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On-Farm Evaluation of the Effects of Nutritional Flushing on Body Weight, Body Condition Score and Reproductive Performances of Doyogena Ewes in Doyogena District, Southern Ethiopia

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MSc Thesis Research

By

Asfaw Tesfaye Ayele

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By

Asfaw Tesfaye Ayele

Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science (MSc) in Feeds and Animal nutrition

Major supervisor: Bimrew Asmare (PhD)

Co-supervisor: Jane Wamatu (PhD)

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Bahir Dar, Ethiopia

THESIS APPROVAL SHEET

As members of the Board of Examiners of the Master of Sciences (MSc) thesis open defense examination; we have read and evaluated this thesis prepared by **Asfaw Tesfaye Ayele** entitled "**On-farm evaluation of the effects of Nutritional flushing on Body weight, Body condition score and Reproductive performances of Doyogena ewes in Doyogena District, Southern Ethiopia**''. We hereby certify that the thesis is accepted for fulfilling the requirements for the award of the degree of Master of Sciences (MSc) in **Feeds and Animal Nutrition**.

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DECLARATION

This is to certify that this thesis entitled **"On-farm evaluation of the Effects of Nutritional flushing on Body weight, Body condition score and Reproductive performances of Doyogena ewes in Doyogena District, Southern Ethiopia"** submitted in partial fulfillment of the requirements for the award of the Degree of Master of Science in "**Feeds and Animal Nutrition** "to the Graduate Program of the College of Agriculture and Environmental Sciences, Bahir Dar University by **Mr. Asfaw Tesfaye Ayele** (ID.No.BDU1207138) is an authentic work carried out by him under our guidance. The matter embodied in this project work has not been submitted earlier for an award of any degree or diploma to the best of our knowledge and belief.

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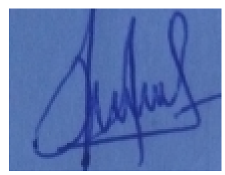
STATEMENT OF THE AUTHOR

I hereby declare and confirm that this thesis is my original work and that all sources of materials were used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MSc degree at Bahir Dar University and deposited at the University's Library and to be made available to borrowers under the rules of the library. The author solemnly declares that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate. Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgment of the source is made. Requests for permission for extended quotation or reproduction of this manuscript in whole or in part may be granted by the head of the Department of Animal sciences or the Dean of School of Graduate Studies when in his or her judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author.



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DEDICATION

I dedicate this thesis research to my father Priest Tesfaye Ayele, he passed away when I was kid.

LIST OF ABBREVIATIONS

ADF	Acid Detergent Fiber
ADL	Acid Detergent Lignin
AI	Artificial Insemination
BCS	Body Condition Score
BW	Body Weigh
CBBP	Community Based Breeding Program
CGIAR	Consultative Group on International Agricultural Research
CR	Conception Rate
CSA	Central Statistical Agency
CSM	Cotton Seed Meal
DAGRIS	Domestic Animal Genetic Resources Information System
DBoA	Doyogena Bureau of Agriculture
DM	Dry Matter
ER	Estrus Response
FR	Fecundity Rate
GLM	General Linear Model
ICARDA	International Center for Agricultural Research in the Dry Areas
ILRI	International Livestock Research Institute
LBW	Lamb Birth Weight
LR	Lambing Rate
LS	Litter Size
M.a.s.l	Meter above sea level
NDF	Neutral Detergent Fiber
PGF2α	Prostaglandin F2α analogue
RCBD	Randomized Complete Block Design
SAS	Statistical Analysis System

LISTS OF ABBREVIATIONS (Continued)

SEM	Standard Error of Mean
SNNPR	Southern Nation Nationalities and peoples representative states
SSA	Sub-Saharan Africa

ABSTRACT

ON-FARM EVALUATION OF THE EFFECTS OF NUTRITIONAL FLUSHING ON BODY WEIGHT, BODY CONDITION SCORE AND REPRODUCTIVE PERFORMANCES OF DOYOGENA EWES IN DOYOGENA DISTRICT, SOUTHERN ETHIOPIA

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The study was conducted to evaluate the effects of nutritional flushing on body condition score, body weight and reproductive performance of Doyogena ewes. Thirty five Doyogena ewes with initial body weight of 27.71±2.87 kg (mean ± SD) were used for the experiment. The experimental design was a randomized complete block design (RCBD) with five blocks consisting of seven ewes per block based on their initial body weight. The supplementary treatments were comprised of grazing natural pasture (T1), 340g enset leaf with 500g concentrate g/ewe/d (T2), 340g enset leaf with 500g concentrate g/ewe/d (T3), 340 g enset leaf with 400g concentrate g/ewe/d (T4) and 340g enset leaf with 250g concentrate g/ewe/d (T5) for 35 days. The ewes received flushing supplementation for three weeks before mating and two weeks after mating. All ewes were synchronized using an intramuscular injection of prostaglandin F2 alpha (PGF2α) on day 21 of the experiment and the ewes coming to heat were artificially inseminated. A general linear model (GLM) procedure of the statistical analysis system (SAS, version 9.2) 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, lambing rate, and fecundity rates were analyzed using nonparametric test. The results showed that during mating and mid pregnancy period the mean body weight of the ewes were significantly ($P<0.01$) higher under (T2, T3, T4 and T5) than T1.Whereas, at lambing period the mean body weight of the ewes were highly significant ($P<0.001$) differences in (T2, T3 and T4) than T5 and T1. The mean body condition score of the ewes under (T2, T3, T4 and T5) was significantly ($P<0.01$) higher than that of T1. The onset of estrus was a highly significant ($p< 0.001$) under T3 and T4 than T1, T2 and T5. The

mean time to duration of estrus under T3 and T4 showed longer duration of estrus than T1, T2 and T5. The result indicated that estrus response rate under T2, T3 and T4 had highly significant (P<0.001) than T1 and T5; 100%, 100% and 85.7%; and 71.4% and 71.4%, respectively. The conception rate under T3 (85.3%) and T4 (83.3%) had significantly higher values (p<0.001) than T1 (60%), T2 (71.4%) and T5 (66.67%). The lambing rates of T3 (100%), T4 (100%) and T5 (100%) were significantly higher (P<0.001) than T1 (66.67%) and T2 (80%). The fecundity rate was highly significant (P<0.001) differences in T3 (157.1%) compared with T2 (100%) and T1 (60%). The litter size under T3 (1.83 ± 0.06) was highly significant (P<0.01) than T1 (1.50 ± 0.20), T2 (1.75 ± 0.11), T4 (1.60 ± 0.22) and T5 (1.50 ± 0.24). The birth weight of lambs under T3 (3.39 ± 0.097) and T4 (3.19 ± 0.106) were significantly (P<0.01) higher than T2 (3.04 ± 0.117), T5 (2.93 ± 0.091) and T1 (2.73 ± 0.088 kg), which could be attributed to high amount of nutritional flushing. Hence it was concluded that feeding 340g enset leaf + 500g concentrate and 340 g enset leaf + 400g of concentrate is ideal feeding regimen as compared to other treatment groups in order to achieve a higher body condition score, body weight and reproductive performance.
Key words*: Doyogena ewes, flushing, body condition score, reproductive performance.*

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CHAPTER ONE: INTRODUCTION

1.1. Background and Justification

Small ruminants are the major economically important livestock in Ethiopia, playing an important role in the livelihood of resource-poor farmers and they are integral part of livestock keeping in Sub-Saharan Africa (SSA) that are mainly kept for immediate cash sources, milk, meat, wool, manure, and saving or risk distribution (Kosgey, 2004; Hagos Abraham *et al*., 2017 and Hagos Hailay *et al*., 2018). Sheep and goat production are among the major economically important livestock in Ethiopia (Adane Hirpa and Girma Abebe, 2008; Ashenafi Hagos *et al*, 2014). Ethiopia has a diverse indigenous sheep population numbering 39.89 million sheep are estimated to be found in the country, out of which about 70.28 percent are females, and about 29.72 percent are males sheep, Of the total sheep population about 70.05% are indigenous breeds which are owned and managed in the rural sedentary areas of the country while the remaining are crossbred and exotic (CSA, 2020). It contributes substantially to the livelihoods of rural households as a source of income, food (meat and milk), and industrial raw materials (skins and wool). In addition to socio economic and cultural functions, sheep contribute to risk mitigation during crop failures, increase property security, and serve as a form of investment (Samson Leta and Friehiwot Mesele, 2015; Markos Tibbo, 2006).

Despite the large number of sheep and their contributions to the livelihood of the farmers and the national economy sheep productivity in Ethiopia is low due to different factors including, attention from scientists, administrators and legislators (Arse Gebeyehu et al, 2013), low genetic potential and policy issues, market and institutional problem and problem of credit facilities; shortage, seasonal unavailability and low nutritive (poor nutrition) value of feed and/or ; prevalence of different diseases and parasites, lack adequate veterinary service, water shortage, capital shortage, market problem and capital shortage (Belete Asefa et al, 2015).

Sheep production and productivity in the country is constrained by feed shortages, diseases, poor infrastructure, lack of market information and technical capacity, and an absence of planned breeding programs and breeding policies. Institutions that are involved in research, extension, and services so far have failed to have a positive influence on traditional sheep husbandry practices (Solomon Gizaw et al., 2013b). The productivity and profitability of local meat and milk industries effectively depend on reproductive performance (Martin *et al.*, 2004).

The reproductive performance of small ruminants has been positively associated with energy balance (Ali et al., 2019). An increase in energy intake around breeding can have a positive impact on reproduction of these animals. Flushing promotes an increase in concentrations of blood metabolites such as glucose, which plays an important role in folliculogenesis and ovulation (Zabuli et al., 2010; Habibizad et al., 2015). The results obtained in flushing programs may vary according to differences in the body condition scores (BCS) of the ewes (Gottardi et al., 2014), the feeds included in their diets (Rekik et al., 2012), and the length of the flushing period (Habibizad et al., 2015).

Reproductive efficiency in sheep is influenced by the availability of feed resources and the energy status of the animals (Sejian et al. 2010), including both amount of body energy stores and feed intake (El-Shahat and Abo-El maaty 2010). As per energy status of the animal, neuroendocrine signals are generated to regulate secretion of gonadotropin realizing hormone (GnRH) and luteinizing hormone (LH) (Archer et al. 2002) which in turn influences follicular development and ovulations (Scaramuzzi et al. 2006). Improved nutrition or feed flushing (concentrate supplementation prior to breeding) has been known as a tool to enhance ovulation rate and overall reproductive efficiency. The plane of nutrition, positive energy balance, and protein absorption are the main regulators for these processes in sheep. Many reviews have been published on the aspect of interaction between reproduction and nutrition in ruminants with special reference to sheep (Scaramuzzi et al. 2006; Karikari and Blasu 2009; Zabuli et al. 2010).

The level of nutrition and quality of feed provided is one of the most important factors that influence the reproductive performance of ruminants, especially small ruminants. The provision of flush feeding is a practice that is commonly used in the sheep industry to improve the overall reproductive performance of the ewe, in combination with the ram effect (Gootwine *et al*, 2016). The practice of flush feeding involves the feeding of diets that are higher in protein and energy to ewes prior to the introduction of the intact ram, as well as during the mating period, for a minimum of two weeks. Prior to the feeding of a flushing diet, ewes will be maintained on a maintenance diet that serves the purpose to meet their daily nutritional need to support maintenance functions. The provision of excess protein and energy, *i.e*. more than what is required for maintenance, allows a ewe to partition the excess energy and protein towards physiological taxing processes such as folliculogenesis, fertilization, conception, gestation, parturition and lactation (Habibizad *et al.*, 2015; 2018).

