



Effect of Elephant grass (*Pennisetum purpureum*) ensiled with different proportions of *Dolichos lablab* (*Lablab purpureus*) on intake, digestibility and growth performance of Horro sheep

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Abstract

The study was conducted at Bako Agricultural Research Center with the aim to evaluate the effect of Elephant grass ensiled with different proportions of *Dolichos lablab* on intake, digestibility and body weight gain of Horro sheep. Elephant grass and *Dolichos lablab* were harvested after eight weeks of regrowth and 50% blooming stage, respectively. Forages were chopped, weighed separately and mixed with 3% molasses before ensiling in a pit. A total of twenty intact male yearling Horro sheep were stratified into four groups based on initial body weight in a Randomized Complete Block Design and randomly assigned to the dietary treatments. Dietary treatments were Elephant grass ensiled alone, with 10, 20 and 30% of *Dolichos lablab* and designated as T1, T2, T3 and T4, respectively. Lambs in all treatments were supplemented with wheat bran at 1.5% body weight. The study comprised 90 days of feeding trial followed by 7 days of digestibility trial. The dry matter content of the silage increased from 30.14 to 35.34 and crude protein content from 8.75 to 12.38% from T1 to T4. However, it contained 15.15, 14.30 and 50.70% NDF, ADF and ADL concentrations, respectively. The total DM intake of lambs fed T4 diets was greater by 19.53, 7.83 and 3.56%, whereas the total CP intake was higher by 31.15%, 17.36%, and 9.66% than T1, T2 and T3, respectively. Higher ADL and lower ADF intake were observed for lambs fed T1 diet. The DM Digestibility of lambs fed T4 diets were increased by 17.59, 10.09 and 6.18% than those on T1, T2 and T3 diets, respectively. Lambs fed T4 diet had higher digestibility of CP and NDF than those fed T3, T2 and T1 with comparable values of NDF obtained for T4 and T3. The lowest ADF digestibility was recorded for lambs fed T1 diet with similar values among other groups. Lambs fed T4 diet had higher final body weight (28.04 kg) compared to T2 (26.08 kg) and T1 (23.52 kg) and higher daily gain of 43.55, 59.55 and 73.11 g/day for T1, T2 and T3, respectively. Higher value of FCE was obtained from lambs fed T4 diet followed by T3 > T2 > T1 in that order. Therefore, addition of 20-30% *Dolichos lablab* in Elephant grass silage enhanced its nutritive value, thereby increasing the nutrient intake and digestibility for better growth of Horro sheep.

Key words; Body weight, Digestibility, *Dolichos lablab*, Elephant grass, Horro Sheep, Silage.

Introduction

Like other developing countries in sub Saharan Africa, small ruminant production is a major component of the livestock sector in Ethiopia. According to Central Statistics Agency (CSA, 2018) report, the total small ruminant

population in Ethiopia is estimated to be 64.04 million, out of which 31.3 million are sheep. At smallholder level, sheep are the major source of food security, serving a diverse functions including cash income, savings, cash for fertilizer purchase and sociocultural

functions (Solomon *et al.*, 2013). However, the productivity of sheep per head is low mainly because of inadequate year round nutrition, both in terms of quantity and quality, unimproved genetic potential and due to prevalence of diseases and parasites (Markos *et al.*, 2006).

Presently, most natural pasturelands are under intensive crop production due to increasing human population pressure. The remaining land is heavily grazed and cannot meet the nutritional requirement of livestock, resulting in reduced growth rate, low production, poor fertility and high mortality particularly in the dry season (Solomon, 2004). The aftermath of grazing and crop residue accounts for 60 to 70% of available basal diet in the highlands of Ethiopia. Such feeds are inherently low in nutritive value such as protein, digestible energy and minerals, which may result in sub-optimal rumen fermentation and lowered animal performance (Malede and Tekele, 2014). Thus, animals could not realize their genetic potential within the growth period for the breed.

To solve this problem, there are options like supplementing animals with agro-industrial by-products such as different oil seed cakes and brans from edible oil and flour processing industries. However, they are expensive and not readily available. The other option could be through cultivation of high-quality forages with high yielding ability that are adapted to biotic and abiotic environmental stresses (Muia *et al.*, 2001; Tessema *et al.*, 2010). Improved pasture crops have many advantages such as providing quality feed and improving soil fertility. The cost incurred for perennial pasture production is high only during the establishment year (Jørgensen *et al.*, 2010) but declined thereafter which could serve for the way forward in feed resources improvement strategies in Ethiopia. Amongst the promising forage species promoted in Ethiopia, Elephant grass could play an important role in providing

a significant amount of high-quality forage to the livestock industry (Ndikumana, 1996; Tessema, 2005) both under the smallholder farmer and intensive livestock production systems with appropriate management practices (Alemayehu, 2004).

The use of improved forage and tree legumes as supplementary options for livestock have been investigated in Ethiopia and elsewhere in Africa (Solomon *et al.*, 2004; Ajebu *et al.*, 2008 and Adegun, 2014). Improved forages could be fed to the animals by direct grazing, cut and carry, or stored and conserved as hay or silage. The potential of legumes for grazing is limited due to their susceptibility to trampling and the preferential grazing by livestock (Phelan *et al.*, 2015). Additionally, fresh feeding of legumes is limited due to the seasonality of rain which reduces the independence from protein-rich feedstuffs during the dry season. Moreover, legume feeding as hay is restricted by high dry-matter losses which occurs during drying, transport and storage. Furthermore, the practical implications of season and plant physiology may prevent timely harvest/drying at the optimal time for hay making (Titterton and Bareeba, 1999).

The limitations due to leaf shattering, harvest timing and availability in the dry season are minimized when forages are conserved as silage, making this probably the most suitable option to feed tropical legumes to ruminants. The development of small-scale intensive systems and the rising costs of concentrate feeds, made the conservation of forage crops an integral part of livestock production (Mapiye *et al.*, 2007). Conserving high quality forages reduces the need to purchase concentrates for use in ruminant rations. Surplus and cultivated quality forages should be conserved during the wet season for use during the dry season. To this effect, silage-making is a common means of preserving

surplus forage which could be fed to livestock during periods of scarcity. By conserving excess forage produced during the wet season to silage, the low production and productivity of livestock during the dry season due to scarcity of forage can be ameliorated (Wong, 2000). Conservation of cereals/grasses produce silages of high energy but low protein concentration (Mhere *et al.*, 2002). On the other hand, legumes alone do not ensile well owing to their high moisture content and buffering capacity, resulting in high effluent losses and unstable silage of high pH (Pahlow *et al.*, 2002). Incorporation of legumes in cereal silage increases protein concentration, improves silage intake and its nutritional quality thereby enhancing ruminant animal performance (Ngongoni *et al.*, 2008).

A number of Elephant grass and *Dolichos lablab* varieties have been shown to produce high dry matter yield and adapted to a wide range of agro ecologies across the country. However, they contribute little to the much needed improvement of livestock production because data regarding the conservation of mixed grass-legume forages as silage are scarce. Similarly, feeding of silage in general and grass-legume mixed silage in particular for sheep as a basal diet is not practiced in the study area. Therefore, alternative feed resources including conserved grass-legume mixed silage and Elephant grass ensiled alone or with different proportions of *Dolichos lablab* have not yet been investigated and exploited.

Thus, the study was undertaken with the objective to evaluate the effect of Elephant grass ensiled with different proportions of *Dolichos lablab* on feed intake, nutrient digestibility and growth performance of Horro sheep.

