, pp.149-156.

Leury, B.J., Murray, P.J. and Rowe, J.B. (1990).Effect of nutrition on the response in ovulation rate in Merino ewes following Short-term lupin supplementation and insulin administration. Australian Journal of Agricultural Research 41: 751-759.

Marzouk KM, El Zanouny AI and Kaoud MA (2018). Flushing vs. Hormonal treatment, which better improve the reproductive performance of Ossimi ewes? Egyptian Journal of Sheep and Goat Sciences,13(2):18-25.DOI:https://10.21608/ejsgs.2018.26245 McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA, Wilkinson RG (2010). Animal Nutrition, 7thed, Prentice hall, Harlow, England, London.

Mekuriaw, S., M. Taye, Z. Mekuriaw, G. Mekuriaw, H. Mazengia and A. Haile (2013) Evaluation of reproductive performances and survival rate of Washera sheep under farm and station management systems in Amhara region, Ethiopia. Agricultural Advances, 2(7):206-215.

Mengesha, M. and Tsega W. (2012), Indigenous sheep production in Ethiopia: a review. Iran. J. Appl. Anim. Sci., 2: 311–318.

Mengistie, T., Girma, A., Sisay, L. and Solomon, G. (2011) Reproductive Performance and Survival of Washera Sheep under Traditional Management System at Yilmanadensa and Quarit Districts of the Amhara National Regional State, Ethiopia. Journal of Animal and Veterinary Advances, 10, 1158-1165. https://doi.org/10.3923/javaa.2011.1158.1165

Metsafe Mamiru, Sandip Banerjee and Aynalem Haile. 2017. Selection Practices of Bonga Sheep Reared in Southern Ethiopia. Proceedings of the Zoological Society. Kolkata, India 2017.

Metsafe, M. (2015) On-Farm Performance Evaluation and Community Based Traditional Selection Methods of Bonga Sheep in Adiyo Kaka District, Southern Ethiopia. M.Sc. Thesis. Hawassa University, Hawassa, Ethiopia

Michaele, Y. (2018), Effects of feeding dried acacia saligna, Sesbania sesban or vigna unguiculata leaves as a replacement for cotton seed cake on production performances and semen quality of Begait sheep in northwestern Tigray, Ethiopia.

Mike, N., 2007. The basics of feeding sheep. Extension Sheep Specialist Purdue University http://ag. ansc. purdue. edu/sheep/articles/index. html (accessed 19 July 2014).

Mirkena, T., G. Duguma, A. Willam, M. Wurzinger, A. Haile, B. Rischkowsky, A.M. Okeyo, M. Tibbo and J. Solkner (2012) Community-based alternative breeding plans for indigenous sheep breeds in four agro-ecological zones of Ethiopia. Journal of Animal Breeding and Genetics 129(3): 244-253.

Montaser Elsayed Ali Abd-Erahem. 2015. Studies on improving fertility rate in native ewe lambs in Egypt. M.Sc Thesis. Assiut University, Faculty of Agriculture,Animal Production Department, Assiut, Egypt, Pp: 65.

Mukasa M, E., D. Anindo, S. Sovani, A. Lahlou-Kassi, S. Tebely, J.E.O. Rege and R.L. Baker. 2002. Reproductive performance and productivity of Menz ewe. Anim. Reprod. Sci. 36, 243– 251

Naqvi SMK, Sejian, V. and Karim SA (2012). Effect of feed flushing during summer season on growth, reproductive performance and blood metabolites in Malpura ewes under semiarid tropical environment. Trop Anim Health Prod (2013) 45:143-148. DOI 10.1007/s11250-012-0185-2.

Naqvi, S.M.K., Soren, N.M. and Karim, S.A., 2011. Effect of concentrate supplementation on performance, ovarian response, and some biochemical profile of Malpura ewes. Tropical Animal Health and Production, 43, 905-913.

Neme, Y. (2016). Production and reproduction performances, producers' trait preferences, and marketing system of small ruminants in Ada Barga and Ejere Districts of West Shoa Zone, Ethiopia. MSc Thesis in Agriculture (Animal Breeding and Genetics). Jimma, Ethiopia: Jimma University.120 pp.