In Ethiopia Doyogena Sheep breed is one of the potential breeds in production and reproduction performance, however; flushing to enhance reproductive performance of sheep has not been demonstrated, there is no trend and standard level of flushing in Ethiopia generally, particularly in Doyogena sheep, there is no study and limited effort has been made to untouched the reproductive performance of Doyogena sheep. Therefore, the aim of the study was to investigate the effect of nutritional flushing on body weight, body condition score and reproductive performance of Doyogena ewes prior to and during breeding.

1.2. Statement of the Problem

Shortage of feed during the breeding season is the main factor, which affect the sheep reproductive performance. Most of the sheep feeds are derived from natural pasture and crop residues. However, such feed resources may not fulfill the nutritional requirements of animals, due to their inherent low nutrient content and poor quality (Alemayehu Tadesse, 2006). Feeding such poor nutritional value feeds results in slow growth rates, poor fertility, and high rates of mortality and consequently reduced productivity of sheep (Getahun, 2013).

Hence, nutrition is generally recognized as a significant regulator of reproduction. Several studies in small ruminants have shown that with nutritional flushing ovulation and fetal implantation in the uterus is improved (Morales et al., 2012). Flushing can be accomplished either by allowing animals to graze lush pastures or by feeding energy-rich supplements (Hamito, 2010). Nutritional flushing has been a common practice among sheep producers to increase ovulation, conception rates and the number of lambs born. The level of nutrition and quality of feed provided is one of the most important factors that influence the reproductive performance of ruminants, especially small ruminants. The provision of flush feeding is a practice that is commonly used in the sheep industry to improve the overall reproductive performance of the ewe, in combination with the ram effect (Gootwine, 2016). The practice of flush feeding involves the feeding of diets that are higher in protein and energy to ewes prior to the introduction of the intact ram, as well as during the mating period, for a minimum of two weeks. Prior to the feeding of a flushing diet, ewes will be maintained on a maintenance diet that serves the purpose to meet their daily nutritional need to support maintenance functions. Despite, its importance of nutritional flushing is to enhance reproductive performance of sheep has not been extensively demonstrated, and only limited effort has been made to assess nutritional effects on reproduction of sheep *(*Aberra Melesse *et al*., 2013*).*

1.3. Objective

1.3.1. General objective

The general objective of this study was to evaluate the effects of nutritional flushing on body condition score (BCS), body weight (BW) and reproductive performances of Doyogena ewes at Doyogena District, Southern Ethiopia.

1.3.2. Specific objectives

- To evaluate effects of nutritional flushing on body condition score and body weight in Doyogena ewes.
- To assess influence of nutritional supplementation on reproductive performances.

1.4. Research Questions

- ✔ What is the effect of nutritional flushing on body weight and body condition score of Doyogena ewes during breeding?
- ✔ What is the effect of nutritional supplementation on reproductive performances?

1.5. Limitation of the study

The study was conducted to evaluate the body weight, body condition score and reproductive performance of ewes. But one of the main limitations of this thesis was missing of economic evaluation of flushing and conducted only in one season.

CHAPTER TWO: LITERATURE REVIEW

2.1. Sheep Production System in Ethiopia

Ethiopia has a diverse sheep population and its distribution is paralleled with its diverse ecology. Ethiopia's sheep population is estimated at 42.9 million (CSA, 2021). It is grouped into 14 indigenous sheep populations with more than 18 breed types widely distributed across the different agro-ecological zones (Solomon Gizaw *et al*., 2007). However, sheep are reared mainly through smallholder farmers and grazed in small flocks on open natural pasture and crop residue (CSA, 2021). According to the report of (Petrovic *et al*., 2011), indigenous sheep breed productivity and performance are varied due to environmental factors. These variations in performances of sheep in Ethiopia are also aroused from within and between breeds, management practice, and across the agro-ecologies.

Sheep production systems are one of the major parts of the livestock production system in Ethiopia (Adane Mezgebu, 2017). They are classified using criteria that included a level of integration with crop production and contribution to livelihood, level of input and intensity of production, agro-ecology, length of the growing period, and relation to land and type of commodity to be produced (Getachew Molla *et al*., 2017). Based on the above classification criteria, the sheep production system practiced in the country is Highland sheep-barley system, mixed crop-livestock system, pastoral and agro-pastoral production system, ranching, and Urban and peri-urban sheep production system (Worku Anteneh and Yadav, 2017).

Commonly, in the country, they are three major sheep production system such as highland sheep–barley system, mixed crop-livestock system, and pastoral and agro-pastoral production systems and two minor production systems (not currently practiced widely) such as ranching and urban and peri-urban (landless) sheep production system are described (ESAP, 2017). The same author reported that the major sheep production system in Ethiopia particularly SNNPR is a mixed Enset (Kocho) crop-livestock system with farmers keeping especially ruminants to different extents in small areas.

2.1.1. Mixed crop-livestock production system

In the mixed farming systems of the highlands, sheep mostly depend on grazing fallow lands, natural pasture, and crop residues with no extra supplement and receive minimum health care. In humid, sub-humid, and highland agro-ecological zones, sheep are kept by smallholders and graze together with goats and other livestock such as cattle (Yoseph Mekasha, 2007). Thus, productivity is low due to nutritional stress for much of the year and carry heavy internal and external parasite burdens (EARO, 2000). Besides, the increased human population has led to decreased farm size and a gradual shift from keeping large to small ruminants, mainly sheep (Peacock, 2005) in central Ethiopia.

2.1.2. Agro pastoral and pastoral system

In the pastoral system, even if there is cultivation in some areas, livestock production forms an integral part of socio-economic life for the vast and diverse human population (Alemayehu Mengistu, 2007). In the lowlands of Ethiopia, livestock is comprised of large flocks and herds of sheep and goats, cattle and camels mainly transhumant, where the only surplus is sold at local markets or trekked to major consumption centers. Sheep are highly produced in pastoral and agro-pastoral systems. Relatively larger flocks are maintained in the lowland (agro-pastoral systems). The major feed resources for sheep include grazing on communal natural pasture, crop stubble, fallow grazing, roadside grazing, crop residues, browses, and non-conventional feeds (household food leftovers, weeds, crop tillers, and fillers). Production of improved forages, improvement of low-quality feed sources such as crop residues, and supplementary feeding (except fattening) are almost non-existent (Solomon Gizaw *et al*., 2008).

2.1.3. Urban and peri-urban system

This system is the production of small ruminants within and at the periphery of cities. Quantitative data is not available on the importance of urban and peri-urban production systems but it is common to observe sheep and goats in urban areas including the capital city of the country, Addis Ababa. Feed resources are usually leftovers from home, market area, mill, by-products, and roadside grazing (particularly in the peri-urban system) (Solomon Gizaw *et al*., 2008).

2.1.4. Highland sheep-barley system

This production system prevails in the high altitude areas (above 3000 m.a.s.l.) where the major crops grown are barley and pulses such as faba beans, lentils, etc. Sheep are the dominant livestock species. The main feed resource-base includes wasteland grazing, stubble, and sometimes straw. Sheep flock sizes range from 30 to several hundred heads. Although sheep are reared mainly for meat skins and coarse wool production for the cottage industry of the central highlands are subsidiary products (Solomon Abegaz *et al*., 2008).

2.1.5. Ranching system

A ranching system is a range-based system of livestock production similar to the pastoral systems but with different production parameters, livestock functions, and management, the system can be considered a modern land-use system. The main function of this system is to generate cash income. Both highland and arid/semi-arid ranching can be undertaken in Ethiopia (Solomon Abegaz *et al*., 2008).

However, in southern Ethiopia, particularly in Doyogena district, Enset based farming or mixed crop-livestock production system is an indigenous and sustainable agricultural system (Belay Elias *et al*., 2018). The district has favorable agro-ecology for sheep producing and they follow enset-crop-livestock production system (Feleke Assefa *et al*., 2015). Enset ventricosum is a staple food in the area. The same author states that the local breeds have better productive and reproductive potentials. However, due to the shortage of capital, lack of credit on required time, land scarcity, feed shortage, awareness problem and poor husbandry system, the district in general and the rural sheep producing households in particular have not been sufficiently benefited from the sheep production sub sector.

2.2. Sheep breeds in Ethiopia

Sheep (*Ovis aries*) are believed to be among the first animals to be domesticated, preceded by the dog and goat. The domestication of both sheep and goats probably dates back to the pre-settled agricultural period. It is also believed that most domestication took place in western Asia where the majority of the present day small ruminant breeds likely originated The hair sheep of Africa and Asia are thought to have descended mainly from the urial (Solomon Gizaw et al., 2007).

Ethiopia has a genetically diverse sheep population three-quarters of which is found in the highlands where mixed crop-livestock and sheep-barley production systems dominate (DAGRIS, 2006). The Ethiopian sheep breeds are classified into 14 traditional populations in 9 breeds within 6 major breed groups. There are about 14 traditionally recognized sheep breeds (Solomon Gizaw, 2007). He further indicated that sheep types in Ethiopia are highly affiliated to specific ethnic communities. Several traditional breeds are reared by and named after specific communities. According to Solomon Gizaw (2008), morphological and molecular characterization of Ethiopian sheep breeds by targeting those populations traditionally recognized by ethnic and/or geographic nomenclatures nine genetically distinct breeds were identified.

2.2.1. Description of Doyogena Sheep

Doyogena sheep is among the sheep breeds reared in the *Enset*-crop-livestock production system of the SNNPR state, Ethiopia. The sheep is particularly found in the Kembata Tembaro zone of the SNNPR. It is characterized and well known by its twining ability (Mengistie Taye *et al*., 2016). The earlier studies showed that this breed was known by different names. Markos Tibbo (2006) reported sheep population found in Kembata Tambaro zone under Arsi Bale breed and Tsedeke Kocho (2007) named these sheep as Adilo or Kembeta area sheep population. In the study of Solomon Gizaw *et al*. (2011a) and Deribe Gemiyo *et al. (*2014) Doyogena sheep was named by Wolayta sheep ecotype. Later in 2013, a team of researchers from Areka Agricultural Research Center partnered with ICARDA conducted a value chain analysis of Doyogena sheep (Ashenafi Mekonnen *et al.,* 2013. The report indicated that Doyogena district is the main source of the sheep whereas Adilo is a large sheep marketplace sourced from Doyogena, Alba and Wolayta area. For the most part, sheep flocks including lambs, ewes and rams from Doyogena market are transported to Adilo market, and then purchased by big and small traders. Accordingly, smallholder farmers found in and around the Adilo area purchase sheep to fatten or for breeding purposes from Doyogena. For that reason, the sheep is named after the marketplace (Adilo).

In the study of Aberra Melesse *et al.* (2013) the morphometric and qualitative traits of the sheep population found in Kembata Tambaro zone was significantly different from the sheep found in Wolayta area. In the report of Zelalem Abate (2018), Doyogena sheep were distributed through Wolayta, Hadiya and Kambata Tambaro zones, called Adilo sheep some years ago, and currently called Doyogena sheep. Morphology of Doyogena sheep is clearly described by Mengistie Taye *et al*. (2016). The sheep was characterized as being large in size, horned with a long fat tail. The mean age at first breeding of Doyogena sheep is 241 and 240 days for female and male sheep, respectively. The same author reported the twinning rate of Doyogena sheep to be 1.45±0.45. In the other study, Tsedeke Kocho (2007) reported the age at first lambing of this sheep is 378 days for lambing. Doyogena ewes are prolific with high incidences for multiple births with occasional triplet and quadruplet (Ayele Abebe, 2018).