Materials and Methods

Description of the study area

The experiment was conducted at Bako Agricultural Research Center which is located in Oromia Regional State, West Shoa Zone at about 257 km from the capital city Addis Ababa on the way to Nekemte town. The center is located at 8 km from Bako town. The altitude of the research center is 1650 m above sea level and lies on Latitude 09°6'N and Longitude 37°09'E. The area has a warm sub-humid climate with annual mean minimum and maximum temperatures of 13°C and 29.9°C, respectively. Mean monthly minimum and maximum temperatures are about 10.4°C and 33.6°C, respectively, with an average monthly temperature of 21°C. The daily mean minimum and maximum temperatures are 9.4°C and 31.3°C, respectively. The area has a unimodal type of rainfall and receives annual rainfall of 1431 mm mainly from May to September with maximum precipitation between the months of June and August. Sixty percent of the soil is Vertisol and clay-loam in texture (Wakene, 2001).

Forage production and preservation

Pre-existing Elephant grass accession (ILRI 14984) at Bako Agricultural Research Center (BARC) forage production station was cut at about 50 cm height above the ground in order to promote re-growth for later silage making. In other fields, *Dolichos lablab* seeds were sown at recommended rate of 20 kg/ha under rain fed after ploughing and harrowing, then hand weeded and safeguarded from different wild animals. The removing (cutting) of Elephant grass was mainly to match its appropriate harvesting time with *Dolichos lablab* during silage making.

Elephant grass was harvested after eight weeks of re-growth at a height of 1m, while the complete foliage of *Dolichos lablab* was harvested at 50% blooming stage. The

Elephant grass and *Dolichos lablab* were separately chopped in to smaller pieces using a tractor driven chopper before ensiling to make it easy to compact silage and remove air from the pit. Before ensiling, plant materials were mixed according to treatment combinations. To improve fermentation quality of ensiling materials 3% molasses was sprinkled uniformly to all treatments over the chopped fodders and thoroughly mixed. For the ease of application, the molasses was diluted with water at a ratio of 3:1 water to molasses before use. The chopped and mixed fodder ready for ensiling were preserved in separate pit silos lined with polythene sheets. It was compacted by trampling with feet, covered with polythene sheets and soil heaped on the pit to maintain anaerobic conditions during storage. The silages was opened after 45 days and used in a feeding trial to evaluate the intake, digestibility and performance of sheep fed Elephant grass and *Dolichos lablab* mixed silage *ad libitum*.

Experimental animals and management

Before the commencement of actual experiment the experimental house, pens, feeding and watering trough were properly cleaned and disinfected. A total of twenty intact male yearling Horro sheep with initial

body weight of 19.47 ± 1.76 kg (mean \pm SD) used for this experiment were bought from local markets. Age of the animals were determined by their dentition and information obtained from owners. The experimental animals were ear-tagged for identification, quarantined for fifteen days and vaccinated against common infectious diseases in the area. During the quarantine period, animals were de-wormed against internal parasites using anti helminthes (Albendazole) and sprayed with acaricide (diazinon 60%) against external parasites. Thereafter, the experimental animals were assigned into different treatments after which the animals were randomly put in to separate well ventilated pens having a feed trough and water was freely provided.

Experimental design and treatments

A Randomized Complete Block Design (RCBD) was used. The experimental animals were grouped into five blocks of four animals based on their initial body weight. Animals in a block were assigned to one of the four treatments and uniformly supplemented with wheat bran at the rate of 1.5% of body weight across all the treatments. The arrangement of dietary treatments were as follows;

T1: Elephant grass ensiled alone

T2: Elephant grass ensiled with 10% *Dolichos lablab*

T3: Elephant grass ensiled with 20% *Dolichos lablab*

T4: Elephant grass ensiled with 30% *Dolichos lablab*

Feeding trial

The feeding trial was conducted for 90 days following an acclimatization period of 14 days. The amount of feeds offered and the corresponding refusals were weighed and recorded for each experimental animal to determine feed intake. Representative samples of feeds offered and refused for each animal was collected and pooled per treatment and

dried in an oven at 65°C for 72 hours. All the experimental animals had free access to clean water and mineralized salt block. Mean daily dry matter and nutrient intake were determined as the difference of offered and that of refused. The daily DM intake expressed as percent of body weight and metabolic body weight of animals was calculated by employing the following formula of (McDonald *et al.* 2002):

$$\text{Total DM intake (Percent BW (g))} = \frac{\text{DM intake (g)}}{\text{BW (kg)}} \times 100$$

$$\text{Total DM intake (Metabolic BW)} \left(\frac{g}{kg} W^{0.75} \right) = \frac{\text{DM intake (g)}}{W^{0.75} \text{ (kg)}}$$

Digestibility trial

Following the feeding trial, the digestibility trial was conducted with the same animals used in the feeding trial. All experimental animals were harnessed with fecal collection bags for three days of adaptation period before the resumption of actual collection of faeces for seven days. Daily total fecal output of each animal was weighed individually and recorded daily each morning before offering feed. The feces were then mixed thoroughly and 20% of the daily fecal output was taken and bulked across the experimental period to form a weekly fecal composite sample for each animal and kept in a deep freezer at -20°C. On

the last day of the collection period, the composite fecal samples were thaw and thoroughly mixed and a representative subsample was taken.

Samples of feed offered and feed refused were also collected every day and sub-sampled at the end of the experiment. The digestibility of DM and nutrients were determined as the difference between nutrients intake and that recovered in feces expressed as a proportion of nutrient intake. The total amounts of apparent nutrient digestibility were calculated using the following equation (Ranjihan, 2001).

$$\text{Nutrient digestibility (\%)} = \frac{\text{Nutrient intake} - \text{Nutrient excreted}}{\text{Nutrient intake}} \times 100$$

The estimated metabolizable energy intake of sheep from treatment feeds were calculated using the formula (McDonald *et al.*, 2002): ME (MJ/Kg DM) = 0.016 X IVDOMD, Where IVDOMD = is gram Digestible Organic Matter per kilogram Dry Matter.

Body weight change and feed conversion efficiency

The initial body weight of each animal was taken at the beginning of the trial and lambs were weighed at 15 days interval during the 90 days of feeding trial to determine body weight change during the experimental period. All animals were weighed after they are denied

access to feed by removing feed not consumed until 6:00 pm on the day before the weighing day using spring balance. Average daily body weight gain (ADG) and Feed conversion efficiency (FCE) were calculated according to the formula of Gulten *et al.* (2000) and Brown *et al.* (2001).

$$ADG = \frac{\text{Final body weight (g)} - \text{Initial body weight (g)}}{\text{Period of experiment (90days)}}$$

$$FCE = \frac{\text{Daily body weight gain (g)}}{\text{Daily feed intake (g)}}$$

Where: ADG is Average Daily Body Weight Gain and FCE is Feed Conversion Efficiency.



Chemical analysis

Partially dried fecal samples were ground to pass through a 1 mm sieve screen using Wiley mill and stored airtight plastic bags pending chemical analysis. The samples were taken to Holeta Agricultural Research Center, Animal Nutrition Laboratory for chemical analysis. The nitrogen (N), Dry matter (DM), Organic matter (OM) and ash contents were analyzed according to AOAC (1990). The crude protein (CP) content was calculated by multiplying N content with a factor of 6.25. Neutral detergent fibers (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed based on the method of Van Soest *et al.* (1994).

Statistical data analysis

The data generated during the experimental period were subjected to analysis of variance (ANOVA) following the General Linear Model (GLM) procedure of SAS version 9.0 (SAS, 2002). Significant means ($P < 0.05$) were separated by Duncan's multiple range tests.

The model used for data analysis was:

$$Y_{ij} = \mu + t_i + b_j + e_{ij}$$

Where;

Y_{ij} = response variable

μ = overall mean

t_i = treatment effect

b_j = block effect

e_{ij} = random error

Correlation analysis was employed to determine the relationship between nutrient intake and its corresponding digestibility and live weight change.

