academicresearchJournals

Vol. 7(7), pp. 437-445, November 2019
DOI: 10.14662/ARJASR2019.127

ISSN: 2360-7874
http://www.academicresearchjournals.org/ARJASR/Index.htm

Academic Research Journal of Agricultural Science and Research

Full Length Research

Dry Matter Yield and Nutritional Value of Desho and Setaria Grasses Mixed With Greenleaf Desmodium at Different Harvesting Times

[1]Minichle Yegrem Gedamu, [2]Berhanu Alemu and [3]Asnakew Awuke

[2]Salale University Department of Animal Sciences, Fiche, Ethiopia
[1,3] Debre markos University Department of Animal Sciences, P.O. Box 269, Debre markos, Ethiopia

Accepted 7 October 2019

The experiment was conducted to evaluate Dry matter yield and nutritional value of Desho and Setaria grasses mix with Greenleaf Desmodium at different harvesting times. The experiment was conducted using 5 x 3 factorial arrangements with five forage planting materials and three harvesting times. The experiment was arranged in a randomized complete block design (RCBD) with three replications. The factors for forage stands were three pure stands (Desho, Setaria and Greenleaf Desmodium) and two forage mixtures (Desho and Setaria grasses mixed with Greenleaf Desmodium). The three harvesting times were (90, 120 and 150 days after planting). The crude protein (CP) content significantly (P<0.01) improved for grass-legume mixture compared to sole grasses. Accordingly, the highest crude protein yield (CPY)(1.43 t/ha) was recorded for Desho mixed with Greenleaf Desmodium at the third harvesting time (DsDeHT3). The highest dry matter yield (9.44 t/ha) was recorded from Desho mixed with Greenleaf Desmodium at the third harvesting time (DsDeHT3) while the least (1.53 t/ha) was recorded for Greenleaf Desmodium at the first harvesting time (DeHT1). Therefore, the results obtained in the current study revealed that Desho mixed with Greenleaf Desmodium could recommend being the best in improving yield and nutritive value at third harvesting times.

Keywords: Grass-legume mixture; harvesting times; Nutritional quality

Cite this article as: Minichle YG, Berhanu A., Asnakew A (2019). Dry Matter Yield and Nutritional Value of Desho and Setaria Grasses Mixed With Greenleaf Desmodium at Different Harvesting Times. Acad. Res. J. Agri. Sci. Res. 7(7): 437-445

INTRODUCTION

Ethiopia has large livestock population in Africa possessing 60.39 million Cattle, 31.30 million sheep, 32.74 million goats, 2.01 million horses, 8.85 million donkeys, 0.46 million mules, camels 1.42 million and 56.06 million poultry population (CSA, 2018). The livestock sector contributed about 16-25% of the total Gross Domestic Product (GDP) of the country and 40-44% of the Agricultural Gross Domestic Product (Stapleton, 2016).

Despite the large number of livestock resources, the productivity is extremely low due to shortage of feeds, particularly during the dry season (Hassen *et al.,* 2010). The availability of feed resources and the nutritional quality of the available feeds are the most important factors that determine the productivity of livestock (Alemayehu, 2005). According to CSA (2017), the information collected on feed usage experience in the country, Grazing (54.59%), followed by crops residue (31.60%), hay (6.81%) and by-products (1.53%) were used as animal feeds. Moreover, a very small amount of improved forage (0.31%) was used as animal feed and other types of feed that accounted for about 5.11% were also used in the country. Grazing as a source of livestock feed declined in recent years, due to increased utilization of land for crop cultivation. Moreover, feed supply from natural pasture fluctuates following seasonal dynamics of rainfall (Solomon *et al*., 2008; Yaynshet, 2010).

The major feed resources are characterized by poor quality and improved forages can be limited in quantity in East Gojjam zone (Addisu *et al.,* 2016). According to the reports of Firew and Getnet (2010), animal feed resources in Gozamen district mainly based on natural pasture grazing and crop residues, which are low in quality, resulting in poor animal performance. It is presumed that the production of the required amount of superior quality forage is the prerequisite for a more efficient and productive livestock industry (Adeel *et al.,* 2014). Forage management tools such as timely harvesting and using grass-legume mixture can achieve optimization of productivity and nutritive value of forages (Bayble *et al.,* 2007). The early harvesting time give high nutritive value and low dry matter yield (DMY), so the appropriate harvest time is the best way to determine good forage quality (Terefe, 2017).