2.3. Sheep Production Constraints

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

2.3.1. Feed shortage

Lack of adequate feed resources as the main constraint to animal production was more pronounced in the mixed crop-livestock systems, where most of the cultivated areas and high human population are located (Yenesew Abebe *et al.,* 2013).
Many authors described the seasonal feed shortages, both in quality and quantity, and the associated reduction in livestock productivity in different parts of the country (Getahun Legesse, 2008 and Yeshitila Alemu, 2007; Shimelis Mengistu et al., 2021). Feed shortage problem was similar throughout the country, being serious in high human population areas where land size is diminishing due to intensive crop cultivation and soil degradation. Study of Mesay Yami *et al.(* 2013), in Lemu-Bilibilo district in Arsi zone reported that, shortage of feed at the end of dry season when all crop residues have been consumed and pasture growth is poor, was the major constraint for livestock production in the area. The feed shortage also appears even in the rainy seasons since more of the lands are occupied by crops.

2.3.2. Water shortage

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

2.3.3. Health constraints

Another serious constraint for sheep production in Ethiopia has been the high prevalence of diseases and parasites. This causes high mortality amongst lambs, diminishing the benefits of their high reproductive performance (Markos Tibbo, 2006; Abraham Kebede, 2021). Animals with good adaptive potential are needed in these stressful environments to sustain the livelihoods of the communities (Solomon Gizaw *et al.,* 2010; Tadele Mirkena, 2010; Zewudu Edea *et al.*, 2012 and Helen Nigussie *et al.*, 2013).

2.4. Reproduction performance of sheep

The reproductive and growth performances of small ruminants are important factors influencing flock productivity. All forms of output including milk, meat, wool and skins depend on these factors. The factors vary mostly between breeds and even within flocks in a given population (Azage Tegegne et al., 2010). These factors are influenced by many factors including genotype, nutrition, diseases and other management practices. In addition, these performance parameters are not a single trait each but the combination of other several traits that determine their expression (Belete Shenkute, 2009).

2.5. Factors affecting sheep reproductive performances

Reproductive performance is influenced by several factors. These include genetic potential of the animal, nutritional status, environmental factors (Mukasa *et al.*, 2002), and health status (Aragaw *et al.*, 2011). Reproductive traits are difficult to measure and are strongly influenced by management (Notter, 2000; Regassa, 2018).

2.5.1. Nutritional flushing effect

Feeding of sheep is one of the most important factors that influence the fertility of sheep, a high level of feed and energy may increase ovulation rate. This result in a higher lambing percentage by increasing the number of twin births, this procedure is known as flushing. Special attention must be paid to mineral and vitamin supplements (Petrovic *et al*., 2012). Flushing is understood as the rapid increase in ovulation rate of ewes receiving a nutrient supplementation before mating. Lassoued *et al*. (2004) showed important interactions between reproduction and level of nutrition. Positive energy balance occurs when the nutrient requirement of an animal is less than the nutrient intake resulting in the storage of the excess nutrients. It is also associated with increased body weight and ovulation rate. Flushing is a feeding management technique commonly used to increase litter size or defined as temporary, but purposeful elevation in the plane of nutrition prior to and a few weeks after mating (Hamito, 2010).

The main purpose is to bring ewes/does into good body condition prior to breeding. This practice will increase ovulation rate (number of ova released), increase conception, and improve embryo survival and consequently increase multiple births. Other added advantages of flushing include decreased percentage of barren ewes and reduced percentage of stillbirths (Hamito, 2010). Flushing prior to the beginning of the breeding season positively affects body condition score (BCS) and improves reproductive performance of Sheep and goats (Walkden-Brown and Bocouier, 2000). Supplemental fats improve ovarian follicle development and corpus luteum activity and are important precursors for the synthesis of reproductive hormones such as steroids and prostaglandins (Ricardo *et al.*, 2000 and Fouladi- nashta *et al.*, 2009). In most cases energy feeds like maize, barley, etc., can be fed at a rate of 250 to 300 g daily, flushing with high protein feeds is advantageous when sheep or goats are on a protein-deficient diet, such as low protein pasture (Hamito, 2010).

Flushing may also increase the proportion of females that exhibit estrus. Boosting these increases lambing and kidding rates by 10-20%, these increases is important because a flock's lambing/kidding rate is one of the primary factors influencing its economic viability (Kerr, 2006). At times, good quality forage can be used for flushing instead of grain. However, it is not recommended to use legumes for flushing (such as fresh alfalfa, clovers and vetch) because they contain estrogen-like compounds that can interfere with ovary function.

Response to flushing is greatest in animals with below average BCS, especially those that had been stressed by a heavy lactation (Hamito, 2010).

This condition could be maintained through pregnancy, yet the growth and viability of the fetus will increase which will reflect on birth weight (Liker *et al.*, 2010). On the other hand, El-Shahat and Abo-El Maaty, (2010) reported that supplementation of energy (fatty acids) to the basal diet had caused significant improvement in the number and size of ovarian pre-ovulatory follicles, and the ovulation rate of ewes.

Titi *et al.* (2008) noted that flushing has also been informed to increase the body condition and weights of ewes/does not only at mating (static effects), but also during their post-partum period, responses to flushing (Sormunen-Cristian and Jauhiainen, 2002; Chemineau *et al.*, 2004).

Generally, Flushing is a well-managed flock's nutrition and reproduction program to ensure that female sheep gain an appropriate amount of weight before being mated. It is utilized to increase the conception rate of the flock and ensures that more ewes that are mated conceive (Petrovic et al., 2012). The practice of flushing is predicated on the understanding that there's distinct relationship between nutrition and reproduction and their interaction has far fetching implications for reproductive competency in goats and sheep. Hence getting the proper nutrition at the proper time is important for the reproductive successes that drive profitable production of sheep and goats (Allaoui et al., 2018). Viability of goats and sheep enterprise are dependent on a need to produce a high percentage of lamb/kid crops, that pull through weaning while developing satisfactory replacement animals. To be successful, goats and sheep producers need to understand nutritional requirements at different life stages (Figure 1).

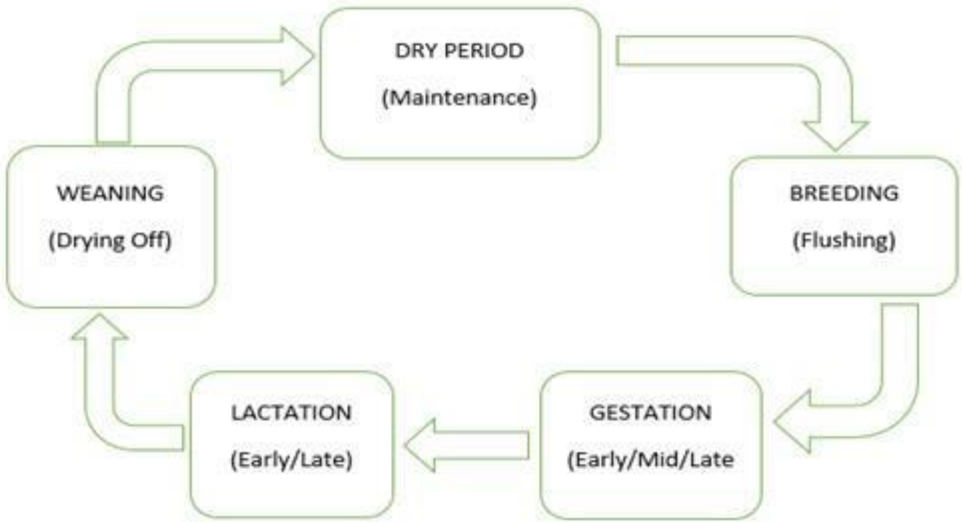

Figure 1: Stages of production in ewes/does which define their specific nutritional requirements.

2.6. Flushing effect on body weight (BW)

Live weight (LW) plays an important role in determining several characteristics of the farm animals, especially the ones having economic importance (Pesmen and Yardimci, 2008). According to Yakubu *et al.* (2011), since LW and body measurement parameters vary with breed and environment, breed specific models need to be developed. The body weight evaluation is commonly used to monitor the nutritional status and growth of animals (Ndlovu *et al.,* 2007). Karikari and Blasu, (2009), stated that the live body weight (LBW) does increase through nutritional flushing. IlkerSerin *et al. (*2010) stated that body weight and body condition score were significantly affecting the pregnancy rates and suggested the necessity of using higher energy feeding in small ruminants with lower body weights and BCS before breeding season.

2.7. Flushing effect on body condition score (BCS)

For an adequate response in breeding programs, ewes must be suitably nourished and maintained in good body condition. Clearly, ewes with a good nutrient intake respond most rapidly to the onset of the breeding season and continue to respond with an increase in ovulation rate (Fukui *et al.*, 2010). Body condition score (BCS) has proved useful as a management tool for subjectively assessing the nutritional status of ewes. In this way, body condition directly affects hypothalamic activity and GnRH secretion, but not pituitary sensitivity to GnRH, and these effects on reproductive performance are also mediated through changes in ovarian hormones or in hypothalamic pituitary sensitivity to ovarian hormones (Rhind *et al*., 1989). Lassoued *et al*. (2004) showed important interactions between reproduction and level of nutrition. In this sense, in highly prolific ewes higher levels of nutrition prior to and during mating were associated with improved reproductive performance. High body condition score has been associated with an increase of ovulation at the beginning of the breeding season (Forcada *et al*., 1992). Most authors recommend a body condition score of 2.5 to 3.0 either for natural or artificially breeding (Contreras-Solis *et al*., 2009). In a study carried out in inseminated ewes, Bru *et al*. (1995) found that, the lowest pregnancy rates 32.7 % were obtained in sheep with a BCS < 2, the average values 48.3% with BCS between 3 and 2 and the higher values 58.8% when BCS was >3. The importance of BCS in fertility has been also reported by Montoro (1995). Fukui *et al*. (2010) concluded that body nutritional condition is an important factor, next to ewe age, influencing the fertility of ewes after AI. The nutritional status or BC of ewes affects reproductive performances by influencing ovarian activity and the duration of seasonal anoestrus, which influences fertility (Benyounes *and* Lamrani, 2013b). As BCS at breeding increases, fertility and prolificacy improve according to Taherti and Kaidi (2016).

2.8. Flushing effect on reproduction performance

Different diets and their compositions have been used for flushing with different consequences that affect reproductive performance. The results from the flushing research were based on differences in the flushing diet (Rekik *et al*., 2012), and the duration of flushing (Habibizad *et al*., 2015). Supplementation with conventional concentrates is economically unsuitable, so more cost-effective and sustainable alternative feeding strategies need to be developed. Flushing ration along with both energizing and protein sources improve sheep and goats' sexual behavior. Garcia-Garcia (2012) suggested that availability of energy has a key influence on reproductive performance, due to sensitivity of the reproductive axis to the adequacy of nutrition and stores of metabolic reserves. This high-level of flushing concentrated feed induced energy to mate and conceive higher than of those does flushed with low level of concentrated feed and none supplemented. However, flushing with high level concentrate supplementation is not effective to reduce abortion (Berhane *et al*., 2020). Energy and protein deficiencies can result in embryonic loss, decreased fetal growth, depressed placental growth, fetal mummification, and the birth of weak young (Edmondson *et al*., 2012).