Results and Discussion

Chemical Composition of Experimental Feeds

The nutrient composition of the feeds used in the study are presented in Table 1. The dry matter, crude protein and digestible organic

matter in dry matter content of the silage increased as the proportion of *Dolichos lablab* in the mixture increased. On the contrary, Ash, NDF, ADF and ADL of the ensiled mixtures reduced with increasing inclusion level of *Dolichos lablab*, showing that addition of *Dolichos lablab* was effective in improving nutritional values of the Elephant grass silage. However, organic matter of the experimental feed was almost similar. T4 diet contained 14.7 and 29.32% more DM and CP, respectively than T1. However, it contained 15.15, 14.30 and 50.70% less NDF, ADF and ADL concentrations, respectively. The CP content of silage used in the present study ranged from 8.75 to 12.38 % which was above the 7% CP required for microbial protein synthesis in the rumen in order to meet the maintenance requirement of ruminants (Van Soest *et al.*, 1994). The result obtained in the present study was comparable with Gachuri *et al.* (2003) and Conteras-Govea *et al.* (2009) that reported the CP content of the Elephant grass silage increased from 9.7% to 11.2% with the addition of 20% *Dolichos lablab*. Furthermore, silage with a high level of CP is beneficial because it allows for increased proteolysis, which results in a buffering effect that hinders the reduction of the pH to levels that are optimum for fermentation (Napasirth *et al.*, 2015).

The CP content of wheat bran was higher than results of 16.1, 14.48, 13 and 15.98% reported by Wondwesen (2010); Radia *et al.* (2013); Teklu (2016) and Abuye *et al.* (2018) respectively. However, it was comparable with values of 17.19, 16.9, 17.77, 18 and 17.46% reported by Getnet (1998); Yenesew *et al.* (2013); Hunegnaw (2015); Mekonnen *et al.* (2016) and Firaol (2017). But it was relatively lower than the CP value of 20.10 and 23.08%

reported by Simret (2005) and Awet and Solomon (2009). The wheat feed nutrient composition varies depending on variety of wheat being milled and the processing method used (McDonald et al. 2002). Regarding feed refusal, the CP and DOMD contents were reduced and that of NDF, ADF and ADL increased with the increasing inclusion levels of *Dolichos lablab* in the mixed silage as compared to the feed offered, indicating selectivity by animals for nutritious parts of the feed.

Dry matter and nutrient intake

The levels of *Dolichos lablab* inclusion in Elephant grass silage influenced the intake of dry matter, crude protein, Organic Matter and Acid detergent lignin ($P < 0.001$), Metabolizable energy ($P < 0.01$), and acid detergent fiber ($P < 0.05$) without influencing the intake of neutral detergent fiber (Table 2).

The total DM and silage dry matter intake was significantly higher ($P < 0.001$) for lambs fed T4 diet than those on T1 and T2 with no statistical difference ($P > 0.05$) between lambs fed in T3 and T4 diets. The total DM intake of the present study showed that lambs fed T4 diets were greater by 19.53, 7.83 and 3.56% than those on T1, T2 and T3 diets, respectively. The difference could be attributed to the high digestible protein content of the T4 diet compared to other dietary treatments, which might have enhanced the efficiency of rumen microorganisms that increased fiber degradability and digestibility thereby, improving feed intake (McDonald et al., 2002). Because all the experimental lambs consumed wheat bran based on their body weight, total DM intake showed the same pattern as silage DM intake.

The total DM intake obtained in the study which ranged from 768.4 to 954.9 g/day was comparable with the total DM intake (740 to 979.3 g/day) reported by Mekonnen et al.

(2016) for the same sheep breed fed *Cynodon dactylon* alone or supplemented with *Cajanus cajan*, *Lablab purpureus* or their mixture. But, slightly higher than the total dry matter intake values (693.0 to 847 g/day, 680.94 to 783.33 g/day and 779.94 to 893.9 g/day) reported by Assefu (2012), Firaol (2017) and Abuye et al. (2018), respectively. Inclusion of legumes in Elephant grass silage based diets has previously been shown to increase dry matter intake (Abdulrazak et al., 1996), which has been attributed to improved palatability and digestibility. This observation has also been shown for wheat-pea silage fed to sheep and cattle (Adesogan et al., 2002) and for maize stover-*Leucaena diversifolia* fed to sheep (Hindrichsen et al., 2002).

The mean feed intake as a proportion of percent body weight and per unit metabolic body weight revealed significant difference ($P \leq 0.001$) among dietary treatments. Lambs fed T4, T3 and T2 diets ($P > 0.05$) had similar performance on %BW basis and were significantly higher than, those on T1 diet. Whereas, significant ($P < 0.001$) difference in per unit metabolic body weight basis was observed for lambs fed T4 diet followed by T3 as compared to T1 and T2 groups. The total DM intake on %BW basis of the present study was within the range of 2 to 6% recommended by the Agricultural Research Council (ARC) (1980) and 2 to 4% suggested by Susan (2003). Similarly, the DM intake per unit metabolic $BW^{0.75}$ (75.97 and 89.62 g/kg) obtained in this study was comparable with the findings of Birhanu et al. (2013) and Jalel (2013) who reported ranges of 75.02 to 86.66 g/kg for Black Ogaden sheep and 76.2 to 85.9 g/kg for Horro sheep. The DM intake on percent BW and per unit metabolic body weight basis recorded in this study were slightly higher than those of Mekonnen et al. (2016) and Abuye et al. (2018) who reported 3.2-3.5% and 70.3–79.2 g/kg and 3.45-3.81% and 75.23-81.69 g/kg for the same sheep breed, respectively.

The observed variations among the studies emanated from the differences in the quality of the feeds used, animal factors (age and physiological status of the animals), rumen fill, rate of passage of articulate matter and digestibility of experimental feeds used.

The total organic matter intake was significantly ($P < 0.001$) higher for lambs fed T4 diets than those fed T2 and T1, but, similar ($P > 0.05$) with those in T3 group, which followed the same trend for DM intake as it is the reflection of total DM intake. Increased OM intake ($P < 0.001$) when lambs were fed silage consisting 30% inclusion level of *Dolichos lablab* might be due to the increased total DM intake and CP intake. The total CP intake was significantly higher ($P < 0.001$) for sheep fed diet in T4 than T1, T2 and T3. The values of the CP intake in this study which ranged from 94.8 to 137.7 g/day were comparable with 93.9 to 145.1 and 103 to 158 g/day reported by Assefu (2012) and Mekonnen *et al.* (2016), respectively. However, the results were higher than the values ranges (90.0 to 108.9 and 81.7 to 116.36 g/day) than those reported by Yeshambel *et al.* (2012) and Abuye *et al.* (2018), respectively. According to Osuji *et al.* (1995), leguminous fodder trees increase protein supply to the host animal by creating a favorable rumen environment resulting in enhanced fermentation of the basal roughage and thus increased microbial protein synthesis. This implies the presence of direct relationship between CP content of feeds and feed intake (Tesfaye, 2007).

Higher ($P < 0.001$) acid detergent lignin intake was observed for lambs fed T1 diet as compared to other dietary treatments, but no significant difference ($P > 0.05$) was observed between lambs fed T2, T3 and T4 diets. Total ADF intake was lower ($P < 0.05$) for lambs fed T1 diet as compared to those in other groups. This might be due to the amount of fiber

fractions that existed in the feed which might have increased with increasing amount of total Dry Matter Intake (DMI). Ash intake was highest ($P < 0.05$) for T1 followed by $T4 < T3 < T2$ in that order. In this study, NDF intake was not affected with increasing inclusion level of *Dolichos lablab* in the Elephant grass silage. According to Lonsdale (1989), feeds that have < 9 , $9 - 12$ and > 12 MJ ME/kg DM are classified as low, medium and high energy sources, respectively. The highest ME intake (9.99 MJ/day) and (9.94 MJ/day) obtained for T4 and T3 were above the estimated daily ME (8.5 MJ/day) requirement of lambs weighing 30 kg and daily gain of 100 g/day (ARC 1980). In this study the metabolizable energy intake was highest for lambs fed T4 diet compared to T1 and T2 that were statistically similar with those on T3 diet. This can be attributed to the difference in OM digestibility. Thus, the advantage of *Dolichos lablab* inclusion in Elephant grass silage is the increased DM intake, which ensured higher digestible nutrient uptake.