Therefore, one of the alternatives to improve livestock feeding, and thereby their productivity could be the cultivation of grass-legume mixtures and offer them to animals during critical periods in their production cycle and at times when other sources of feeds are in short supply (Befekadu and Berhanu, 2000).

Grass-legume mixtures are preferred due to their several advantages over monoculture that mixing grass with forage legumes can improve both quality and quantity of fodder over a pure grass (Ibrahim *et al.,* 2012). Legumes have ability to fix atmospheric nitrogen into the soil through their symbiotic relationship with bacteria of *Rhizobium* species, which could help in sustaining soil fertility and improving forage quality (Albayrak *et al.,* 2005). Their production potential and utilization under arid conditions are providing low cost fodder to animals particularly during the dry season. Its ease agronomic practices to produce these forage species make them to be a priority choice for the resource poor farmers (Getu *et al.,* 2012).

The use of grasses-legume mixture, Desho (*Pennisetum pedicellatum*) and Setaria (*Setaria sphacelata*) mixed with Greenleaf desmodium *(Desmodium intortum)* for this study is based on their high potential to fill the gap of feed shortage and low quality. They are the most promising due to their high biomass yield, palatability, and high nutritive value. For this reason, the evaluation of the potential yield and nutritive value of grass-legume mixture at Gozamin district is the paramount importance. However, there is limited information on the agronomic performances, biomass yield, and nutritive value of Desho and Setaria grasses when grown alone or in mixture with Greenleaf Desmodium. Therefore, this study was designed with the objective of Dry matter yield and nutritive value of grass-legume mixtures and pure stands at different harvesting times.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted at Debre Markos University, located in Debre Markos town, Gozamin District, East Gojjam Zone of Amhara National Regional State. The town is located 300 km northwest of the capital Addis Ababa and 265 km Southeast of Bahir Dar, the capital of Amhara National Regional State. It is situated at an altitude of 2400 meters above sea level. According to WAMSBD (2017) report, the highest monthly rainfalls of the area recorded were 259.08 mm in May and 243.84 mm in July, but no rainfall was recorded in December and January. The town has 1182.78 mm annual rainfall and minimum and maximum temperatures of 11.1°C and 22.9°C, respectively (WAMSBD, 2017).

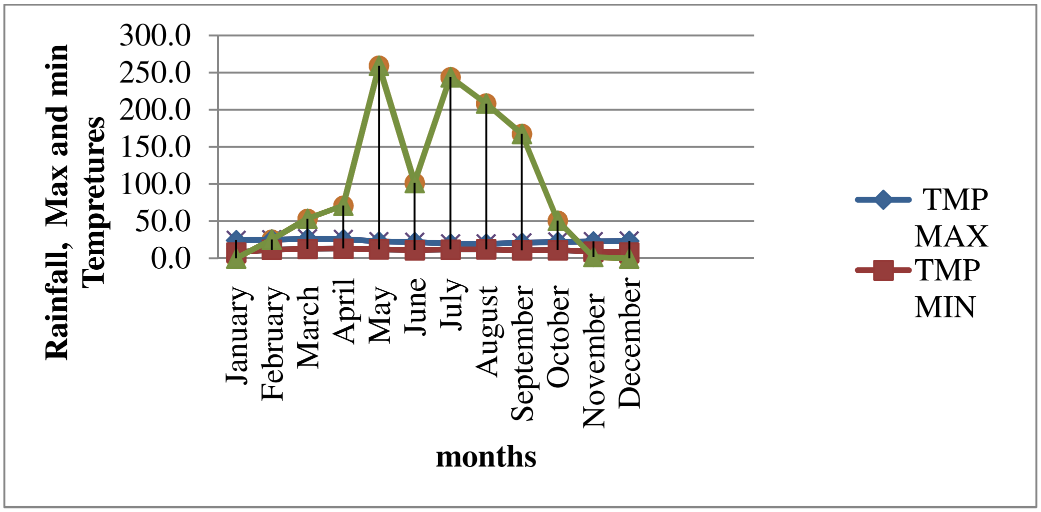

Figure 1: Rainfall, maximum and minimum temperature of Gozamin district
Source: Western Amhara Meteorological Services Bahir Dar, Ethiopia (2017)

Land Preparation, Planting and Experimental Materials

Planting materials, the grass species (Setaria and Desho) and Legume (Greenleaf Desmodium) were collected from Debre Markos University grass nursery site and Finote Selam, respectively. Land ploughing and bed preparation were made in July 2017. After preparing a fine bed, planting, was done in August 2017, the planting materials for the two grass species were root splits whereas; the planting material for legume specie was root cutting.