Since nutritional requirements vary throughout the reproductive cycle, strategic feed supplementation can also be an important tool to improve reproductive efficiency. Nutrition is as a significant regulator of reproduction (Silvestris *et al*., 2019) and that improvement in the nutritional status of ewe particularly precede mating (flushing), is known to increase fertility in small ruminants due to dynamic effects of nutrition on ovulation rate (Shaukat *et al.,* 2019). In another study, the quantity of energy and protein was restricted from the diet since day 70 of pregnancy to parturition, negative effects were observed. First of all, mothers´ behavior during the first hour postpartum was, in general, poorer than well fed females during pregnancy. Mothers' care towards their second litter was more affected, thus undernourished females spent less time licking their second newborn lamb in contrast to well fed females (Terrazas *et al.,* 2012).

2.8.1. Flushing effect on ovulation and conception rates

Flushing, or giving supplementary feed to ewes before breeding, has been shown to enhance ovulation rate and embryo survival in sheep (Never Assan, 2022). Feed supplementation before or during mating has a positive effect on fertility and ovulation rate and ovulation rates immediately (Karikari and Blasu, 2009). The maternal nutrition through its effect on body condition is one of the factors that strongly influences ovulation rate (Never Assan, 2022).

Prior to mating, enhancing ewes/does nutritional status with high-quality feed resources ensures that they gain weight and improve their physical condition, which improves estrus activity, ovulation, and conception rates. Protein or energy-based supplemental feeding (flushing) during mating usually improves reproductive performance by increasing the expression of ewe estrus, conception, fecundity and twin proportions (Rodriguez et al., 2015). In the ewe, short-term nutritional supplementation stimulates folliculogenesis and increases ovulation rate (Somchit et al., 2007).

Unflushed dams had a shorter and false start of oestrus prior to synchronization, in addition to reduced pregnancy and ovulation rates (Never Assan, 2022). For pre-mating feeding or flushing, Naqvi et al. (2011) harmonious with, it increases the ovulation rate in sheep and the birth of lambs. Ewes in low body condition had a suppressed or delayed oestrus, no matter the extent of nourishment that they had before entering, within the same study, a far better body condition was connected to more ovulation. Reduced ovulation due to malnutrition approximately months earlier than mating, on the alternative hand, becomes now no longer as speedy compensated for via way of means of short flushing (Never Assan, 2022).

2.8.2. Flushing effect on lambing rate and litter size

Restriction of dietary energy intake pre-mating resulted in less body weight gain, delay oestrus following synchronization and reduced litter size (Hafez *et al.,* 2011). Mohammed *et al.* (2016) showed that increasing energy in the sheep ration can increase fertility and litter size (being 10% higher). Hafez *et al.* (2011) found that twinning rate was significantly lower with the low energy treatment than high level, but the medium level achieved satisfactory results in estrus incidence, conception rate, lambing and twining rates. Acero-Camelo *et al.* (2008) found that the twinning rate was significantly lower for the low energy treatment than for the others and recommend the medium level to achieve satisfactory results in terms of estrus, conception rate, fecundity and twining rates. Protein or energy-based supplementary feeding (flushing), around the time of mating usually improves reproductive performance by increasing the expression of estrus, conception, fecundity and twinning rates of sheep (De Santiago-Miramontes *et al.,* 2008). Rodriguez *et al.* (2009) had shown that feed supplementation during the mating period improved ovulation and pregnancy rates in low yielding sheep. Nutritional requirements during pregnancy is essential to support placental and foetal development, which is vital for lamb survival (Mun˜oz et al., 2009). The lower pregnancy rates observed in underfed ewes could be mediated through this alteration in the signal of maternal recognition of pregnancy (Never Assan, 2022).

2.8.3. Flushing effect on birth weight

When BCS is low due to non-flushing, dams experience low conception rates, low lambing rates, and low weight at birth and weaning (Urrutia Morales et al., 2012). Flushing may be maintained during pregnancy, but it increases fetal growth and survival and affects birth weight (Liker et al., 2010). Weight changes in pregnant dams often indicate prenatal development of the fetus, as evidenced by the significant correlation between offspring birth weight and maternal weight (Bosso et al., 2007). Flushing ewes before breeding resulted in a significant increase in the average daily gain of lambs before weaning, according to Idris et al. (2011).

CHAPTER THREE: MATERIALS AND METHODS

3.1. Description of the Study Area

The study was conducted at Serera, Anicha Sedicho and Lemi Kebeles, in Doyogena district, Kembata- Tembaro Zone, SNNPRS, Ethiopia (Figure 3.2). The district is located 258 km from South-West of Addis Ababa, at an altitude ranging from 1900 and 2748 meter above sea level (m.a.s.l) located between $7^0$018'25"N- $7^0$21'49"N latitude and37^{0}45'33"E-37^{0}48'51"E longitude. The district comprised a total land area of 17,263.59 hectares. About 86% of the total land area is used for crop cultivation, 11.8% forest and bushes, 2% grazing land, and 0.2% degraded land. The district has two major agro ecologies, Highland (70%) and midland (30%). Some 10% of the area is plain land while the remaining 90% is mountainous /hilly. It has a minimum and maximum temperature of 10°C and 16°C, respectively and receives average annual rainfall of 1400 mm (DBoA, 2020). The major crops cultivated in the highlands of the Doyogena district are ensete (*Ensete ventricosum*), cabbage, potato, barley, wheat, faba bean and field pea. In the low altitude of the district, farmers cultivate sugarcane and maize. The district has a livestock population of 46,703 cattle, 13,822 sheep, 1,444 goats, 6,343 equines and 27,253 poultry (DBoA, 2020). The topography of the study area is characterized by 64% moderately sloping (undulating to rolling plains), 25 % plateau and rugged terrain slope, and 11% flat to gently sloping plains (DBoA, 2020). The average landholding size of the district is 0.5 hectares per household, which is less than the national average of 1.01 ha (DBoA, 2020).

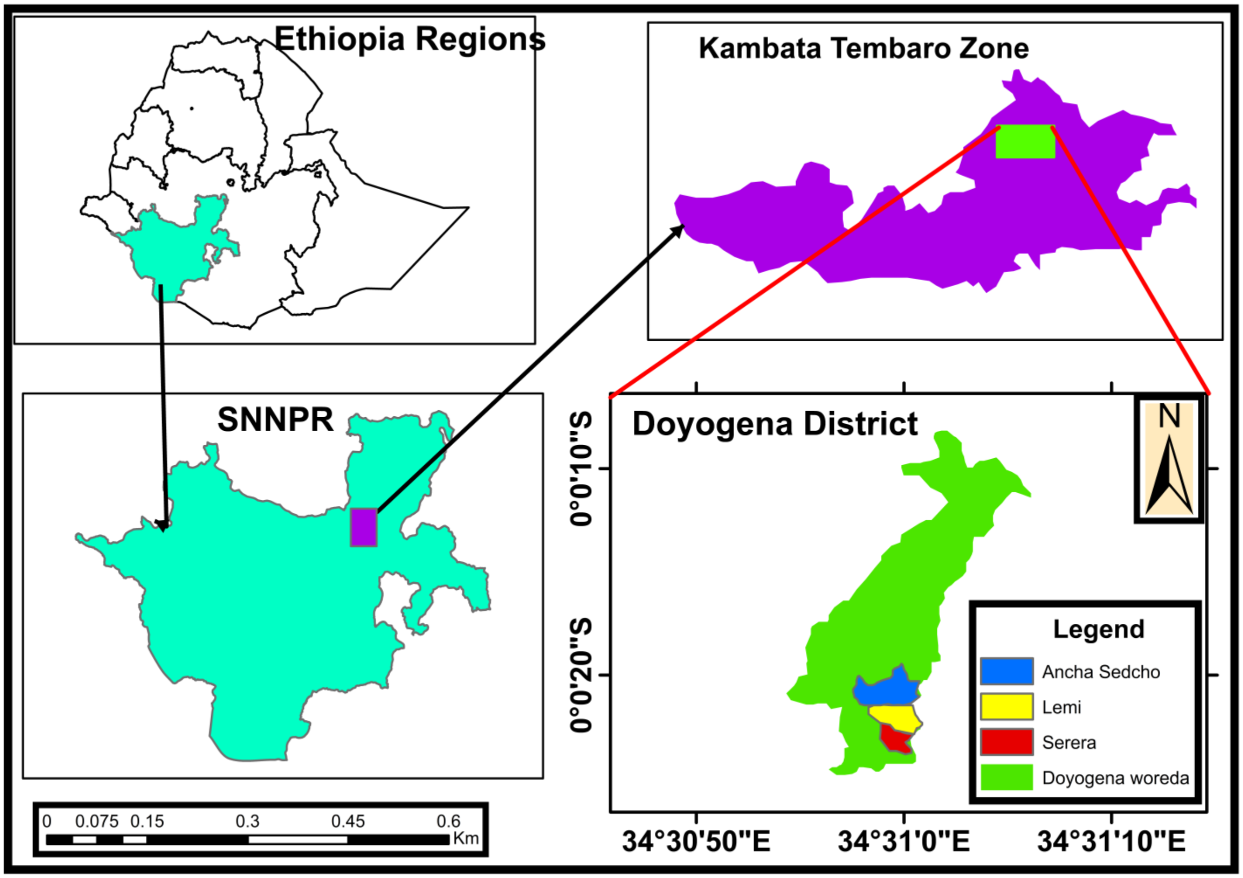

Figure 2: Map of Doyogena District

3.2. Peasant Association and Farmers selection

For the current study among the rural peasant associations in Doyogena district, Serera, Anicha Sedicho and Lemi were selected purposively based on the availability of a sufficient sheep population, farmers' interest, and willingness to participate as well as the PAs participated in the CBBP. Then after, from the total households of Serera, Anicha Sedecho and Lemi, twelve volunteer farmers found in six different villages in the PAs and owned more than 6 sheep were selected for the trial. Subsequently, thirty-three non-pregnant ewes from eleven farmers and two from one farmer were selected from the flock of each farmer based on uniformity of body weight, body condition score, age and health status. Short-term training was undertaken before the commencement of the trial for all participant farmers and for their sons and daughters who could read and wrote, data enumerators (project employed) and agricultural development agent workers were trained on the purpose of the research, how to supplement the animal, feed storage, and improved housing, feeding management and data collection.

3.3. Experimental animals and their management

Thirty-five non-pregnant Doyogena ewes, aged between 2 and 5 years of age, were used in the study. An initial body weight of the ewes was 27.71±2.87 kg (mean ± SD) and the average body condition score ranged from 2 to 2.5 and ewe's parity ranges from 2 to 5 prior to the feeding of the flushing diets. Before the commencement of the trial, the ewes were maintained in each farmer's separate house, and visually and physically were isolated from the breeding rams. A teaser ram for three ewes and one for two ewes were introduced after injection of hormone and prior to the insemination of AI, as part of the behavioral stimulus of the teaser ram effect, used in combination with a flushing diet to synchronize oestrus in the ewes (Gootwine, 2016).