Apparent nutrient digestibility

Apparent nutrient digestibility of Horro sheep fed Elephant grass ensiled with different proportions of *Dolichos lablab* is presented in Table 3.

Dry matter and organic matter digestibility of the diets varied significantly ($P < 0.001$) across the treatments with higher digestibility for T4 as compared to T1 diet. Apparent DM and OM digestibility were significantly higher ($P < 0.001$) for lambs fed T4 diet as compared to those fed T2 and T1 diets with no significant difference ($P > 0.05$) from lambs fed T3 diet.

The improved DM and OM digestibility for lambs fed T3 and T4 diets might be associated with higher CP intake that have created a better environment by providing more N for rumen microorganisms. According to Bonsi *et al.* (1996) lower CP content of feeds affect microbial growth and fermentation in the rumen and consequently digestibility of DM

and nutrients. In support of the present finding, Lapenga *et al.* (2009) noted that supplementation of Mubende goats fed Elephant grass with different protein and energy sources increased DM and OM digestibility. The DM Digestibility of the current study revealed that lambs fed diets in T4 were increased by 17.59, 10.09 and 6.18% than lambs in T1, T2 and T3 diets, respectively. Similarly, Awet and Solomon (2009) reported significant variation in apparent digestibility of DM and OM for Afar sheep fed urea treated teff straw supplemented with graded level of wheat bran. Getahun (2014) also reported that lambs supplemented with 300 g/day of leucena to untreated wheat straw significantly increased the apparent digestibility coefficients of DM and OM compared to the sole untreated straw. Olorunnisomo (2011) pointed out that the DM digestibility (%) of red Sokoto goats fed Elephant grass ensiled alone increased from 54.67 to 68% with the addition of 50% cassava peel in the mixture. The DM digestibility was slightly greater than the range (57±1.4 to 60±1.3%) reported by Gachuri (2003) for Elephant grass ensiled with 20% of *Dolichos lablab*.

Significant differences ($P<0.001$) were observed in digestibility of CP among dietary treatments. Lambs fed T4 diet had higher CP digestibility than those on T3, T2 and T1 with no significant difference ($P>0.05$) between T2 and T3 with the lowest digestibility coefficient recorded for lambs fed T1 diet. Banamana *et al.* (1990) reported that increasing CP in the diet increased the digestibility of OM, ADF and CP. Mulligan *et al.* (2001) also reported that increasing dietary CP content increased the digestibility of low quality hay. In this study, increased CP intake with increasing levels of *Dolichos lablab* in the silage mixture was followed with increase in DM, OM, and CP digestibility. In agreement with the present study, significantly different apparent

digestibility of CP was reported by Berhanu *et al.* (2014) in Washera sheep. Firisa *et al.* (2013) also reported significantly improved CP digestibility in Horro lambs supplemented with graded levels of *V. amygdalina* leaves and sorghum grain mixture. Furthermore, Abuye *et al.* (2018) reported that digestibility of CP for sheep fed basal diets of natural grass hay were improved when supplemented with Gebisa-17 and Beresa-55 cultivars of *L. purpureus* and concentrate mixture.

Significant differences ($P<0.01$) were observed in the digestibility of NDF among the dietary treatments. The highest digestibility of NDF was recorded in T4 followed by T3>T2>T1 in that order with almost comparable values obtained in T4 and T3. Apparent digestibility of ADF was significantly different ($P<0.05$) among treatments with the lowest ADF digestibility recorded for lambs fed T1 diet and similar values among other groups. Olorunnisomo (2011) also reported significant ($P<0.05$) improvement in NDF and ADF digestibility with the increasing inclusion level of cassava peel in Elephant grass silage.

Growth Performance of Horro Sheep

Mean initial body weight, Final body weight, body weight change and average daily body weight gains among dietary treatments are presented in Table 4. The mean initial body weights of lambs assigned to dietary treatments were not significantly different ($P>0.05$) in all groups. Significant differences were recorded in final body weight between dietary treatments.

The highest ($P<0.001$) Final Body Weight (FBW) was observed for lambs fed T4 diet which was statistically similar ($P>0.05$) with T3. Lambs fed diets in T4 had final body weight greater by 16.08, 10.98 and 6.99% than those on T1, T2 and T3 diets, respectively. The growth rate of lambs fed T4 was higher as compared to those fed other dietary treatments.

Also their daily gain was more by 55.66, 39.37 and 25.56% than T1, T2 and T3 groups, respectively. Similar trend was also observed among all treatments in BW change attributes. The lower body weight gain for lambs fed Elephant grass ensiled alone could be attributed to the low CP and ME intake resulting in poor supply of nutrients. Ensminger (2002) also showed that low energy intake that results from either feed restriction or low ration component digestibility prevents sheep from meeting their requirements and attaining their genetic potential.

In this study, an increasing trend was observed in body weight change from T1 to T4 (Figure 1) and animals fed T1 diet were lighter by 4.92 kg than those fed T4. This appeared to be consistent with difference in nutrient digestibility like, DM, CP and OM (Table 3) that might have resulted in difference in nutrient intake available for absorption and metabolism. Increased live weight gain of Horro sheep supplemented with different levels of concentrate on a basal diet of barley (mosnoo) straw was reported (Gemeda *et al.* 2003). The mean values of the final body weight (FBW) in this study (23.52-28.04 kg) were comparable with 23.2-28.6 and 23.82-30.32 kg reported by Mekonnen *et al.* (2016) for Horro and Firaol (2017) for Arsi-Bale sheep, respectively. However, FBW obtained were slightly higher than those reported by Assefu (2012) and Abuye *et al.* (2018) for the same breed. Takele *et al.* (2004) reported that supplementation with higher levels of wilted *Leucaena pallida* leaf 410 g/h/d and 150 g/h/d ground maize or maize-noug at a level of 300 g/h/d had improved final body weight, total weight gain and average daily gain.

The values of ADG observed for all group of lambs fed Elephant grass silage containing different proportion of *Dolichos lablab* in the current study were considerably higher than the highest value (36.7 g/day) of ADG

achieved at higher level of lowland bamboo leaf hay inclusion in Washera lambs fed mixtures of lowland bamboo leaf hay and natural pasture grass hay at different proportion (Yeshambel *et al.*, 2012) and the highest ADG value 47.2g/day reported by Getahun (2014) for the Ethiopian highland sheep supplemented with 300g/day leucaena on urea treated and untreated straw. Similarly, lower ADG values ranged from 33.3 to 58.7g/day for Horro lambs and 40.2 to 48.7g/day for Washera lambs were reported by Assefu (2012) for lambs fed rations containing different roughage to concentrate ratios.

Comparative results to present study ADG values of 27.8 to 87.4 g/day was reported by Mokennen *et al.* (2016) for the same breed fed *Cynodon dactylon* alone or supplemented with *Cajanus cajan*, *Lablab purpureus* or their mixture and rations containing different roughage to concentrate. Similarly, comparable ADG values (32.33 to 85.11 g/day) were reported by Malisetty *et al.* (2013) for Nellore ram lambs fed maize silage supplemented with concentrate and legume hay. The highest ADG value 98.22 g/d observed in lambs fed T4 diet in this study was within the range (69.1 to 104.1g/day and 49.33 to 116.22 g/day) reported by Belete *et al.* (2013) and Firaol (2017), respectively. However, the results were slightly higher than that (29.33 to 75.56 g/day) reported by Abuye *et al.* (2018) for Horro sheep fed natural grass hay and supplemented with Gebisa-17 and Beresa-55 cultivars of *Lablab purpureus* and concentrate mixture. The positive ADG observed for lambs fed Elephant grass silage alone was due to the supplementation with wheat bran.