Experimental Layout, Design and Treatments

The study was conducted using 5 × 3 factorial arrangements in randomized complete block design (RCBD). Planting materials (Desho, Setaria, Greenleaf Desmodium, Desho and Setaria mixed with Greenleaf Desmodium) and three harvesting times (90, 120 and 150 days) were considered as factors. The spaces between row and plant for Desho and Setaria grasses were 75 cm by 50 cm, respectively and Greenleaf Desmodium was planted at the side of grass in the same row.

The experiment consisted of three replications with 15 treatment combinations. The spaces between replications and plots were 1.5 m and 0.5 m, respectively. Each experimental unit had 3 *3 m with a total area of 9 m^2. The total area of the experimental site was 624 m^2 (12 m x 52 m). Each plot had five rows on which plantings were planted uniformly. The treatment combinations are indicated in Table 1.

Table 1. Treatment combinations.

Harvesting times	Grass, legume and their mixtures				
	Desmodium Intortum	Desho	Setaria	Desho+ *D. Intortum*	Setaria+ *D. Intortum*
Harvesting time 1	DeHT1(T1)	DsHT1(T4)	StHT1(T7)	DsDeHT1(T10)	StDeHT1 (T13)
Harvesting time 2	DeHT2(T2)	DsHT2(T5)	StHT2(T8)	DsDeHT2(T11)	StDeHT2 (T14)
Harvesting time3	DeHT3(T3)	DsHT3(T6)	StHT3(T9)	DsDeHT3(T12)	StDeHT3 (T15)

DeH1(T1)=Desmodium intortum with harvesting time1; DeHT1(T2)=Desmodium intortum with harvesting time2;DeHT2(T2)=Desmodium intortum with harvesting time3; DeHT3(T3)=Desmodium intortum with harvesting time3; DsHT 1(T4)= Desho with harvesting time1; DsHT2 (T5)= Desho with harvesting time2; DsHT3 (T6)= Desho with harvesting time3; St HT1(T7)= Setaria with harvesting time1; StHT2(T8)=Setaria with harvesting time2; StHT3(T9) = Setaria with harvesting time3; DsDeHT1(T10)=Desho+Desmodium intortum with harvesting time1; DsDeHT2(T11)=Desho + Desmodium intortum with har vesting time 2; DsDeHT3(T12)=Desho+ Desmodium intortum with harvesting time3; StDeHT1(T13)= Setaria+ Desmodium Intortum with harvesting time1; StDeHT2(T14) = Setaria + Desmodium Intortum with harvesting time2;StDeHT3(T15) = Setaria + Desmodium Intortum with harvesting time3.

Chemical Analysis

The chemical analysis was done at Debre Berhan Agricultural Research Center Animal Nutrition laboratory. The DM, N and ash contents were determined using the procedure described by AOAC (1990). Analysis of neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined following the procedure of Van Soest *et al.* (1991).

Statistical Analysis

Data analysis was subjected to analysis of variance using the General Linear Model procedure of the statistical analysis system (SAS, 2002). Differences among treatment means were separated using Duncan's Multiple Range Test (DMRT), when treatment effects are significant (P< 0.05). The statistical model used for this design was:

$Y_{ijk} = \mu + ri + S_j + H_{k} + SH_{jk} + e_{ijk}$ Where,

Y_{ijk} =the response variable
μ = overall mean
ri = i^{th} replication effect
$S_{j=j}^{th}$ factor effect (forage species)
$H_{k=K}^{th}$ factor effect (Harvesting times)
$SH_{jk} = {}_{jk}^{th}$ interaction effect (Forage species X Harvesting times)
e_{ijk} = random error

RESULTS AND DISCUSSIONS

Dry Matter yield

There were significant differences (P<0.01) in Dry matter yield (DMY) due to harvesting times, forage stands and their interactions (Table 2). The highest (9.44 t/ha) DMY was recorded from DsDeHT3 followed by StDeHT3 (8.26 t/ha), while the least dry matter yield was obtained from StHT1 (1.76 t/ha) and DeHT1 (1.53 t/ha).