The experimental animals were monitored daily for general wellbeing by experimenter and data enumerators. The experiment was undertaken on a farmer's house using concentrate mixture and enset feeds as flushing feeds. Their ages were estimated using guide of age estimation from dentition and the information from the farmer. Experimental ewes were allowed to graze freely on natural pasture for 6 hours on a day. Half of the flushing feeds were given in the morning and half in the evening, individually. All ewes have got free access to clean water and salt throughout the experimental period.

All experimental ewes were ear-tagged, have been sprayed with an acaridae and vaccinated against major diseases (sheep and goat pox and ovine pasteurellosis) and sprayed against internal and external parasites. Ewes were weighed at the beginning of feeding and every week after that weighed at mating, mid pregnancy and at lambing. Ewes have been divided into five groups based on initial body weight. Nutritional flushing was undertaken three weeks before mating and continued after insemination for a period of two weeks.

3.4. Experimental feed preparation and management

The experimental feeds consisted of enset leaf, commercial concentrate mixture in the proportion of (35% wheat bran, 30% noug seed cake, 35% coarsely ground maize grain, and 1% salts) and free grazing of natural pasture around the homestead during at mid-summer season. Enset leaf was purchased from farmers in the selected kebeles and distributed to the selected farmers and properly chopped (at the size of 1-10cm) to improve feed intake experimental ewes before feeding it on a fresh basis. The commercial concentrate mixture was also purchased from Hosanna town; John farm animal feed processing factories and stored in a cool and dry place until it was incorporated into experimental ration. Experimental feeds were distributed to the owners of the experimental sheep on a daily basis.

Feed supplements are randomly allocated and all ewes have received supplements, twice a day, mornings (8am) and evenings (5pm) in troughs separately. Supplementation was given for 3 weeks before mating (with AI; no ram mating took place) and Supplementation was continued 2 weeks after AI, insemination.

3.4.1. Chemical composition of the supplements

The nutrient composition of the supplemented feed showed in Table 3.4.

Table.3.4: Chemical composition of the treatment diets fed to Doyogena ewes

Nutrients	NPG	Enset(leaf)	CFM
DM	93.56	16.57	92.99
Ash	10.98	6.34	11.30
NDF	65.85	61.56	33.93
ADF	40.23	38.14	19.38
ADL	5.94	4.89	3.91
CP	14.31	13.21	17.55

Where; ADF = acid detergent fiber; ADL = acid detergent lignin; CFM = concentrate feed mixture; DM= dry matter; NDF=neutral detergent fiber; NPG= natural pasture grazing and CP=crude protein

3.5. Experimental design and treatment diets

The experimental design was a randomized complete block design (RCBD) with seven replications. Experimental ewes were blocked into seven groups based on their initial body weight (BW) and randomly assigned to one of the five supplementary treatments. Before commencement of the experiment, initial BW and BCS were measured and recorded. Supplementary treatments are shown in Table 3.5.

The experimental animals were allocated to the treatment groups to ensure that all initial body weight groups represented in the respective treatment groups, and identified with ear-tags that differed in terms of color to allow for the easy separation of the ewes for weighing, and feeding. The experimental diets fed to the ewes for five weeks, *i.e*. for a period of three weeks before the insemination of AI, and for two weeks after insemination. All ewes received supplements, twice a day, in the morning (8am) and evenings (5pm). The sample selected randomly using randomized complete block design with seven replications and five treatments. The amounts of the supplements were calculating using the CP contentment of the supplements as determined by laboratory analysis to make them is-nitrogenous with the concentrate mixture. (Table 3.5):

Table 3.5: Supplementary Treatments

Treatment group	Supplement diet in gram/day
T1	Only natural pasture(control)
T2	340g enset leaf + 350g concentrate /day
T3	340g enset leaf + 500g concentrate /day
T4	340g enset leaf + 400g concentrate /day
T5	340g enset leaf + 250g concentrate /day

Where: g=gram, T=treatment

3.6. Experimental animal estrus synchronization

To manage the heat estrus period, all ewes were synchronized using an intramuscular injection of prostaglandin PGF2α on day 21 of the experiment and the ewes coming to heat were artificially inseminated. Estrous synchronization is the manipulation of the estrous cycle of ewes to come to heat within a predefined time frame (36 to 96 hours). In small ruminants, estrous synchronization is achieved either by injection of PGF2α by reducing the length of the luteal phase of the estrous cycle or by extending the cycle artificially with application of exogenous progesterone or more potent progestogens (Girma, 2008). The PGF2α injection was given at the end of the three weeks nutritional supplementation to obtain the ewes a uniform onset of estrus after the end of synchronization.

3.7. Estrus detection and mating

Following injection with prostaglandins, ewes were observed for behavioral estrus manifestation for an hour four times daily for two consecutive days (48 hours). In each part of the study, behavioral observations were conducted by trained observers every day from morning 3:00 to 4:00, from afternoon 8:00 to 9:00, from evening 12:00 to 1:00, from night time 5:00 to 6:00. Ewes were considered to be in estrus when they “stand to be mounted” by teaser rams. Other signs such as vigorous tail-wagging, restlessness, frequent bleating and frequent adoption of urination were also considered.

3.8. Time fixed Artificial insemination

Fresh semen was collected by artificial vagina (AV) and immediately evaluated for volume, appearance (*i.e.* color, contamination, etc.), concentration and motility, as well as later determination of sperm morphology and the presence of foreign cells. Once screened for normality, ejaculates used for AI are assessed for sperm concentration, morphology and sperm motility. The AV method is preferable because it does not stress the animal and results in the collection of higher quality semen. The qualified semen to be used for AI is then processed and safely stored. The processing includes dilution of the ejaculate with a semen extender in order to provide an insemination AI started 48 hours after prostaglandin F2*α*, PGF2α administration. Ewes began to be inseminated with fresh extended semen. One skilled veterinarian technician performed AI. AI was performed using a vaginal speculum fitted with a white LED light and QuicklockR guns covered with a Minitub sheath.

3.9. Data Collection

The experiment was studied for a period of 185 days which included about 35 days (about two breeding cycles) and pregnancy period of 150 days. The following parameters were recorded during the trial period.

3.9.1. Body weight (kg)

The body weight was recorded at weekly intervals until giving birth using a suspended spring balance of 100 kg Salter scale after thoroughly securing the animals. Live weight measurements for all ewes were taken at 8 a.m. in the morning before feeding and watering. The weight was expressed in kilograms. In addition, the dam's weight was recorded before and after parturition to assess the loss in weight due to lambing.

3.9.2. Body condition scoring

The BCS were evaluated by palpating the fullness of muscling and fat cover over and around the vertebrae in the loin area. The body condition score (BCS) ewes was 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 fairly high accuracy, body condition scoring was done in accordance with the technique described by Thompson and Meyer (1994).

3.9.3. Reproductive performances

The following estrus and reproductive performance parameters were evaluated;

1) Estrus response (%) = the number of ewes showing standing estrus, over the total number of ewes in each treatment group, expressed in percentage.

2) Time to onset of estrus= this is measured by recording the time (hours) interval of ewes to first expression of standing estrus (heat) after treatments and exposure to AI.

3) Duration of estrus= this is measured by the time (hours) between the first and last standing estrus

4) Conception rate (%) = number of pregnant ewes/number of ewes showed heat & mated X 100.

5) Lambing rate (%) = number of ewes lambing / number of pregnant ewes X 100.

6) Fecundity rate = number of lambs born/number of ewes inseminated)*100

7) Gestation length= the period elapsed from conception till parturition

8) Litter size at birth= number of lambs born/number of ewes lambed

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

3.9.4. Lambs birth weight

Birth weight is the weight that is recorded soon after birth within 24 hours. Birth weight is the first parameter to be assessed in newborns, as it has great importance in evaluating growth performance and survival of lambs (Hatcher *et al*., 2009, Ptacek *et al*., 2017)

3.10. Chemical Analysis

Samples of natural pasture were collected randomly from around the homestead that ewes were grazed at mid-summer season. Samples of feed offered and natural pasture were analyzed at ILRI Animal Nutrition Laboratory, Addis Ababa. Representative samples of feed offered were dried at 60°C for 48 hours in a forced draft oven and ground to pass through 1 mm size using Wiley mill and packed into paper bags and stored pending further laboratory works. The samples were determined for DM, Ash, NDF, ADF, ADL and ME, using the Near-Infrared Reflectance Spectroscopy (NIRS).

3.11. Data Analysis

The collected data; body weight, BCS, onset of estrus, duration of estrus, lambs birth weight, litter size, and gestation period were analyzed by the GLM procedure of SAS (2002) version 9.2 in a completely randomized design. Treatment means were then separated by Duncan Multiple Range Test. Chi-square categorical analysis was also conducted for estrus response rate, conception rate, lambing rate, and fecundity rates. General Linear Model (GLM) procedures were used to compare means within treatment groups. Mean differences were considered significant when $P<0.05$, whereas $0.05<P<0.10$ was considered to show a statistical tendency for difference. The appropriate model used for data analysis was depicted here under:

$Yij = \mu + Ti + Bj + Eij$ Where:

Yij = response variables (onset of estrus, conception rate, lambing rate, litter size…)

μ = the overall mean

Ti = treatment (nutritional feeding) effect

Bj = block (body weight) effect

Eij = random error

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Effects of Nutritional Flushing on Body Weight of Doyogena ewes

In the present study, the mean body weight measured at different physiological stages (at the beginning of flushing, mating, mid pregnancy and lambing) during nutritional flushing in Doyogena ewes in different treatment groups are presented in Table 4.6. The result showed that there was no significance difference ($P > 0.05$) in the mean body weight (BW) of the ewes at the beginning of the experiment. This confirmed that the animals were appropriately distributed within treatment groups.

The mean body weight (30.86-32.89 kg and 36.14-38.07 kg) brought by the groups fed on the nutritional flushing containing 340 enset leaf + 250-500 concentrate g/day were significantly higher ($P<0.01$) than that of the control group in experimental ewes during flushing period at mating and mid pregnancy period respectively. Meanwhile, in the present study at lambing period the mean body weight (35.57-36.14 kg) brought by the groups fed on the nutritional flushing containing 340 enset leaf+400-500 concentrate g/day attained significantly higher ($P<0.01$) than that of the other groups in experimental ewes during flushing period. On the Contrary, there was no significant difference between the treatment groups fed on the nutritional flushing containing only natural pasture(control) and 340 enset leaf + 250 concentrate g/day in the mean body weight ($P>0.05$). This study showed that during the mating period the result obtained in treatment groups (T2, T3, T4 & T5) was highly significant ($P<0.01$) than the control group (T1). In the current study, the mean body weight of Doyogena ewes at mating period was 30.86-32.89 kg. This result was higher than the previous results obtained by Stanzaki *et al* (2021), who found the body weight of Marwari ewes was 26.9-28.08 kg, when ewes flushed by 300g of concentrate supplementation for 21 days. This result also higher than the results recorded by Njoya *et al* (2002) and Vasanthakumar (2015), who found that the mean body weight for Fulbe ewes was 22.1 kg and for Madras Red ewes was 24.88 kg at mating period, when ewes supplemented with concentrate feed and cottonseed meal (CSM), respectively. Inversely, this result, lower than the previous result obtained by Zanouny *et al.* (2018), who reported that the mean body weight for Ossimi ewes was 39.64 kg at mating period, when ewes flushed by concentrate feed mixture of 500 g/ewe/day up to 1 kg/ewe/day, for one month. This difference among the current and previous one might be due to the differences in types of breed and management across the experiment. Meanwhile, in the current study, the results were significantly higher ($P<0.01$) in (T2, T3, T4 and T5) treatment groups of ewes as compared to control group (T1) at mid pregnancy period. In the present study, at mid pregnancy period the mean body weight of Doyogena ewes was 36.14-38.07 kg. This result was higher than the results recorded by Vasanthakumar (2015), who found that the mean body weight in Madras Red ewes was 29.98-30.91 kg, when ewes fed on cottonseed meal (CSM). Whereas, at lambing period the mean values of the body weights of ewes in T3 and T4 treatment groups did not differ ($p>0.05$) in BW, but they had greater BW ($p<0.001$) than T2, T5 and T1 ewes, which in turn, did not differ ($p>0.05$). In the present study, the mean body weight of ewes at lambing period was 32.79-36.14 kg. This result was disagreement with the results found by Marzouk *et al*. (2018), who recorded 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. The variations in the case of current and previous investigation might be due to differences in breed types and time of flushing.