In the present study, higher value in FCE was obtained by lambs in T4 (0.1) followed by T3 (0.08) > T2 (0.07) > T1 (0.06) showing that lambs in T4 utilized diet better than other diets. The reduction in FCE for lambs fed T1 diet

was probably the result of low protein and energy intake and high fiber content of the diet that might have caused the net efficiency of use of metabolizable energy to be depressed slightly. Lambs fed legumes have more efficient dietary protein utilization and grow faster than lambs fed grass, in part due to a more rapid rate of digestion (Howes, 2015).

Correlation among intake, digestibility and body weight gain

Correlation between nutrient intake, digestibility and body weight gain parameters investigated on Horro lambs fed Elephant grass ensiled with different proportion of *Dolichos lablab* are presented in Table 5. Total DM intake was strongly and positively ($P < 0.001$) correlated with CP intake, digestible dry matter, digestible crude protein and average daily body weight gain. This indicates that with increasing DMI, there was increasing BW gain as result a positive association was observed between these parameters. DMI, Digestible Dry Matter (DDM), DCP and ADG were strongly ($P < 0.001$) and positively associated with CPI. In consistent with present study Tewdros (2011) reported that CP intake was positively and significantly correlated with Crude Protein Digestible (CPD) and ADG. Similarly, Mekonnen (2017) reported that CP intake for Horro sheep fed *Cynodon dactylon* hay alone or supplemented with *Cajanus cajan*, *Lablab purpureus* or their mixture is strongly and positively ($P < 0.001$) associated with DMD, CPD and ADG.

Conclusion

It is concluded that mixing *Dolichos lablab* with Elephant grass had beneficial effects on silage properties, intake and digestibility of the nutrients. The addition of 20 to 30% *Dolichos lablab* in Elephant grass silage enhanced the nutritive value of the silage thereby, increasing the nutrient intake and digestibility for better growth of Horro sheep.

References

- Abdulrazak, S.A., Muinga, R.W., Thorpe, W. and Orskov, E.R. (1996). The effects of supplementation with *Gliricidia sepium* or *Leucaena leucocephala* forage on intake, digestion and live weight gains of *Bos taurus* x *Bos indicus* steers offered Napier grass. *Journal of Animal Science* 63:381-388.
- Abuye, T., Yadav, R.K. and Diriba G. (2018). Supplementary value of two *Lablab purpureus* cultivars and concentrate mixture to natural grass hay basal diet based on feed intake, digestibility, growth performance and net return of Horro sheep. *International Journal of Livestock Production* 9(6): 140-150.
- Adegun, M.K. (2014). Voluntary Feed Intake and Nutrient Utilization of West African Dwarf Sheep Fed supplements of *Moringa oleifera* and *Gliricidia sepium* Fodders. *American Journal of Agriculture and Forestry*, 2(3): 94-99.
- Adesogan, A.T., Salawu, M.B., Williams, S.P., Fisher, W.J. and Dewhurst, R.J. (2002). Reducing concentrate supplementation in dairy cow diets while maintaining milk production with pea-wheat intercrops. *Journal of Dairy Science*, 87: 3398–3406.
- Ajebu, N., Adugna T., Eik, L.O. and Sundstol, F. (2008). Feeding value of ensiled (*Ensete ventricosum*), *Desmodium intortum* hay and untreated or urea and calcium oxide treated wheat straw for sheep. *Journal of Animal Physiology and Animal Nutrition*, 93: 94-104.
- Alemayehu, M. (2004). Pasture and forage resource profiles of Ethiopia. EDM Printing Press, Addis Ababa.
- Association of Official Analytic Chemists (AOAC). (1990). Official Methods of Analysis. 15th edition. AOAC. Inc.

- Anc. Arlington, Virginia, U.S.A. 12-98.
- Agricultural Research Council (ARC). (1980). The Nutrient Requirements of Ruminant Livestock Technical review by an Agricultural Research Council Working party published on behalf of the Agricultural Research Council by the Common Wealth Agricultural Bureaux, Farnham Royal, England pp.114-151.
- Assefu, G. (2012). Comparative feedlot performance of Washera and Horro sheep fed different roughage to concentrate ratio. An MSc Thesis Presented to School of graduate studies of Haramaya University, Haramaya, Ethiopia.68p.
- Awet, E. and Solomon, M. (2009). Supplementation of Graded Levels of Wheat Bran to Intact and Castrated Afar Sheep Fed Urea Treated Teff Straw: Effects on Feed Intake, Digestibility, Body Weight and Carcass Characteristics. *East African Journal of Science*, 3(1): 29-36.
- Banamana, M.S., Oldman, J.D. and Mowlem, A. (1990).The effect of amount of protein in the Concentrate on hay intake and rate of passages diet digestibility and milk production in British Saanen goat. *Journal of Animal Production*, 51:333-342.
- Belete, Sh., Abubeker, H., Abule, E. and Nura, A. (2013). Performance of Arsi-Bale kids supplemented with graded levels of pigeon pea in dry season in Mid Rift valley of Ethiopia. *African Journal of Agricultural Research*, 8(20): 2366-2370.
- Berhanu, A., Getachew, A. and Adugna, T. (2014). Effect of *Millettia ferruginea* (Birbra) foliage supplementation on feed intake, digestibility, body weight change and carcass characteristics of Washera sheep fed natural pasture grass hay basal diet. *SpringerPlus*. pp.4-6.
- Birhanu, T., Getachew, A., Mengistu, U. (2013). Effect of Green *Prosopis juliflora* Pods and Noug Seed (*Guizotia obissynica*) Cake Supplementation on Digestibility and Performance of Blackhead Ogaden Sheep fed hay as a Basal Diet Science Technology Arts Research Journal, 2(2): 38-47.
- Bonsi, M.L.K., Tush, A.K., Osuji, P.O., Nsahlai, I.V. and Umunna, N.N. (1996). The effect of protein supplement source or supply pattern on the intake, digestibility, rumen kinetics, nitrogen utilization and growth of Ethiopian Menz sheep fed teff straw. *Journal of Animal Feed science and Technology*, 64(1): 11-25.
- Brown, L., Hindmarsh, R., Mcgregor, R. (2001). Dynamic Agricultural book three (2nd Ed.): McGraw-Hill Book Company, Sydney, 357p.
- Contreras-Govea, F.E., Muck, R.E., Armstrong, K.L. and Albrecht, K.A. (2009). Nutritive value of corn silage in mixture with climbing beans. *Animal Feed Science Technology*, 150: 1-8
- Central Statistical Agency Agricultural (CSA). (2018). Sample survey 2017/18. Report on Livestock and livestock characteristics (private peasant holdings) volume, II.
- Ensminger, M.E. (2002). Sheep and goat science (Animal Agriculture Series). 6th ed. Interstate publishers, Inc. Daville, Illinois, U.S.A. 693p
- Ferreira, D.J., Zanine, A.M., Lana, R.P., Souza, A.L., Ribeiro, M.D., Negrão, F.M., Alves, G.R. and Castro, W.J.R. (2017). Intake and digestibility in