Table 2. Dry matter yield as influenced by forage stands, harvesting time and their interactions

Experimental Plants	Harvesting stages			Mean
	HT1	HT2	HT3	
Ds	2.18^{fg}	3.22^{ef}	5.13^{cd}	3.51^{c}
St	1.76^{g}	2.45^{fg}	3.98^{de}	2.73^{d}
DsDe	3.47^{ef}	5.84^{c}	9.44^{a}	6.25^{a}
StDe	3.30^{ef}	4.90^{cd}	8.26^{b}	5.49^{b}
De	1.53^{g}	2.73^{efg}	3.58^{ef}	2.62^{d}
Mean	2.45^{c}	3.82^{b}	6.08^{a}	4.12
SEM=0.58				
CV=14.13				
P-value				
FS = <.0001				
HT = <.0001				
FS X HT= <.0001				

abcdefg, means with similar superscripts in columns or rows are not significantly different at (P>0.05); De=*Desmodium intortum*; CV=coefficient of variation; SEM =standard error of mean; Ds = Desho; St = Setaria; StDe = Setaria mixed with desmodium; DsDe=Desho mixed with desmodium; FS = forage stands (Setaria, Desho, Desmodium, Setaria and, Desho mixed with Desmodium); HT1 – HT3 = Harvesting times 1 – 3; HTs x FS = interactions

With regard to harvesting time, the highest DMY (6.08 t/ha) was recorded at the third harvesting time (150 days, while the least (2.45 t/ha) value was recorded from the first harvesting time, confirming the potential effect of harvesting time on DMY. This indicated that DMY increased with increasing harvesting time. This might be due to the development of additional tiller, leaf formation, leaf elongation, stem development and vegetative growth of the plant. Moreover, increment of forage yield was found to be directly proportional to increasing plant height and numbers of tillers/plant (Aysen and Ferda, 2012; Shah *et al*., 2015). Desho and Setaria mixed with Greenleaf Desmodium resulted in significantly higher (P<0.01) DMY than their pure stands. DsDe was showed the highest DMY (6.25 t/ha) as compared with other species and combinations. This might be due to more number of tillers and density of the leaves in Desho grass. The current finding is in agreement with Albayrak and Ekiz (2005), who concluded that the DMY of mixtures were superior to the sole grass or sole legume stands. The high DMY in mixtures might be due to the utilization of symbiotically fixed nitrogen and more enhanced interception of light.

Chemical Composition

Crude protein content

CP content showed significant difference (P<0.01) due to the effects of harvesting times, forage species and their interaction (Table 3). The highest (16.42%) CP content was recorded at the first harvesting time (90 days), while least (13.56%) CP content was recorded at the third harvesting time (150 days). This showed that CP content decline as the age of the plant increased. This may be due to the fact that CP content of plants generally declines with advanced maturity. As plant becomes matured, there could be progressive increase in cell wall contents of the grasses and legume with a concomitant reduction in CP contents. The present result is inconformity with Seyoum *et al*. (1998) and Tessema *et al.* (2002) who reported the decline in CP content attributed to dilution of the CP contents of the forage crops by the rapid accumulation of cell wall carbohydrates at the latter stages of growth.

Among the forage species, De showed the maximum CP (18.40%) content as compared to Ds (12.31%), St (11.34%), DsDe (16.32%) and StDe (16.34%). DsDe and StDe had significantly (P<0.01) higher CP content than Ds and St, respectively. The findings of this study correspond to the results of Eskandari *et al*. (2009), who reported that grasses grown intercropped with legumes had higher CP content than grasses harvested from the monocultures. This suggests that legumes grown with grass increase the N uptake of the companion plants by partitioning the atmospheric fixed N to the non-nitrogen fixing plants grown in mixture with them. With regard to interaction effect, the highest CP (20.38) content was recorded for DeHT1 followed by DeHT2 (18.09), while St was recorded the least CP content at all harvesting time.