The mean body weight in T3 and T4 groups fed at 340 enset leaf + 500 concentrate g/ewe/day and 340 enset leaf + 400 concentrate g/ewe/day showed higher increments of body weight from mating to lambing. This increase in body weight in two treatment groups of T3 and T4 compared to Control (T1); T2 and T5 groups was as a result of amount of supplemental feeding during the breeding season. The conversion of flushing supplementation into body reserves and thereby increases in the body weight of treatment groups are in accordance with the studies of Rafiq *et al*. (2003) who recorded an increase in body weight of ewes of Pakistan which were fed flushing diet and supplemental feeding of concentrate during breeding period. Similar findings were stated by Islam *et al*. (2007) and Santos *et al*. (2009) in Corriedale ewes supplemental feeding on concentrate. But, the findings of Kassem *et al*. (1989) and Smith (1985) reported on Awassi sheep supplemented on barely were in contrast to the current findings. A close relation between the body weight of ewe and its reproductive performances were observed in the current study which is in agreement with the findings of Ambreen, M. *et* *al*. (2014) who reported a strong correlation between the fertility of the corriedale ewes and body weight at the time of mating on supplemental feeding of concentrate.

Table 4.6: Effects of nutritional flushing on body weight of Doyogena ewes.

Parameters	Treatment groups						
	T1	T2	T3	T4	T5	SEM	P-value
BWB	27.14	27.70	28.29	28.00	28.14	1.47	0.9106
BWM	28.14[b]	30.91[a]	31.14[a]	32.89[a]	30.86[a]	1.37	0.0054
BWP	33.93[b]	36.14[a]	38.07[a]	37.93[a]	36.64[a]	1.13	0.0036
BWL	31.14[c]	34.43[ab]	36.14[a]	35.57[a]	32.79[c]	1.26	0.0011

*BW: Body weight; BWB: Body weight at the beginning; BWM: Body weight at mating; BWP: Body weight at mid pregnancy; BWL: Body weight at lambing; Different superscript within a column represent statistical significance among treatment groups; NS: not significant; **: significant at (P<0.01); ***: significant at (P<0.001) and with the same letter (a, b, or c) are not significantly differ*.

4.2. Effects of Nutritional Flushing on Body Condition Score of Doyogena ewes

In the current study, during mating, mid pregnancy and lambing period, flushing of ewes revealed that all nutritional flushed treatment groups (T2, T3, T4 and T5) gained higher body condition scores were recorded significantly (P<0.05) higher than that of control group (T1) (Table 4.7). At mating period flushing ewes, the values were significantly (P<0.01) higher in T2, T3 and T4, than the control (T1) and T5 groups. In the present study, the body condition score of ewes was 2.79-3.07 at mating period. This finding is, in agreement with the findings of Ambreen, M. *et al*. (2014) who reported that Corriedale ewes supplemented with 500 concentrate g/ewe/day at mating have higher body condition scores. Also, the findings of Santos *et al*. (2009) and Kerr (2006) for Markhoz and Awassi ewes, respectively that are fed on nutritional flushing are in agreement with the current study. However, this result was higher than the findings that recorded by Idris *et al*. (2010), who found that the mean body condition score in Sudanese Desert ewes was 2.6-2.9, when ewes supplemented with ration composed of groundnut seed cake. Inversely, the result of the mean body condition score of Doyogena ewes in the current finding was lower than the previous result reported by Njoya *et al*. (2002), who obtained that the mean body condition score for Fulbe ewes was 3.12 at mating period, when ewes supplemented with concentrate feed. Possible variations observed may be due to the management conditions and duration of supplementation**.** During the mid-pregnancy period, the values were significantly (P<0.05) higher in T3 and T4, than the control (T1); T2 and T5 groups. Statistical analysis revealed significantly (P<0.05) higher body condition score in T2,T3 and T4 groups than that of control (T1) and T5 between, however no significant difference was observed between control (T1) and T5 groups as well as among T2, T3 and T4 groups, respectively. In the present study, the body condition score of Doyogena ewes at mid pregnancy was 2.86-3.16. The result was higher than the results recorded by Idris *et al*. (2010), who obtained that the mean body condition score in Sudanese Desert ewes was 2.6-2.7, when ewes supplemented with ration composed of groundnut seed cake. Deviation of results of current study from previous reports might be due to types of feed supplemented and time of flushing. Whereas, during the lambing period, the mean body condition scores were significantly (P<0.05) higher in T2, T3 and T4, than the control (T1) and T5 groups. In this study, the body condition score from 2.76-3.03 was higher than the findings that reported by Idris *et al*. (2010), who recorded that the mean body condition score in Sudanese Desert ewes was 2-2.3, when ewes supplemented with ration composed of groundnut seed cake. This variation might be due to differences in type of feed.

Generally, with increase in body condition score there was an increase in estrus response rate, conception rate, lambing rate and fecundity rate Gunn *et al*. (1991) who stated that conception and lambing rates increased significantly with increasing body condition score and decreased significantly below 2.5 levels. Afonson and Thompson (1996) who stated better the condition score at mating, the higher the ovulation rate and therefore the higher the potential lambing rate in ewes during periods of supplemental feeding.

Table 4.7: Effects of nutritional flushing on body condition score of Doyogena ewes.

Parameters	Treatment groups						
	T1	T2	T3	T4	T5	SEM	P-value
BCSB	2.53	2.51	2.56	2.54	2.53	0.17	09996
BCSM	2.57[b]	2.90[a]	3.07[a]	3.00[a]	2.79[ab]	0.18	0.0100
BCSP	2.71[c]	2.97[abc]	3.16[a]	3.03[ab]	2.86[bc]	0.16	0.0232
BCSL	2.70[b]	2.94[ab]	3.03[a]	3.00[ab]	2.76[b]	0.13	0.0227

*BCS: Body condition score; BCSB: Body condition score at the beginning; BCSM: Body condition score at mating; BCSP: Body condition score at mid pregnancy; BCSL: Body condition score at lambing; Different superscripts within a column represent statistical significance among treatment groups; NS: not significant; *: significant at (P<0.05); **: significant at (P<0.01) and with the same letter (a, b, or c) are not significantly differ.*

4.3. Effects of Nutritional Flushing on the Reproductive performances of Doyogena ewes

4.3.1. Effect of Nutritional Flushing on Onset of estrus (hours)

In the current study, the mean time to onset and duration of estrus data recorded from Doyogena ewes fed on nutritional flushing are presented in table 4.8. The mean time to onset of estrus was a highly significant (p< 0.001) and shorter in treatment groups T3 and T4 than that of T1 (control group); where treatment groups T3 and T4 accelerates the ewes to come into heat earlier than treatment groups T1, T2 and T5 it might be due to higher nutritional supplementation.

The mean time to onset of estrus in the treatment group (T2) was 35.39±3.93 hours after estrus synchronization. This result is in accordance with the previous results of Naqvi *et al*. (2012); who found that the mean time to 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 after estrus synchronized when ewes fed on concentrate supplementations. However, this result was lower than the precious results that recorded by Moghaddam *et al*. (2019), (29 ±.33 hours) Farahani ewes after synchronized with flurogestone acetate sponges (FGA), when the ewes were given 300 g/day/ewe concentrate. Such differences might be attributed to the species difference and differences in the amount of nutritional supplementation.

In the present study, the mean times to onset of estrus in treatment groups (T3 & T4) were 32.43± 5 and 34.14 ± 6.08 hours, respectively. These results were nearly similar with the results that obtained by Danjuma *et al*. (2015), who recorded that the mean time to 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 mean time to 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 Doyogena ewes of treatment group (T5) was 39.35± 4.54 hours). This result is akin 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/ ewe/ 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. These differences might be due to the species difference and time of flushing.

4.3.2. Effect of Nutritional Flushing on Duration of estrus (hours)

In the current study, the mean time to duration of estrus were found to be 24.66, 30.33, 35.46, 34.63 and 29.04 h in T1, T2, T3, T4 and T5, respectively with differences being highly significant ($P<0.001$), whereas T3 and T4 showed the longer duration of estrus (Table 4.8). Longer duration of estrus recorded in the present findings in treatment groups T3 and T4 might be due to higher nutritional supplementation than T2 and T5 and also longer duration of estrus recorded in the current investigation in treatment groups T3 and T4 than that of control group (T1) might be due to supplementation before mating. The mean time to duration of estrus of Doyogena ewes ranged from 24.66-35.46 h. The results of the present study are akin with the previous findings that reported by (Montaser Elsayed, 2015) in native ewe lambs (21 to 35.9 h); Naqvi et al. (1997) in Kheri ewes (28.5 to 30.6 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; and relatively consistent with that recorded by (Tezera Aderajew, 2015) in Local ewes . However, Naqvi et al. (2011) reported that the duration of estrus in Malpura ewes which fed on concentrate mixture was earlier (22.7 h) compared to the present experiment. These differences might be due to amounts of nutritional flushing and species differences.

The duration of estrus in treatment groups T3 and T4 were 35.46 ± 3.47 and 34.63 ± 3.26 hours respectively. These results were nearly similar with the previous findings that were recorded by Venter and Greyling (1994), who reported that the estrus duration was 33.9 hours in Merino ewes that were flushed on 600 g/ewe/day of treated maize. However, these results were higher than that reported by (Moghaddam *et al*. 2019) and Danjuma *et al*. (2015), they recorded that, the estrus duration were 20 and 25.3 hours in Farahani and Yankasa, when the ewes flushed by concentrate mixture and cottonseed cake, respectively. The results of this investigation were also higher than the previous findings that reported by Farrag (2019), who recorded that the estrus duration was 31.27 hours in Abou-Delik ewes that flushed on 300g of barley grain/ ewe/ day. Such differences might be attributed to types of nutritional flushing. Whereas, under treatment group (T5) the duration of estrus was 29.04 ± 2.70 hours. This result was nearly similar with the previous results that made by Naqvi *et al.* (2012), who obtained that the estrus duration was 31.08± 1.8 hours in Malpura ewes that fed on concentrate supplementation but lower than the results that recorded by Zohara *et al.* (2014), who found that the duration of estrus was 33.17 ±3.01 hours for Indigenous ewes in Bangladesh which fed on concentrate mixture. This is due to the difference in amount of supplement and management across experiments.

Table 4.8: Effects of nutritional flushing on onset of estrus and duration of estrus in Doyogena ewes.