- sheep fed on marandu grass silages added with dehydrated barley. *Pesquisa Veterinária Brasileira* 37(2):171-178.
- Firaol, E. (2017). Effects of replacing different proportion of cafeteria leftover for concentrate mix on performance of Arsi – Bale sheep. A Thesis submitted to School of Animal and Range Sciences (Postgraduate Program Directorate) Haramaya University.
- Firisa, W., Adugna, T. and Diriba, D. (2013). Feed Intake, Digestibility and Growth Performance of Horro lambs fed Natural Pasture hay Supplemented Graded Level of *Vernonia amygdalina* Leaves and Sorghum Grain Mixture. *Science and Technology Arts Research Journal*, 2(2):30-37.
- Gachuri, C.K. and Mbutia, E.W. (2003). Effect of inclusion of *mucuna pruriens* and *Dolichos lablab* forage in Napier grass silage on silage quality and on voluntary intake and digestibility in sheep. *Tropical and Subtropical Agroecosystems*, 1: 123–128.
- Gemeda, D., Takele, K., Ulfina, G. and Solomon, A. (2003). The effect of age and sex on growth performance and carcass characteristics of Horro lamb, 99-103. Proceedings of 10th Annual conference of the Ethiopian Society of Animal Production (ESAP). 22-24 August 2002, Addis Ababa, Ethiopia.
- Getahun, K.Y. (2014). Effect of concentrate supplementation on performances of Ethiopian lowland *afar* and blackhead *Ogaden* lambs. *Anim. Vet. Sci.*, 2(2):36-41.
- Getnet, B. (1998). Performance of Somali Goats Supplemented with Different Proportions of Groundnut Cake and Wheat bran. MSc Thesis, Haramaya University, Haramaya, Ethiopia.
- Gulten, K., Rad, F. and Kindir, M. (2000). Growth performance and feed conversion efficiency of Siberian Sturges juveniles (*Acipenser baeri*) Reared in concentrate ways. *Turkey Journal of Veterinary and Animal Science*, 24:28.
- Hindrichsen, I.K, Osuji, P.O, Odenyo, A.A, Madsen, J. and Hvelplund, T., (2002). Effects of supplementation of a basal diet of maize stover with different amounts of *Leucaena diversifolia* on intake, digestibility, nitrogen metabolism and rumen parameters in sheep. *Animal Feed Science and Technology Journal*, 98:131-142.
- Howes, N.L, Bekhit, A.E.A., Burritt, D.J. and Campbell, A.W. (2015). Opportunities and implications of pasture-based lamb fattening to enhance the long-chain fatty acid composition in meat. *Comprehensive Review in Food Science and Food Safety*, 14:22–36.
- Hunegnaw, A. (2015). Effects of supplementation with pigeon pea (*cajanus cajan*), cowpea (*vigna unguiculata*) and lablab (*lablab purpureus*) on feed intake, body weight gain and carcass characteristics of wollo sheep fed on grass hay. MSc Thesis, Addis Ababa University, Addis Ababa. Ethiopia.
- Jalel, F. (2013). Effect of feeding graded levels of wild silver leaf desmodium (*Desmodium uncinatum*) on feed intake, digestibility, body weight change and carcass characteristics of Horro sheep fed a basal diet of Natural pasture hay. MSc Thesis, Haramaya University, Haramaya, Ethiopia, pp. 24-36.
- Jørgensen, S.T., Pookpakdi, A., Tudsri S., Stølen O., Ortiz R. and Christiansen J.L. (2010). Cultivar-by-cutting height

- interactions in Napier grass (*Pennisetum purpureum* Schumach) grown in a tropical rain-fed environment *Acta Agriculturae Scandinavica, Section B- Plant Soil Science* 60: 199-210.
- Lapenga, K. O., Ebong, C. and Opuda-Asibo, J. (2009). Effect of feed supplementation on weight gain and carcass characteristics of intact male Mubende goats fed Napier grass (*Pennisetum purpureum*) ad libitum in Uganda. *Journal of animal and veterinary advances*, 8 (10): 2004-2008.
- Lonsdale, C. (1989). Raw Materials for Animal Feeds Compounders and Farmers. Chalcombe Publications, Great Britain. pp. 17-47.
- Malede, B. and Takele, A. (2014). Livestock feed resources assessment, constraints and improvement strategies in Ethiopia. *Middle East Journal of Scientific Research*, 21(4): 618–704.
- Malisetty, V., Yerradoddi, R.R., Devanaboina, N., Mallam, M., Cherala, H.K., Admal, R.R. and Manthani, G.P. (2013). Effect of feeding maize silage supplemented with concentrate and legume hay on growth in Nellore ram lambs, *World*. 6(4): 209-213, doi:10.5455/vetworld.2013.209-213
- Mapiye, C., Mwale, M., Mupangwa, J.F., Mugabe, P.H. Poshiwa, X. and Chikumba, N. (2007). Utilisation of ley legumes as livestock feed in Zimbabwe. *Tropical Grass*, 41: 84-91
- Markos, T., Phillips, J.S. and Worknesh, A. (2006). Sustainable sheep breeding in the Tropics: a Framework for Ethiopia conference on International Agricultural Research for Development, University of Bonn, October, 2006.
- McDonald, P., Edwards, A.R., Greenhalgh, D.F.J. and Morgan, A.C. (2002). *Animal Nutrition*. 6th ed. Prentice Hall, London. 245-477.
- Mekonnen, D., Mengistu, U. and Gameda, D. (2016). Effects of supplementation with *cajanus cajan*, *lablab purpureus* or their mixture on feed utilization, growth and carcass characteristics of Horro sheep fed a basal diet of natural grass hay. *Journal of Biology, Agriculture and Healthcare*. 6(17): 2224-3208.
- Mhere, O., Maasdorp, B. and Titterton, M. (2002). Growing and ensiling annual and perennial forage crops suited to marginal and semi-arid areas of Southern Africa. *Forage Production and Conservation Manual*.
- Muia, J.M.K., Tamminga, S., Mbuguam, P.N. and Kariuki, J.N. (2001). Rumen degradation and estimation of microbial protein yield and intestinal digestion of Napier grass (*Pennisetum purpureum*) and various concentrates. *Animal Feed Science and Technology*, 93: 177-192.
- Mulligan, F.J., Caftrey, P.J., Rath M., Keny, M.J and Mare, F.P.O'. (2001). The effect of dietary protein Content and hay intake level on the true and apparent digestibility of Hay. *Livestock production science*, 68: 41-52.
- Napasirth, V., Napasirth, P., Sulinthone, T., Phommachanh, K. and Cai, Y. (2015). Microbial population, chemical composition and silage fermentation of cassava residues. *Animal Science Journal*, 86: 842–848.
- Ndikumana, J. (1996). Multi locational evaluation of Napier and *Pennisetum* hybrids: Highlights of from the Addis Ababa. AFRNET (Africa Feed