Table 3. Crude protein content as influenced by species, harvesting time and their interaction

Experimental Plants	Harvesting Times			Mean
	HT1	HT2	HT3	
Ds	14.21^{e}	11.47^{f}	11.25^{f}	12.31^{c}
DsDe	17.26^{bc}	16.56^{c}	15.16^{d}	16.32^{b}
St	13.45^{e}	11.26^{f}	9.31^{g}	11.34^{d}
StDe	16.87^{c}	16.81^{c}	15.35^{d}	16.34^{b}
De	20.38^{a}	18.09^{b}	16.75^{c}	18.40^{a}
Mean	16.42^{a}	14.85^{b}	13.56^{c}	14.94
SEM = 0.57				
CV = 3.80				
P-value				
SPP =<0.0001				
HT =<0.0001				
SPP X HT=0.0010				

^{abcdefg}, means with similar superscripts in columns or rows are not significantly different at (P > 0.05); CV=coefficient of variation's=standard error; De= *Desmodium intortum*; Ds = Desho; St= Setaria; StDe = Setaria mixed with desmodium; DsDe=Desho mixed with desmodium; SPP= forage species (Setaria, Desho and Desmodium); HT1 – HT3 = Harvesting times 1–3; HTs x SPP = interaction of harvesting time with forage species (Setaria, Desho and Desmodium)

Crude protein yield

The CPY was significant difference (p<0.01) due to the effect of harvesting time, forage species and their interaction (Table 4). In this regard, the highest (1.43 t/ha) CPY was recorded from DsDeHT3 followed by StDeHT3 (1.27 t/ha), while St was recorded the least CPY at all harvesting times. In case of harvesting time, the highest (0.85 t/ha) crude protein yield (CPY) was obtained at 150 days of harvesting time, while the least value was obtained at 120 days (0.59 t/ha) and 90 days (0.40 t/ha). Hence, in the current study, the lowest CPY was recorded at first harvesting times as lower DM concentration and higher water content in the plant tissues resulted in lower DMY. This may be due to the reason that, CPY is the product of total dry matter yield and CP concentration in the plant. The current result is agreed with Bayble *et al.* (2007) who reported that CPY increased with harvesting time increased in case of Napier grass.

The effect of grass-legume mixture was also significantly affected CPY. The highest (1.00 t/ha) CPY was recorded from DsDe, while the least (0.29 t/ha) was recorded from St this showed that integration production of Desho grass with desmodium provided the highest CPY. This may be due to the reason that, highest DMY yield was observed from DsDe, which contributed for the highest CPY as well.

Table 4. Crude protein yield as influenced by species, harvesting time and their interaction

Experimental Plants	Harvesting times HT1	HT2	HT3	Mean
Ds	0.31^{f}	0.37^{ef}	0.58^{d}	0.42^{c}
DsDe	0.60^{d}	0.97^{c}	1.43^{a}	1.00^{a}
St	0.24^{f}	0.28^{f}	0.37^{ef}	0.29^{d}
StDe	0.56^{d}	0.82^{c}	1.27^{b}	0.88^{b}
De	0.31^{f}	0.49^{de}	0.60^{d}	0.47^{c}
Mean	0.40^{c}	0.59^{b}	0.85^{a}	0.61
SEM =0.087				
CV = 14.12				
P-value				
SPP = <0.0001				
HT = <0.0001				
SPP X HT= <0.0001				

^{abcdef} means with similar superscripts in columns or rows are not significantly different at (P>0.05); CV=coefficient of variation; SEM=standard error of mean; De= *Desmodium intortum*; Ds = Desho; St= Setaria; StDe = Setaria mixed with desmodium; DsDe=Desho mixed with desmodium; SPP= forage species (Setaria, Desho and Desmodium); HT1 – HT3 = Harvesting times 1 – 3; HTs x SPP = interaction of harvesting time with forage species (Setaria, Desho and Desmodium)

Neutral detergent fiber

The effect of harvesting time and forage species had significant effect (P<0.01) on NDF content, but no significant effect (P>0.05) by the interaction (Table 5). With regard to forage stands, the highest value of NDF content was recorded from St (52.70%) while the least was recorded from De (46.10%).

The highest value (52.68%) was recorded at 150 days of harvesting while the least (44.66%) was recorded at 90 days of harvesting. The present result of NDF significantly increased (P<0.01) with the advanced age of the plant at all forage species. This study is in line with the finding of Kidane (1993) and Ashagrie (2008) who reported increasing trend in NDF content with advanced age of plants. This might be due to an increase in fiber content, lignified structural tissue at later stage of growth.