Treatment groups	Parameters	
	Onset of estrus (hours)	Estrus duration (hours)
T1	46.65 ± 3.77^{a}	24.66 ± 2.53^{c}
T2	35.39 ± 3.93^{bc}	30.33 ± 2.92^{b}
T3	32.43 ± 5.77^{c}	35.46 ± 3.47^{a}
T4	34.14 ± 6.08^{c}	34.63 ± 3.26^{a}
T5	39.35 ± 4.54^{b}	29.04 ± 2.70^{b}
P-value	0.0001	0.0001

*N: Number of ewes in treatment group; Different superscript within a column represent statistical significance among treatment groups ***: significant at (P<0.001)*

4.3.3. Effect of Nutritional Flushing on Estrus response rate in Doyogena ewes

In the current study, the estrus response, conception and lambing rates for each treatment in the study had been presented in (Table 4.9). This study revealed that treatment groups T2, T3 and T4 had highly significant effect on percentage of estrus response ($P < 0.001$) than T1 (control) and T5 (flushed); 100% and 100%; 85.7%, 71.4%; and 71.4%, respectively.

In the current study, the estrus response rate under treatment groups T2 and T3 were 100%, 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 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, these results were in agreement with the results of Daghigh Kia *et al.* (2019), who reported that the estrus response rate in Ghezel ewes was 100%, when using a flushing diet containing barley grain selenium. On the other side, these results were nearly similar with Huseyin *et al*. (2006) who reported that, 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 the present study, in the treatment group (T4) estrus response was 85.7%. This result was in accordance with Sabra and Hassan (2008), they 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 3Kg Egyptian clover (80%). Such differences may be due to the species difference, amounts of supplementation and management during feeding trials.

In this study, under treatment group (T5) estrus response rate was 71.4%. The result of this study was in disagreement with (Rana *et al*., 2017)**,** who found that the percentage of ewes showed estrus response was 100%, when Barki ewes flushed by a pelleted concentrate feed mixture. Also, I disagree with (Abd-Erahem, 2015)**,** who reported that the estrus response was 60% when Egypt native ewes flushed by 3 kg clover and 500gm concentrate. Meanwhile, this result was inconsistent with (Shambel Gdey, 2017), who stated that the percentage of ewes showed estrus response rate was 80%, when ewes were flushing under traditional management. Due to the efficiency of most sheep production systems can be ameliorated by nutritional and/or hormonal treatments, resulting in higher estrus response rates and subsequent conception rates (Kridli et al., 2003).

Table 4.9: Effects of nutritional flushing on estrus response, conception, lambing and fecundity rates in Doyogena ewes.

Treatment groups	Parameters			
	ER (%)	CR (%)	LR (%)	FR (%)
T1	71.4^{c}	60^{d}	66.67^{c}	60^{e}
T2	100^{a}	71.4^{b}	80^{b}	100^{d}
T3	100^{a}	85.7^{a}	100^{a}	157.1^{a}
T4	85.7^{b}	83.3^{a}	100^{a}	133.3^{b}
T5	71.4^{c}	66.67^{c}	100^{a}	120^{c}
P-value	0.0001	0.0001	0.0001	0.0001

*Different superscript within a column represent statistical significance among treatment groups ***: significant at (P<0.001); ER: Estrus response; CR: Conception rate; LR: Lambing rate; FR: Fecundity rate*

4.3.4. Effect of Nutritional Flushing on Conception rate of Doyogena ewes

The conception rate in the present study revealed that treatment groups T3 and T4 had significantly higher values ($p<0.001$) than that of T1 (control), T2 and T5 treatment groups (85.3% and 83.3%; and 60%, 71.4% and 66.67%), respectively, (Table 4.9).

In the present study, the conception rate, under the treatment group (T2) was 71.4%. This result is in agreement with (Shafiullah *et al*., 2022), who reported that the conception rate was 72.72%, when Marwari ewes flushed by 300gm/day concentrate supplementation for 21 days and also similar with (Ahmad *et al*., 2022), who reported that the conception rate was 70%, when Ossimi ewes were flushed with corn (energy source) 500 g/ewe/day. However, this result is lower than that reported by Huseyin *et al*. (2006) and Bahaa (2019), they stated that the conception rates were 83.33% and 100% for Akkaraman and Abou-Delik ewes when the ewes were flushed by barley 700g/ewe/day for 35 days and 300g of barley grain/ewe day for 21 days, respectively. These differences from present results may be attributed to differences in breed used or method and time of flushing.

The conception rate, in treatment groups (T3 and T4) were 85.7% and 83.3% respectively. These results were higher than that recorded by Abdulkareem et al., (2014), who found that the conception rate in Awassi ewes was 66.6%, when the ewes were fed on 500 g/head/day of concentrate diet for 3 weeks pre-mating. Also, higher than that reported by Lassoued et al., (2014), who recorded the conception rate was from 52-68% for Barbarine ewes were supplemented with a diet composed of 0.5 kg of hay and 0.5 kg of concentrate per ewe per day. The differences might be due to amounts of feed supplemented.

The conception rates of ewes under treatment groups (T3 and T4) in the current result is comparable to the reports of Ravindranath *et al* (2014) who reported conception rate was 83.3% for Nari Suwarna Ewes fed ragi straw and supplemented with concentrate feed. On the other hand, the result of the present study was comparable to the results of El-Hawy *et al.* (2019) who reported the conception rate was 85% from Barki ewes fed on concentrate feed mixture and bean straw. Also, these results were in agreement with results that reported by (Shambel Gdey, 2017) who found that, the conception rate in local ewes with flushing under traditional management was 83.3%.

In the current study, the conception rate in the treatment group (T5) was 66.67%. This result was nearly similar with Venter and Greyling (1994) who stated that the conception rate was 69.2% for Merino ewes were allocated to flushing 600g/ewe/d of treated maize. However, this result was higher than that recorded by Abdulkareem et al., (2014) who reported that the conception rate was 50% for Iraq Awassi ewes subjected to flushing on extension farms. This result attributed to the high level of nutrition may increase ovulation rate.

4.3.5. Effect of Nutritional Flushing on Lambing rate of Doyogena ewes

In the current study, the lambing rates of T3, T4 and T5 treatment groups were significantly higher (P<0.001) than those control group (T1) and treatment group T2 (100%, 100% and 100%; and 66.67% and 80%, respectively, Table 4.9). These results were similar with Blumer *et al*. (2015), Sejian *et al*. (2013) and El-Hag *et al*. (1998 and 2007) who recorded that strategic supplementary feeding of ewes increased lambing rates of ewes. This study revealed that the lamping rate in the treatment group (T2) was 80%. This result was similar with

Ahmad *et al*. (2022), who recorded that the lambing rate was 80%, when Ossimi ewes were flushed with soya bean 500 g/ewe/day. Meanwhile, Sabra and Hassan (2010) reported that, the lambing rate in ewes was 80%, when ewes treated with 0.5 Kg sesban forage. On the contrary, this result was higher than Venter and Greyling (1994) who stated that the lambing rate was 65.1% for Merino ewes were allocated to flushing 600g/ewe/d of treated maize. Such difference may be due to types and amounts of feeds, and types of breeds

The present study reported that the lambing rate in treatments T3, T4 and T5 (flushed) were 100%. These results were in accordance with Bahaa Farrag (2019) reported that the lambing rate in ewes was 100%, when ewes treated with flushing ration (300g of barley grain/ head/ day), flushed group. On the other hand, the results of T3, T4 & T5 were similar with (Abdulkareem *et al*., 2014) who reported that the lambing rate was 100% for Iraq Awassi ewes subjected to flushing on extension farms. However, these were higher than Zanouny *et al*. (2018) who recorded that the lambing rate was 78% for Ossimi ewes flushed on concentrate feed mixture. Also, higher than that stated with Niar *et al*. (2001); and Kridli *et al*. (2003), they reported that the lamping rates were from 43 to 84% and from 20 to 60%, respectively. This might be due to the difference in nutritional supplementation and time of flushing to be essential to improve reproductive performance.

4.3.6. Effect of Nutritional Flushing on Fecundity rate of Doyogena ewes

In the present study, fecundity rate revealed that there were highly significant (P<0.001) differences in the treatment group T3 157.1% compared with the treatment groups of T2, T4, T5 and T1 (control) 100, 133.3, 120 and 60% respectively. In the present study, the fecundity rate, under the treatment group (T2) was 100%. This result is in agreement with Rana *et al*. (2017), who reported that the fecundity rate was 100%, when Barki ewes were fed on a pelleted concentrate feed mixture and ad libitum t of Egyptian clover hay. Also, in agreement with Idris *et al*. (2010) who reported that the fecundity rate was 99%, when Sudanese desert ewes were supplemented with ration composed of ground nut cake, common salt, and salt lick (GNC). However, this result was higher than that reported by Bushara *et al*. (2019) and Zanouny *et al.* (2019), they stated that the fecundity rates were 63.33% and 75% for Sudan desert ewes and Ossimi ewes when the ewes supplemented with concentrate diet 500g/ewe/day and 250g of concentrates/ewe/day, respectively. These differences from present results may be attributed to differences in breed used or method and time of flushing.

The current result indicated that, the fecundity rate in treatment group (T3) was 157.1%. This result was higher than that recorded by Venter and Greyling (1994), who found that the fecundity rate was from 104-123% for Merino ewes were allocated to flushing 600g/ewe/d of an alkali-inophore treated maize. Also, higher than that reported by Bushara *et al*. (2019) and Zanouny *et al.* (2019), they stated that the fecundity rates were 63.33% and 75% for Sudan desert ewes and Ossimi ewes when the ewes supplemented with concentrate diet 500g/ewe/day and 250g of concentrates/ewe/day, respectively. On the contrary, this result was lower than that reported by Dhahir *et al.*(2022), who stated that the fecundity rate was 200% for Awassi ewes when the ewes fed on 800 g carrot/ewe/day. The differences might be attributed to types and duration of nutritional flushing as well as differences in breed.

The fecundity rates of Doyogena ewes in treatment groups (T4 and T5) in the current results were 133.33% and 120%, respectively. These results were inconsistent with the reports of Njoya*et al* (2002) who reported fecundity rate was 112.5% for Fulbe ewes supplemented on 200 g cottonseed meal (CSM)/ewe/day. Meanwhile, the results of the present study were inconsistent with the results of *Baheg et al.* (2017) who reported the fecundity rate was 80% from Barki ewes fed on concentrate feed mixture. Also, these results disagree with the result that reported by (Shambel Gdey, 2017) he found that, the fecundity rate in ewes with flushing under traditional management was 75%. On the other hand, these results were in disagreement with Abdalla, E. et al., (2014), who recorded that fecundity rates 100%,134% and 94%. This variation due to the variation associated with types of nutrition and management conditions across studies.

4.3.7. Effect of Nutritional flushing on Gestation period

In the current study, the gestation period is presented as shown in Table 4.10. This result revealed that there was a nonsignificant change among treatment groups in gestation period. The mean gestation periods were 151.43± 2.07, 150.29± 1.60, 150 ± 1.15, 149.07 ± 1.24 and 150.57 ± 1.72 days for T1, T2, T3, T4 and T5, respectively. These results were in accordance with the results of Mekoya, A. *et al. (*2008), who recorded that the length of gestation period ranged between 151.8 and 152 days. Also, akin with the result found by Mukasa-Mugerwa and Viviani (1992) and (Solomon Melaku, 2002) that the length of gestation period were 150 and 151 days in sheep supplemented with concentrate 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 concentrate mixture. On the other hand, this result was lower than from the previous result that reported by Sabra and Hassan, (2010), who found that the gestation period were 167±2.92 and 168±7.72 days, in ewe supplemented with 0.5 Kg sesban forage. Such differences might be due to differences in types of feed, amounts in supplement and management during experimental periods.