Njoya, A.; Awa, D.N.and Chupamom, J. (2002): The effects of a strategic supplementation and prophylaxis on the reproductive performance of primiparous Fulbe ewes in the semi-arid zone of Cameroon. Small Ruminant Research 56(2005) 21-29.

Nwogwugwu, C.P., Lee, S. H., Freedom, E. C., Manjula, P., and Lee, J. H. (2018) Review on challenges, opportunities, and genetic improvement of sheep and goat productivity in Ethiopia. Journal of Animal Breeding and Genomics 2 (1), 001-008.

on the reproductive performance of Baladi sheep as compared to Barseem (Egyption clover). Journal of reproduction and infertility, 1(3):66-70.

Owen, J. B. (1976). Sheep Production, Bailliere Tindal, London. pp. 184-185.

Philipsson J, Rege JEO, Okeyo AM (2006) Sustainable breeding programs for tropical farming systems. In: ILRI-SLU 2006. ILRI (International Livestock Research Institute), Nairobi, Kenya and SLU (Swedish University of Agricultural Sciences), Uppsala, Sweden.

Rafiq M., Khan M.F. and Aujla K.M. (2003). Economic benefits offlushingand supplemental feeding of salt-range ewes on Pothwar Ranges of Pakistan. *Pakistan J. Biol. Sci*. 6(2**),** 115-121.

Ranjhan, S.K., 2001. Animal Nutrition in the Tropics. 5th Revised Edition.Vikas Publishing House.Pvt. Ltd. Masjid Road, Jangpura, New Delhi, India, 557.

Ravindranath, B. M., Krishnaswamy, A., and Chandrashekara Murthy, V. 2014. Conception rate and frequency of single and multiple births in estrus synchronized Nari Suwarna ewes maintained under two different systems of feeding strategies. International journal of livestock research ISSN 2277-1964.4 (5): 288-293.

Robinson, J. J. C. J. Ashworth, J. A. Rooke. (2006). Nutrition and fertility in ruminant livestock. Animal Feed Science and Technology. Review, 126,259-276.

Sabra, H. A. and Hassan, S. G. (2008): Effect of new regime of nutritional Flushing on reproductive performance of Egyptian Barki Ewes. Global Veterinaria., 2, (1): 28-3.

Sabra, H. A. and Hassan, S. G. (2010): Effect of sesban (sesbania egyptiaca) supplementation on the reproductive performance of Baladi sheep as compared to Barseem (Egyption clover). Journal of reproduction and infertility, 1(3):66-70.

Santos G.M.G., Silva K.C.F., Casimiro T.R., Costa M.C., Mori R.M., Mizubuti I.Y., Moriera F.B. and Seneda M.M. (2009). Reproductive performance of ewes mated in the spring when given nutritional supplements to enhance energy levels. Anim. Reprod. 6, 422-427.

Shafiullah, S.; Ashok, K.; Amit, K. and Purohit,G. (2021): Effect of flushing of ewes on body weight, oestrous response and conception rate, Indian Journal of Small Ruminants 2022, 28(1): 218-220.

Shambel Gdey. 2017. Evaluation of estrus response and fertility in ewes with and without flushing and mated to Begait rams under traditional management in Eastern Tigray, Northern Ethiopia. M.Sc Thesis. Mekelle University, Mekelle, Ethiopia, 46.

Smith J.F. (1985). Protein, energy and ovulation rate. Genet. Reprod. Sheep. 20, 349-359.

Smith, 2010. Flushing and winter grain feeding results with sheep NSt. Wool Grower. 23:17-19. Sep

Smith, J.F., Jagusch, K.T. and Farquhar, P.A. (1983).The effect of duration and timing of flushing on the ovulation rate of ewes. Proceedings of New Zealand Society of Animal Production 43:13-16.

Stanzaki, H.S and Choudhary, A.K. (2021); effect of flushing of ewes on body weight, oestrous response and conception rate CS and 2.25 to 2.30.

SUDCA (Sustainable Development Consulting Association). 2007. Data collection and analysis final report, Menjo Woreda. Ethiopia.