Acid detergent fiber

The effect of harvesting times had significant effect (P<0.01) on the ADF content, while plant species and its interaction with harvesting times had no significant effect (P>0.05) (Table 5). The highest ADF (41.88%) was recorded at 150 days of harvesting while the least (33.75%) was at 90 days of harvesting. In other words, there is a linear increase in ADF content with a corresponding increase in days of harvesting (P<0.01). The harvest age is a decisive factor in the concentration of fibrous material. This might be due to an increase in ADF concentration with a decrease in a leaf to stem ratio and an increase in cell wall lignifications with advanced stages of growth (Gebrehiwot *et al.,* 1996).

Acid detergent lignin

The ADL content was significant difference (P<0.01) due to harvesting time, but no significant difference (P>0.05) by forage species and interaction effect (Table 5).

The highest ADL (10.03%) content was observed in the third harvesting time compared to the first harvesting times (7.70%) and second harvesting times (8.73%), this indicating the occurrence of rapid lignifications as the development of forages species advanced. The result of this study was in agreement with the finding of Bayble *et al.* (2007) and Bimrew (2016) who reported increasing lignin content with the concomitant increase in the time of harvesting. This might be due to the fact that as plants become matured there is a greater development of structural carbohydrates. However, there was no significant difference (P>0.05) in the pure stand of legume, grasses and their mixtures.

Table 5. Neutral detergent fiber, Acid detergent fiber and Acid detergent lignin contents as influenced by forage stands and harvesting times

	Forage stands	NDF	ADF	ADL
	Ds	48.66^{b}	37.86	9.07
	DsDe	48.80^{b}	37.85	8.82
	St	52.70^{a}	38.86	8.24
	StDe	48.10^{bc}	37.50	9.26
	De	46.10^{c}	36.11	8.73
	P-value	0.0046	Ns	ns
Harvesting times				
	90 days	44.66^{c}	33.75^{c}	7.70^{c}
	120 days	49.04^{b}	37.28^{b}	8.73^{b}
	150 days	52.68^{a}	41.88^{a}	10.03^{a}
	SEM	2.52	2.64	1.09
	CV	5.17	7.01	12.38
	p-value	<0.0001	<0.0001	<0.0001

^{abc} means with different superscripts in columns are significantly different at (P < 0.05); CV=coefficient of variation's; SEM=standard error of mean; ns=not significant; De= *Desmodium intortum*; Ds = Desho; St= Setaria; StDe = Setaria mixed with desmodium; DsDe=Desho mixed with desmodium; NDF=Neutral Detergent Fiber; ADF =Acid Detergent Fiber; ADL=Acid Detergent Lignin ;FS= forage stands (Setaria, Desho and Greenleaf Desmodium, Setaria and Desho mix with Greenleaf Desmodium); HT1 – HT3 = Harvesting times 1 – Harvesting times 3.

Total ash contents

The effect of harvesting time and forage species had significant effect (P<0.01) on ash content, while no significant difference (P>0.05) due to their interaction (Table 6). The highest ash (13.80%) content was recorded at 90 days of harvesting while the least ash (11.27%) content was recorded at 150 days of harvesting. The ash content decreased as harvesting time increased. This result supported by the report of McDonald *et al*. (2002) indicated that mineral concentration declines with age increased and influenced by soil type, soil nutrient levels and seasonal conditions. This might be due to the earlier dilution and translocation of different minerals associated with vegetative portion of leaf at late stage of maturity. The sole Desho grass had the highest ash (13.92%) content than the others. On the other hand, sole Desmodium provided lower (10.96%) ash content than the rest of the experimental plants. It can be concluded from these results that species varied in efficiency to absorb nutrients, which may be due to variable rooting depth and rooting pattern. The present result is consistent with the finding of Fantahun (2016) who recorded lower ash content in pure stand of vetch than oat-vetch mixtures.