4.3.8. Effect of Nutritional flushing on Litter size

In this study, litter size in Doyogena ewes is presented in table 4.10. In the present study, there was an increase in litter size in the treatment group (T3) as compared to the other treatments. The mean litter size within treatment groups T1, T2, T3, T4 and T5 were 1.50 ± 0.20, 1.75 ± 0.11, 1.83 ± 0.06, 1.60 ± 0.22 and1.50 ± 0.24, respectively. Treatment group (T3) showed highly significant ($P<0.01$) than the other treatment groups. The highest litter size was obtained in the treatment group (T3), and this could be attributed to increase nutritional supplementary feeding (flushing). These results were in agreement with those findings which were recorded by Ribeiro et al. (2002) for ewes supplemented with 0.5 kg per animal of ground corn. In line with these results Marzouk et al. (2018) recorded that increasing ration during breeding period is enough to ameliorate the reproductive performance of Ossimi ewes.

4.3.9. Effect of Nutritional flushing on Lamb birth weight

The effect of nutritional flushing on lamb birth weight is presented in table 4.10. There were highly significant ($P<0.01$) differences among the experimental treatment groups in the productive characteristic of Doyogena ewes. The birth weights of lambs under T3 and T4 were significantly ($P<0.01$) higher than T2 and T5, and that of T1 (control) which could be attributed to higher amounts of nutritional supplementation. These results were higher than with the previous findings that studied by Sabra and Hassan, (2008), who found that the lamb's birth weight ranged between 2.43 and 3.04 Kg, when ewes flushed by a balanced mixture of crushed yellow corn 58% and crushed soybean 41%. However, these results were lower than the result that was found by Khan *et al.* (2009) and Semra *et al*. (2013), who recorded that the birth weights were 4.01±0.21 and 4.13±0.5 Kg, respectively. The differences might be due to differences in amounts of supplementation, types of feeds and management across the experiment.

Table 4.10: Effects of nutritional flushing on gestation period (days), litter size and lambs birth weight (Kg.) in Doyogena ewes.

Treatment groups	Parameters		
	Gestation period (days)	Litter size	Lambs birth weight (Kg.)
T1	151.43 ± 2.07	1.50 ± 0.20^{c}	2.73 ± 0.088^{c}
T2	150.29 ± 1.60	1.75 ± 0.11^{ab}	3.04 ± 0.117^{bc}
T3	150.00 ± 1.15	1.83 ± 0.06^{a}	3.39 ± 0.097^{a}
T4	149.07 ± 1.24	1.60 ± 0.22^{bc}	3.19 ± 0.106^{ab}
T5	150.57 ± 1.72	1.50 ± 0.24^{c}	2.93 ± 0.091^{bc}
P-value	NS	0.0052	0.0021

*N: Number of ewes in treatment group; Different superscript within a column represent statistical significance among treatment groups; NS: not significant; *: significant at (P<0.05**)** and with the same letter (a, b, or c) are not significantly differ.*

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The current study was conducted to evaluate the effect of flushing Doyogena ewes with nutritional supplementation on body weight, body condition and reproductive performances.
The supplemental nutrition provided to Doyogena ewes appears necessary to maintain a high level of ewe reproductive performance. It could be concluded that short term nutritional flushing Doyogena ewes by concentrate with enset leaf improved body weight, body condition score, onset of estrus, duration of estrus, estrus response, lambing rate, litter size and birth weight. However, gestation period was not affected by nutritional flushing supplemented on concentrate with enset leaf. Generally, the current experiment result indicated that nutritional flushing of Doyogena ewes for three weeks before mating and two weeks after mating can improve body weight, body condition which influences the reproductive performances of ewes.

5.2. Recommendations

Based on the present study, the following are recommended:

- ❖ Supplementation before, during and after mating period should be undertaken using concentrate feed mixture and the local available enset on supplementary feed of 500g concentrate with 340g enset leaf and 400g concentrate with 340g enset leaf to improve reproductive performances .
- ❖ Doyogena ewes appear to be more effective in the nutritional flushing of conception and lambing rates than unflushed groups, and needs to be confirmed by further experiments in large numbers of ewes.
- ❖ Since the experiment was conducted in one season, more studies are needed to examine the effect of nutritional flushing at different times of the year in order to provide comprehensive recommendation and develop a complete nutritional package for different seasons of the year.
- ❖ Scaling up and out

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7. APPENDICES TABLES AND FIGERS

7.1 APPENDICES TABLES

Table 7.1 ANOVA for BWB

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	99.6000000	9.9600000	1.70	0.1389
Error	24	140.6857143	5.8619048		
Corrected total	34	240.2857143			
R-Square	Coeff Var	Root MSE	BWB Mean		
0.414507	8.691261	2.421137	27.85714		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	5.71428571	1.42857143	0.24	0.9106

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, BWB= Body Weight at Beginning*

Table 7.2 ANOVA for BWM

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	217.7428571	21.7742857	4.15	0.0021
Error	24	125.9000000	5.2458333		
Corrected total	34	343.6428571			
R-Square	Coeff Var	Root MSE	BWM Mean		
0.633631	7.109822	2.290378	30.788		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	101.0000000	25.2500000	4.81	0.0054

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, BWM= Body Weight at mating*

Table 7.3 ANOVA for BWP

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	147.6142857	14.7614286	3.79	0.0036
Error	24	93.5714286	3.8988095		
Corrected total	34	241.1857143			
R-Square	Coeff Var	Root MSE	BWP Mean		

0.612036	5.259430	1.974540	36.542		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	78.82857143	19.70714286	5.05	0.0042

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, BWP= Body Weight at mid Pregnancy*

Table 7.4 ANOVA for BWL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	194.6142857	19.4614286	4.55	0.0011
Error	24	102.6285714	4.2761905		
Corrected total	34	297.2428571			
R-Square	Coeff Var	Root MSE	BWL Mean		
0.654732	6.079490	2.067895	34.014		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	118.1714286	29.5428571	6.91	0.0008

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, BWP= Body Weight at Lambing*

Table 7.5 ANOVA for BCB

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	1.72800000	0.17280000	1.12	0.3910
Error	24	3.71885714	0.15495238		
Corrected total	34	5.44685714			
R-Square	Coeff Var	Root MSE	BCB Mean		
0.317247	15.41096	0.393640	2.554286		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	0.02114286	0.00528571	0.03	0.9976

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, BCB=Body Condition at Beginning*

Table 7.6 ANOVA for BCM

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	2.76400000	0.27640000	3.29	0.0081
Error	24	2.01600000	0.08400000		
Corrected total	34	4.78000000			
R-Square	Coeff Var	Root MSE	BCM Mean		

0.578243	9.994053	0.289828	2.900000		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	0.94000000	0.23500000	2.80	0.0488

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, BCM= Body Condition at Mating*

Table 7.7 ANOVA for BCP

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	1.87657143	0.18765714	2.94	0.0147
Error	24	1.53085714	0.06378571		
Corrected total	34	3.40742857			
R-Square	Coeff Var	Root MSE	BCP Mean		
0.550729	8.565448	0.252558	2.948571		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	0.69314286	0.17328571	2.72	0.0536

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, BCP=Body Condition at mid Pregnancy*

Table 7.8 ANOVA for BCL

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	1.96971429	0.19697143	3.66	0.0045
Error	24	1.29200000	0.05383333		
Corrected total	34	3.26171429			
R-Square	Coeff Var	Root MSE	BCL Mean		
0.603889	7.793382	0.232020	2.977143		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	0.59600000	0.14900000	2.77	0.0505

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, BCL= Body Condition at Lambing*

Table 7.9 ANOVA for OE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	1267.549657	126.754966	8.55	<.0001
Error	24	355.666931	14.819455		
Corrected total	34	1623.216589			
R-Square	Coeff Var	Root MSE	OE Mean		
0.780888	10.24010	3.849605	37.59343		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	900.1871886	225.0467971	15.19	<.0001

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, OE=Onset of Estrus*

Table 7.10 ANOVA for DE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	644.5356800	64.4535680	9.31	<.0001
Error	24	166.2257086	6.9260712		
Corrected total	34	810.7613886			
R-Square	Coeff Var	Root MSE	DE Mean		
0.794976	8.538125	2.631743	30.82343		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	541.5401314	135.3850329	19.55	<.0001

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, DE= Duration of Estrus*

Table 7.11 ANOVA for LS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	0.82404000	0.08240400	2.57	0.0283
Error	24	0.76940000	0.03205833		
Corrected total	34	1.59344000			
R-Square	Coeff Var	Root MSE	LS Mean		
0.517145	10.94428	0.179048	1.636000		
Source	DF	Type III SS	Mean Square	F Value	Pr > F

Trt	4	0.62244000	0.15561000	4.85	0.0052

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, LS= Litter Size*

Table 7.12 ANOVA for LBW

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	2.03742857	0.20374286	2.62	0.0257
Error	24	1.86328571	0.07763690		
Corrected total	34	3.90071429			
R-Square	Coeff Var	Root MSE	LBW Mean		
0.522322	9.114196	0.278634	3.057143		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	1.79071429	0.44767857	5.77	0.0021

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, LBW= Lamb Birth Weight*

Table 7.13 ANOVA for GP

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	16.5714286	1.6571429	0.45	0.9061
Error	24	88.5714286	3.6904762		
Corrected total	34	105.1428571			
R-Square	Coeff Var	Root MSE	GP Mean		
0.157609	1.278273	1.921061	150.2857		
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Trt	4	1.42857143	0.35714286	0.10	0.9825

*Where; Ns= p>0.05; ***P=<0.001; **=P<0.01; *=P<0.05, DF= degree of freedom, GP= Gestation Period*

7.2 APPENDIX FIGURES

Figure 7.1 Selection of non-pregnant ewe in the study area

Figure 7.2 Feeding experimental ewes in farmer's temporary house throughout the trial period

K2

Figure 7.3 Measuring body weight and body condition during experimental period

Figure 7.4 Hormone injecting experimental ewes

Figure 7.5 Artificial insemination

Figure 7.6 Giving birth

BIOGRAPHICAL SKETCH

The author, Asfaw Tesfaye Ayele was born on May 24, 1988 from his mother Migibnesh Tegegne and his father priest Tesfaye Ayele in Dabat District, North Gondar Administrative Zone of Amhara Region, Ethiopia. He attended his primary school education in Dabat Elementary School. He continued his secondary and preparatory education in Dabat Junior Secondary School and Maksegnit Comprehensive Secondary School, respectively. Then, he joined Hawassa University in 2009 to pursue his BSc study and graduated with Bachelor of Science degree in Animal and Range Sciences in July 2011 with distinction academic status. Soon after graduation he was employed by the Ministry of Agriculture at Metema District and had served as livestock production expert for seven months. In June 2013, he was employed by Amhara Regional land administration and use planning bureau at wegera land use planning sector in a position of livestock and forage development expert. In October 2019, he joined the School of Graduate Studies at Bahir Dar University to pursue his postgraduate study in Feeds and Animal nutrition.