- Resources Network) newsletter, 6: 1-11.
- Ngongoni, N.T., Mwale, M., Mapiye, C., Moyo, M.T., Hamudikuwanda, H. and Titterton, M. (2008). Evaluation of cereal-legume intercropped forages for smallholder dairy production in Zimbabwe. *Tropical Grassland Science*, 42: 188–192.
- Olorunnisomo, O.A. (2011). Intake and digestibility of elephant grass ensiled with cassava peels by Red Sokoto goats. Conference on International Research on Food Security, Natural Resource Management and Rural Development. University of Bonn, October 5-7, 2011.
- Osuji, P.O., Fernandez-Rivera, S. and Odenyo, A.A. (1995). Improving fiber utilization and protein supply in animals fed poor quality roughages: ILRI nutrition research and plans. 1-22. Rumen Ecology Research Planning. Addis Ababa, Ethiopia, In: 13-18 March 1995, ILRI.
- Pahlow, G., Slottner, D., Rammer, C. and Touri, M. (2002). Ensiling of legumes. Published in: Landbauforschung Völkenrode Sonderheft 234, PP. 27-31.
- Phelan, P., Moloney, A.P., McGeough, E.J., Humphreys, J., Bertilsson, J., O’Riordan, E.G. and O’Kiely, P. (2015). Forage legumes for grazing and conserving in ruminant production systems. *Critical Reviews in Plant Sciences*, 34(13): 281–326.
- Radia, H., Firew, T., Zelalem, Y., Zeleke, M., Mengistie, T. (2013). Feed Intake, Milk Yield and Milk Composition of Fogera Cows Supplemented with Different Feeds. *World's Veterinary Journal*, 3(2): 41 - 45.
- Ranjihan, S.K. (2001). Animal nutrition in the Tropics. 5th revised edition Vikas publishing Resources Information. 43: 25–40.
- Statistical Analysis System (SAS). (2002). User’s Guide: version 9.0. SAS Institute, Inc. Cary, NC.
- Simret Betsha. 2005. Supplementation of graded levels of peanut cake and Wheat bran mixture on nutrient utilization and Carcass parameters of Somali goats. Thesis presented to the School of Graduate Studies of Haramaya University. Haramaya, Ethiopia. 75p
- Solomon, B. (2004). Assessment of livestock production system and feed resource base in Sinana Dinsho district of Bale high lands south east Oromia. MSc. thesis Haramaya University, Haramaya, Ethiopia. 60-64.
- Solomon, M., Peters, K.J. and Azage, T. (2004). Effects of supplementation with foilages of selected multipurpose trees, their mixtures or wheat bran on feed intake, plasma enzyme activities, live weight and scrotal circumference gain in Menz sheep. *Livestock Production Science*, 89: 253-264.
- Solomon, G., Solomon, A., Rischkowsky B. Haile, A., Mwai, A.O. and Tadele, D. (2013). Review of sheep research and development projects in Ethiopia. Nairobi, Kenya: International Livestock Research Institute (ILRI).
- Susan, S. (2003). An introduction to feeding small ruminants. Western Maryland Research and Education Center Maryland Cooperative Extension. <http://www.sheepandgoat.com/index.html>
- Takele, K., Gemed, D., Fayo, D. and Solomon, A. (2004). Growth

- performance of Horro lambs supplemented with different levels of wilted *Leucaena* (*Leucaena Pallida*) leaf. pp.248-252. Proceedings of the 12th annual conference of the Ethiopian Society of Animal Production (ESAP), 12-14 August 2004, Addis Ababa, Ethiopia.
- Teklu, W. (2016). Effects of feeding different varieties of faba bean (*vicia faba* L.) straws with concentrate on feed intake, digestibility, body weight gain and carcass characteristics of Arsi-Bale sheep. MSc Thesis, Haramaya University, Haramaya, Ethiopia.
- Tesfaye, H. (2007). Supplementation of Afar rams with graded levels of mixtures of protein and energy sources: Effects on feed intake, digestibility, live weight and carcass parameters. An MSc Thesis presented to School of Graduated Studies Haramaya University, Haramaya, Ethiopia. 24p.
- Tessema, Z. (2005). Variation in growth, yield, chemical composition and *in vitro* dry matter digestibility of Napier grass accessions (*Pennisetum purpureum*). *Tropical Science*, 45: 93-99.
- Tessema, Z., Ashagre, A. and Solomon, M. (2010). Botanical composition, yield and nutritional quality of grassland in relation to stages of harvesting and fertilizer application in the highland of Ethiopia. *African Journal of Range and Forage Science*.
- Tewdros, E. (2011). Effect of inclusion of different proportions of tassign (*thymus serrulatus*) in concentrate mix supplement on feed intake, digestibility, body weight change and carcass parameters of Menz sheep fed grass hay. MSc Thesis Presented to the School of Graduate Studies of Haramaya University, Haramaya, Ethiopia. 57p.
- Titterton, M. and Bareeba, F. (1999). Paper 4.0: Grass and legume silages in the tropics. FAO, Rome, Retrieved from <http://www.fao.org/docrep/005/x8486e/x8486e0c.htm> [Cited 23 October 2016].
- Van Soest, P.J., Robertson, B.J. and Lewis, B.A. (1994). Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*, 74: 3583-3597.
- Wakene, N. (2001). Assessment of important physicochemical properties of Alfisols under different management systems in Bako area, Western Ethiopia. An MSc Thesis Presented to the School of Graduate Studies of Alemeya University, Haramaya, Ethiopia. 93p.
- Wondwesen, B. (2010). Effect of substitution of concentrate mix with *Sesbania sesban* on feed intake, digestibility, body weight change, and carcass parameters of Arsi-Bale sheep fed grass hay. MSc Thesis, Haramaya University, Haramaya, Ethiopia.
- Wong, C.C. (2000). The place of silage in ruminant production in the humid tropics. In: *Silage Making in the Tropics with Particular Emphasis on Smallholders* ('t Mannelje L., Ed.)
- Yenesew, A., Solomon, M. and Azage, T. (2013). Effect of supplementation of grazing sheep with groundnut cake and wheat bran. *Journal of Agricultural Research*, 2(8): 212-217.
- Yeshambel, M., Mengistu, U. and Getachew, A. (2012). Intake, digestibility, live weight changes and rumen parameters of Washera sheep fed mixtures of lowland bamboo (*oxytenanthera*

abyssinica) leaves and natural pasture grass hay at different ratios. *Pakistan Journal of Nutrition*, 11 (4): 322-331.

Table 1. Chemical composition of experimental feeds

Feed Samples	DM%	Chemical Composition, (% DM)						
		Ash	CP	OM	NDF	ADF	ADL	IVDOMD
T1	30.14	10.86	8.75	89.14	72.14	42.23	8.77	55.1
T2	32.40	8.64	10.19	91.36	63.00	40.89	4.56	56.24
T3	34.70	8.21	11.06	91.79	61.11	38.86	4.02	56.55
T4	35.34	7.83	12.38	92.17	61.21	36.19	4.32	58.87
WB	90.76	6.09	17.37	93.91	37.36	15.21	3.88	78.61
Refusal								
T1	30.08	13.1	6.48	86.9	70.86	42.51	9.32	36.65
T2	30.83	12.58	6.87	87.42	72.82	41.68	4.63	38.19
T3	31.44	12.52	7.13	87.48	71.64	40.86	4.59	39.81
T4	31.92	11.23	7.25	88.77	71.6	40.79	4.59	40.43

DM= dry matter; OM= organic matter; NDF=neutral detergent fiber; ADF=acid detergent fiber; ADL= acid detergent lignin; CP= crude protein; IVDOMD= In vitro digestible organic matter in dry matter; NG= Elephant grass; DL= *Dolichos lablab*; WB = wheat bran; T1=Elephant grass ensiled alone; T2= Elephant grass ensiled with 10% *Dolichos lablab*; T3=Elephant grass ensiled with 20% *Dolichos lablab*; T4=Elephant grass ensiled with 30% *Dolichos lablab*.