CONCLUSIONS

The highest DMY was recorded at 150 days of harvesting from Desho mixed with Greenleaf Desmodium. The CP contents of pure stands of Greenleaf Desmodium, Desho, Setaria, Desho with Greenleaf Desmodium and Setaria with Greenleaf Desmodium significantly decreased when harvesting time increased. On the other hand, neutral detergent fiber, acid detergent fiber and acid detergent lignin increased during later harvesting times. The ADF and ADL contents showed significant difference (P<0.01) due to harvesting times, but non-significant difference (P> 0.05) was observed among forage species. The DM content was higher at harvesting time three as compared to early harvesting times. Total ash content was significantly (P<0.01) affected by grass-legume mixture and harvesting time. The NDF content observed with grass-legume mixtures and harvesting times had significant difference (P<0.01), while their interaction showed absence of significant difference (P>0.05).Thus, mixture of grasses and legume may improve the nutritional values of grasses. Moreover, improvement in biomass yield and CP content due to mixing of grasses (Desho and Setaria) with legume (Greenleaf Desmodium) have been noticed in the current study. Therefore, Desho mixed with Greenleaf desmodium with the third harvesting time would be recommended based on forage quantity and quality.

Scope for future study

- Desho mixed with Desmodium mixture should be done at the beginning of the rainy season with different plant spacing due to its good biomass yields and quality.

REFERENCES

Addisu Endalew, Firew Tegegne and Getnet Assefa, 2016. Constraints and Opportunities on Production and Utilization of Improved Forages in East Gojjam Zone, Amhara Region, Ethiopia: *Journal of Biology, Agriculture and Healthcare.* 6(9): 136-152.

Adeel, K., Anjum M., Khashi Q., Zaman U. and Ullah R., 2014. Comparative Study on Quantitative and Qualitative Characters of Different Oat (*Avena sativa* L.) Genotypes under Agro-climatic condition of Sargodha, Pakistan. *American, J. Plant Sci.* 5: 3097-3103.

Albayrak, S. and Ekiz H, 2005. An investigation on the establishment of artificial pasture under Ankara's ecological conditions. *Turkish J of Agriculture and Forestry.* 29: 69-74.

Albayrak, S., Guler M. and Tongel M., 2004. Effects of seed rates on forage production and hay quality of vetch-triticale mixtures. *Asian Journal of Plant Science.* 3(6): 752-756.

Alemayehu Mengistu, 2005. Feed resources base of Ethiopia: Status and opportunities for integrated development. 377–386P. In Proceedings of the 12th Annual Conference of the Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia, August 12–14.

analysis.15thed. AOAC Inc., Arlington, Virginia, USA. 1298p.

AOAC (Association of Official Analytical Chemistry), 1990. Official method of

Ashagre Abate, 2008. Effect of Nitrogen Fertilizer and harvesting stage on yield and quality of natural pasture in Fogera district, northwestern Ethiopia. An MSc. thesis submitted to the

Aysen, U. and Ferda A., 2012. The effect of mixture rates and cutting stages on some yield and quality characters of pea (*Pisum sativum L.*) + oat (*Avena sativa L.)* mixture Turkish *Journal of Field Crops.* 17(1): 62-66.

Bayble, T., Melaku S. and Prasad N K., 2007. Effects of cutting dates on nutritive value of Napier *(Pennisetum purpureum)* grass planted sole and in association with Desmodium *(Desmodium intortum)* or Lablab (*Lablab purpureus*). *Livestock Research for Rural Development. Volume 19, Article #11.* Retrieved April 30, 2018, from http://www.lrrd.org/lrrd19/1/bayb19011.htm.

Befekadu Degefe and Berhanu Nega, 2000. The Ethiopian Economic Association. Annual Report on the Ethiopian Economy, Volume I. Addis Ababa, Ethiopia.

Bimrew Asmare, 2016. Evaluation of the Agronomic, Utilization, Nutritive and Feeding Value of Desho Grass (*Pennisetum pedicellatum*). PhD. Dissertation. Jimma University, Jimma, Ethiopia. 127p.

CSA (Central Statistical Agency), 2017. Agricultural Sample Survey. Report on livestock and livestock characteristics (Private peasant holdings), volume II, Statistical Bulletin, 585.Addis Ababa, Ethiopia.194p.

CSA (Central Statistical Agency), 2018. Agricultural Sample Survey. Report on livestock and livestock characteristics (Private peasant holdings), volume II, Statistical Bulletin, 587.Addis Ababa, Ethiopia.100p.

Eskandari, H., Ghanbari A. and Javanmard A., 2009. Intercropping of Cereals and Legumes for Forage Production. Notulae Scientia Biologicae. 1(1): 07-13.

Fantahun Dereje, 2016. The effect of variety and seed proportions on yield, nutritional quality and compatibility of oats and vetch mixtures. An MSc Thesis Submitted to the School of Animal and Range Sciences, Haramaya University, Haramaya, Ethiopia. 65p.