Teramaj Abebe (2020) Sheep Breeding Practices and reproductive performance in Lagambo District, South Wollo Zone, Amhara Region in Ethiopia

Tesfay, H., 2007. Supplementation of Afar rams with graded levels of mixtures of protein and energy sources: effects on feed intake, digestibility, live weight and carcass parameters. An MSc Thesis presented to School of Graduated Studies Haramaya University, Haramaya, Ethiopia. 24p.

Tesfaye Getachew. (2008).Characterization of Menz and Afar indigenous sheep breeds of smallholders and pastoralists for designing community-based breeding strategies in Ethiopia. MSc Thesis. Haramaya, Ethiopia: Haramaya University.

Tsedeke, K. (2007) Production and Marketing Systems of Sheep and Goats in Alaba, Southern Ethiopia. Msc Thesis, Hawassa University, Hawassa.

Wilson, R.T. (1989) Reproductive Performance of African Indigenous Small Ruminants under Various Management Systems: A Review. Animal Reproduction Science, 20, 265-286. https://doi.org/10.1016/0378-4320(89)90075-4.

Wilson, RT. (2011). Populations and production of fat-tailed and fat-rumped sheep in the Horn of Africa .Tropical Animal Health Production. 43(7):1419–1425

Zanouny, A.; Marzouk, K.M..; El Zanouny, AI and Kaoud, M. A.2018. Flushing vs. Hormonal treatment, which better improve the reproductive performance of Ossimi ewes. Egyptian Journal of Sheep & Goat Sciences, 13, No. 2, 18-25.

Zewdie, B., and Welday, K. (2015). Reproductive performance and breeding strategies for genetic improvement of goat in Ethiopia: a review. Greener Journal Agricultural Science, 5 (1), 023-33.

Zewdu, E., Aynalem, H., Markos T., Sharma, A. K., Dejene, A., Sölkner, J. and Maria, W. (2009) Morphological Characterization of Bonga and Horro Indigenous Sheep Breeds under Smallholder Conditions in Ethiopia. Ethiopian Journal Animal Production, 9, 117-136.

APPENDICES TABLES AND FIGURES

Appendix I

Table 8. ANOVA for onset of estrus

Source of variation	DF	SS	MS	F-value	p-value
Treatment	5	4895.484375	979.096875	3.41	0.0130
Block (replication)	7	4809.661458	687.094494	2.39	0.0414
Error	35	10058.05729	287.37307		
Total	47	19763.20313			

Table 9. ANOVA for estrus duration

Source of variation	DF	SS	MS	F-value	p-value
Treatment	5	1377.854167	275.570833	3.53	0.0109
Block (replication)	7	841.979167	120.282738	1.54	0.1859
Error	35	2731.645833	78.047024		
Total	47	4951.479167			

Table 10. ANOVA for Liter size

Source of variation	DF	SS	MS	F-value	p-value
Treatment	5	2.93750000	0.58750000	3.93	0.0062
Block (replication)	7	2.14583333	0.30654762	2.05	0.0758
Error	35	5.22916667	0.14940476		
Total	47	10.31250000			

Table 11. ANOVA for Gestation period

Source of variation	DF	SS	MS	F-value	p-value
Treatment	5	70881.85417	14176.37083	3.81	0.0074
Block (replication)	7	37071.97917	5295.99702	1.42	0.2274
Error	35	130249.6458	3721.4185		
Total	47	238203.4792			

Table 12. ANOVA for Body weight at the beginning

Source of variation	DF	SS	MS	F-value	p-value
Treatment	5	4.6666667	0.9333333	2.80	0.0614
Block (replication)	7	969.3333333	138.4761905	415.43	<.0031
Error	35	11.6666667	0.3333333		
Total	47	985.6666667			

Table 13. ANOVA for Body weight at mid pregnancy

Source of variation	DF	SS	MS	F-value	p-value
Treatment	5	33.2668750	6.6533750	26.10	<.0001
Block (replication)	7	963.3597917	137.6228274	539.91	<.0001
Error	35	8.921458	0.254899		
Total	47	1005.548125			

Table 14. ANOVA for Body weight at lambing

Source of variation	DF	SS	MS	F-value	p-value
Treatment	5	23.831667	4.766333	9.92	<.0001
Block (replication)	7	1020.700000	145.814286	303.33	<.0001
Error	35	16.825000	0.480714		
Total	47	1061.356667			