Table 2. Dry Matter and Nutrient Intake of Horro Lambs fed Elephant grass ensiled with different proportion of *Dolichos lablab*

Parameters	Treatments				SEM	SL
	T1	T2	T3	T4		
Dry Matter Intake (g/day)						
Silage	470 ^c	573.3 ^b	612.8 ^{ab}	635.4 ^a	19.469	***
Wheat Bran	298.4	306.9	308.1	319.5	5.2922	NS
Total	768.4 ^c	880.1 ^b	920.9 ^{ab}	954.9 ^a	22.530	***
%BW	3.515 ^b	3.903 ^a	4.065 ^a	4.074 ^a	0.0727	***
g/KgW ^{0.75}	75.978 ^c	85.038 ^b	88.678 ^{ab}	89.622 ^a	1.6383	***
Total Nutrient Intake (g/day)						
CP	94.8 ^d	113.8 ^c	124.4 ^b	137.7 ^a	2.1900	***
OM	701.0 ^c	820.8 ^b	855.2 ^{ab}	888.8 ^a	20.193	***
Ash	67.3 ^a	59.3 ^b	65.7 ^{ab}	66.2 ^{ab}	2.3550	*
NDF	451.6	469.5	481.2	501.1	14.561	NS
ADF	243.6 ^b	280.6 ^a	283.4 ^a	275.4 ^a	8.4247	*
ADL	52.3 ^a	38.0 ^b	36.1 ^b	39.7 ^b	1.2794	***
ME (MJ/day)	8.18 ^c	8.86 ^{bc}	9.4 ^{ab}	9.99 ^a	0.0246	**

^{a,b,c,d} =Means within a row with different superscripts differ significantly (P<0.05); *=(P<0.05); **=(P< 0.01); ***=(P < 0.001); SEM=standard error of means; SL= significance level; NS = non-significant; %BW basis =dry matter intake on BW basis; g/KgW^{0.75} = per unit metabolic body weight basis; OM=organic matter; NDF=neutral detergent fiber; ADF=acid detergent fiber; ADL= acid detergent lignin; CP=crude protein; WB=wheat bran; BW =body weight; ME=metabolizable energy; T1=Elephant grass ensiled alone; T2= Elephant grass ensiled with 10% *Dolichos lablab*; T3=Elephant grass ensiled with 20% *Dolichos lablab*; T4=Elephant grass ensiled with 30% *Dolichos lablab*.

Table 3. Apparent Nutrient digestibility (%) in Horro sheep fed Elephant grass ensiled with different proportion of *Dolichos lablab*

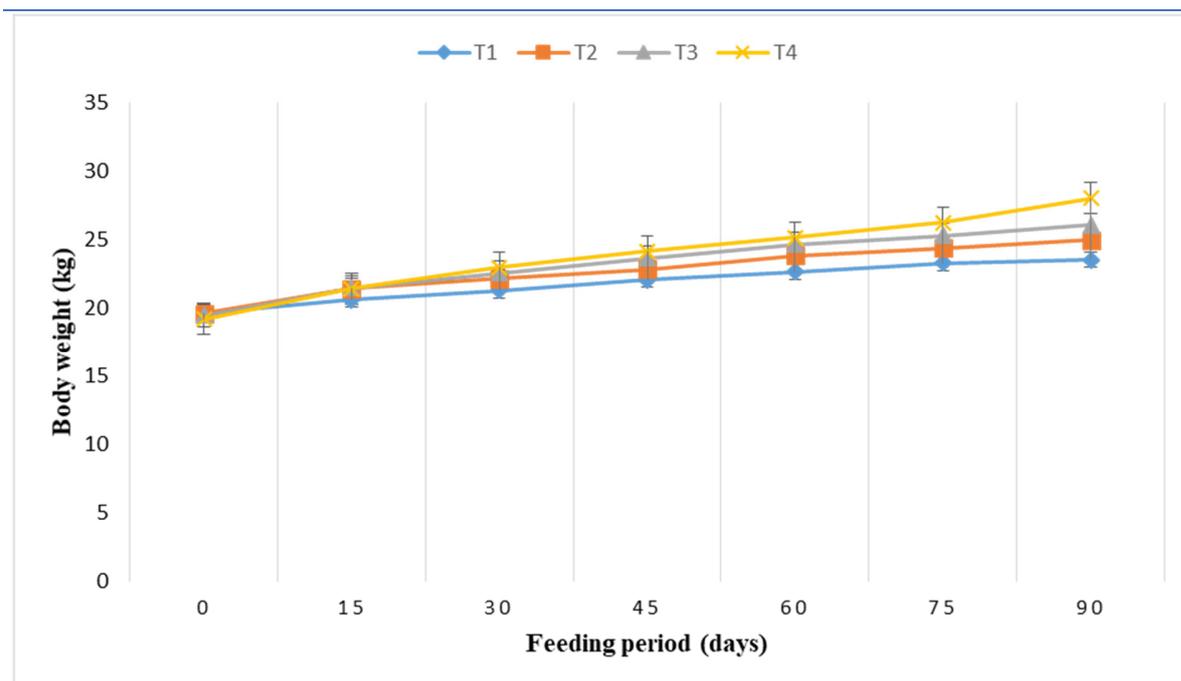
Digestibility (%)	Treatments				SEM	SL
	T1	T2	T3	T4		
DM	61.54 ^c	67.14 ^b	70.08 ^{ab}	74.68 ^a	1.6012	***
OM	64.0 ^c	69.91 ^b	72.26 ^{ab}	76.41 ^a	1.4826	***
CP	84.06 ^c	86.57 ^b	87.31 ^b	89.95 ^a	0.6244	***
NDF	58.76 ^b	60.60 ^b	63.95 ^{ab}	69.80 ^a	1.9432	**
ADF	45.44 ^b	53.54 ^a	55.95 ^a	60.22 ^a	2.6261	*

^{a,b,c,d}=Means within a row not bearing a common superscript differ significantly; *(P<0.05); **=(P<0.01); ***=(P<0.001); DM= dry matter; OM= organic matter; NDF=neutral detergent fiber; CP= crude protein; SEM=standard error of means; SL= significance level; T1=Elephant grass ensiled alone; T2= Elephant grass ensiled with 10% *Dolichos lablab*; T3=Elephant grass ensiled with 20% *Dolichos lablab*; T4=Elephant grass ensiled with 30% *Dolichos lablab*.

Table 4. Body weight change and feed conversion efficiency of Horro lambs fed Elephant grass ensiled with different proportion of *Dolichos lablab*

Parameters	Treatments				SEM	SL
	T1	T2	T3	T4		
Initial Body Weight (Kg)	19.6	19.6	19.5	19.2	0.215	NS
Final Body Weight (Kg)	23.52 ^b	24.96 ^b	26.08 ^{ab}	28.04 ^a	0.46	***
Body Weight Change (Kg)	3.92 ^d	5.36 ^c	6.58 ^b	8.84 ^a	0.422	***
Average Body Weight Gain (g/day)	43.55 ^d	59.55 ^c	73.11 ^b	98.22 ^a	4.693	***
FCE	0.06 ^c	0.07 ^{bc}	0.08 ^b	0.1 ^a	0.004	***

^{a,b,c,d}=Means within rows for different groups with different superscripts differ (P<0.05); *(P<0.05); **=(P<0.01); ***=(P<0.001); SEM=standard error of means; SL= significance level; FCE= feed conversion efficiency; T1=Elephant grass ensiled alone; T2= Elephant grass ensiled with 10% *Dolichos lablab*; T3=Elephant grass ensiled with 20% *Dolichos lablab*; T4=Elephant grass ensiled with 30% *Dolichos lablab*.



T1=Elephant grass ensiled alone; T2= Elephant grass ensiled with 10% *Dolichos lablab*; T3=Elephant grass ensiled with 20% *Dolichos lablab*; T4=Elephant grass ensiled with 30% *Dolichos lablab*.

Figure 1: Trends in live weight of Horro lambs fed Elephant grass ensiled with different proportion of *Dolichos lablab*

Table 5. Correlation among feed intake, digestibility and body weight gain of Horro sheep

	DMI	CPI	DDM	DCP	ADG
DMI	1	0.945***	0.7193***	0.6965***	0.7596***
CPI		1	0.7898***	0.8008***	0.8795***
DDM			1	0.9849***	0.7466***
DCP				1	0.7669***
ADG					1

*= (P < 0.05); **=(P< 0.01); ***=(P< 0.001); DMI= dry matter intake; CPI= crude protein intake; DDM= digestible dry matter; DCP= digestible crude protein; ADG= average daily gain.