Firew Tegegne and Getnet Assefa, 2010. Feed resource assessments in Amhara National Regional State. Ethiopian Sanitary and phyto-sanitary standards and livestock and meat marketing program (SPS-LMM) Texas A and M University system Addis Ababa, Ethiopia. 106p.

Gebrehiwot, L., McGrow R. L. and Assefu G., 1996. Forage yield and quality profile of three annual legumes in the tropical highlands of Ethiopia. *Journal of Agriculture.* 73: 83-98.

Getu K., Mesfin D., Aemiro K. and Getnet A., 2012. Comparative evaluation of tree lucerne (Chamaecytisuspalmensis) over conventional protein supplements in supporting growth of yearling horro lambs. *Livestock Research for Rural Development. Volume 24, Article 8.*Retrieved January 11 2017, from http://www.lrrd.org/lrrd24/1/getu24008.htm

Hassen, A., Ebro A., Kurtu M. and Treydte A. C., 2010. Livestock feed resources utilization and management as influenced by altitude in the Central Highlands of Ethiopia. *Livestock Research for Rural Development. Volume 22, Article #229.*Retrieved December 23, 2017, fromhttp://www.lrrd.org/lrrd22/12/hass22229.htm.

Ibrahim, M., Ayub M., Tanveer A. and Yaseen M., 2012.

Forage quality of maize and legumes as monocultures and Mixtures at different seed ratios. *The Journal of Animal & Plant Sciences.* 22(4): 987-992.

Kidane Getnet, 1993. Effects of cutting date on botanical composition and nutritive value of native pasture in the central highlands. An MSc Thesis presented to the School of Graduate Studies of Haramaya University. 104p

McDonald, P., Edward R A., Greenhalgh J F D. and Morgan G A., 2002. Animal Nutrition (6th ed.), Pearson Educational Limited, Edinburgh, Great Britain. 544p

SAS (Statistical Analysis System). (2002). SAS Institute Inc., Version 9.1, Cary, NC, USA

School of Graduate studies Haramaya University.94p.

Seyoum Bediye, Zinash Sileshi, Tadesse T/Tsadik and Liyusew Abebe, 1998. Evaluation of Napier (*Pennisetum purpureum*) and *Pennisetum* hybrids (*Pennisetum purpureum* x *Pennisetum typhoides*) in the central high land of Ethiopia.194 –202p. In Proceeding of the fifth conference of Ethiopia Society of Animal Production (ESAP). 15-17 May 1997. Addis Ababa Ethiopia.

Shah, S., Akhtar L. H., Minhas R., Bukhari M. S., Ghani A., Anjum M. H., 2015. Evaluation of different oat *(Avena sativa L.)* varieties for forage yield and related characteristics. *Sci Lett.* 3(1): 13-16.

Solomon Bogale., Solomon Melaku and Alemu Yami, 2008. Matching livestock systems with available feed resources in the Bale Highlands of Ethiopia. *Outlook on Agriculture.* 37(2): 105-110.

Stapleton, J., 2016. Unlocking the potential of Ethiopia's livestock sector: growth, jobs and environmental sustainability.In"https://news.ilri.org/2016 /02/04/unlocking the potential- of-the-livestock-sector-Ethiopia/".

Terefe, T. 2017. Effect of Nitrogen Fertilizer and Harvesting Days on Yield and Quality of Rhodes Grass *(ChlorisGayana)* Under Irrigation at Gewane, North-Eastern, Ethiopia. MSc Thesis Haromaya University, Ethiopia. 80P.

Tessema Zewdu, Baars R.M.T. and Alemu Yami., 2002. Effect of plant height at cutting, source and level of fertilizer on yield and nutritional quality of Napier grass (*Pennisetum purpureum* (L.) Schumach). *African Journal of Range and forage Science*. 19: 123-128.

Van Soest, P.J., Roberston J. B. and Lews B.A., 1991. Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *J. Dairy Sci*. 74: 3583-3597.

WAMSBD (Western Amhara Meteorological Services Bahir Dar), Ethiopia, 2017.

Yaynshet Tesfay, 2010. Feed Resources Available in Tigray Region, North Ethiopia, For Production of Export Quality Meat and Livestock Addis Ababa Ethiopia. 9-16p.