International Journal of Scientific Engineering and Science
Volume 4, Issue 4, pp. 7-11, 2020. ISSN (Online): 2456-7361

Determination of Appropriate Cutting Time of Perennial Elite Lowland Adaptive Forage Grass Species of Degun Gizia/Panicum Maximum/For Optimum Yield and Quality of Hay in Metekel Zone of Benishangul Gumuz

Habtie Arega[1], Mezgebu Getnet[2], Esubalew Shitaneh[2], Bainesagn Worku[3]
[1, 2, 3]Ethiopian Institute of Agricultural Research, Pawe Research Center, P.O. Box 25 Pawe, Ethiopia

Abstract**—** *The presence of lignified forage is a major problem in lowland agro-ecology. The study was conducted at Pawe Agricultural Research Center, Pawe District, Metekel Zone, Benishangul Gumuz Regional State, Ethiopia for three consecutive years during 2016 to 2018 cropping seasons, to determine the appropriate cutting date of Degun gizia perennial forage species for optimum and quality yield of hay. Six different cutting stage Before heading but ready to heading(BH), 10%Heading, 25%Heading, 50%Heading, 75%Heading and 100%Heading of cutting were evaluated for their agronomic traits and its chemical composition in randomized complete block design with four replications. Data on plant height, leaf to stem ratio, fresh biomass yield, dry matter yield and chemical composition were analyzed using the general linear model procedures of SAS and least significance difference was used for mean comparisons. The combined analysis of variance indicated that the main effect differences among treatments, years and the interaction effects vary significantly for measured agronomic traits. The combined analysis for plant height significantly (P<0.05) different, which ranged from 140.3 to 182.1cm with a mean of 163.3cm. 75% heading cutting gave the highest mean plant height followed by 100%, 10%, 25%, and 50%heading while before heading gave the lowest over years. The highest mean dry matter yield was recorded in 75% heading (12.54t/ha) followed by 100% heading (11.94 t/ha) and 50% heading (11.55 t/ha).The combined analysis indicated that dry matter yield varied significantly (P<0.05) different between before heading and the other five treatments and the yield ranged from 6.95 to 12.54 t/ha with a mean of 10.6 t/ha. The combined analysis for CP were not significantly (P>0.05) different, which ranged from 9.3 to 10.72% with a mean of 10.2%. It is suggested that Degun gizia should be harvested at appropriate time in order to have high nutritive values with relatively high biomass production. Therefore, among tested treatments 10%heading of cutting will be promoted in the study area and similar environment.*

Keywords**—** *Degun gizia cutting date plant height dry matter yield leaf to stem ratio crud protein.*

I. Introduction

Ethiopian grasslands account for over 30% of the land cover and constitute to 66 percent of feed resources for livestock (CSA, 2011). Natural pasture, crop residue, improved pasture and agro industrial by products and other by-products like food and vegetable refusal are major livestock feed resources of which the first two contribute the largest feed type (Alemayehu, 2003). As in many parts of the country, livestock farmers, are highly dependent on grazing lands and crop residues. Native feed resources contribute over 75% of the total feed supplies in this area(BoARD, 2006) while the contribution of natural pastures to livestock feeding as conserved hay is limited to 2.8%(CSA, 2011). Alemayehu (2002) indicated that hay produced from natural grasses, improved forage legumes and browse legumes is the most appropriate conserved forage for small-scale fattening or dairy production in Ethiopia.

Seasonality in quality and quantity of forage supplied is one of the prior problems of livestock owners in tropical lowland climate. As quality and quantity of hay is highly dependent on growth stage of the grass, considerable attention should be given to harvesting time. At early stage of growth plants put most of their energy into vegetative growth and contain high concentrations of starches, proteins and minerals, the biomass yield is lower. On the other hand, as plants mature, their fiber component increases and traps the nutrients within indigestible cell walls. Thus compromising biomass yield and nutritive value is an important issue when we decide the appropriate cutting age of the grass for quality hay. The high temperature in tropical countries changes the nutritive values of the grass component rapidly during the late growth stages of the grassland (McDonald *et al*.,2002) and harvesting management is predominantly responsible for these changes (Cop *et al*., 2009).

In Metekel zone there is a problem of feed shortage during dry season, because the farmers are not done conserving forage in the form of hay making for dry season, rather than the grasses stay for a long period of time from the field it leads advancing maturity, as plants mature, it losses essential nutrient contents. various species of grasses, legumes and other browse plants are available in the area, there is considerable loss of livestock productivity in the dry season as the animals are restricted only on crop residues and the inadequate dry swards of grasses. Thus, grasses are cut at the right growth stage and dried for later use, the existing feed problems can significantly be reduced.

Volume 4, Issue 4, pp. 7-11, 2020.
ISSN (Online): 2456-7361

Time and frequency of harvesting, botanical composition, fertility of the soil and climatic conditions are the major factors that determine biomass yield and nutritive value of pastures (Adane and Berhan, 2005; Yihalem *et al*., 2005; Tessema *et al*., 2010). The most important adaptive lowland perennial grass species Degun gizia /panicum maximum/ are released in the last four years. These grass variety are dominant in the area and start to demonstrate for farmers for giving priority for this grasses.

A detailed knowledge of seasonal growth and nutritive value of the grass-lands is also necessary to utilize the available pasture efficiently. Still the problem are encountered on the issue of how can you conserve forage in the form of quality hay making by determining appropriate cutting date of the Degun gizia forage grass. Now governments will expect in GTP2 from the current 68 million tons produced to 184 million tons of forage will produced by using different mechanisms like improving natural pasture, producing improved pasture, crop residue and industrial by product

Our intention is that determining appropriate cutting date of the grass, the farmers enable to handle by forage conservation mechanism in the form of quality hay their own available forage on hand. To solve such kinds of problem this proposal were designed. Therefore, the objective of this study was to identify the appropriate cutting time of perennial elite lowland adaptive Degun gizia/*panicum maximum/*for optimum quality and yield of hay.

Objectives

- To determine the appropriate cutting date of Degun gizia perennial forage species for optimum and quality yield of hay

II. Materials and Methods

Descriptions of the Study Areas

The experiment was conducted for three consecutive years during 2016 to 2018 cropping season at Pawe Agricultural Research Center (On-station), Metekel Zone, Benishangul Gumuz Regional State, Ethiopia. It is located at a distance of 572 km North West of Addis Ababa. The area is with an elevation 1150 meters above sea level. Meteorological data of Pawe Agricultural Research Center indicate that the zone receives an annual rainfall ranging from 900 to 1450 mm with annual minimum and maximum temperature of 20 and 35°C, respectively.

Experimental Design and Treatments

Six treatments were used by using flowering phenology of Degun gizia, while the treatments were cut before heading but ready to heading (1), 10%heading (2), 25%heading (3), 50%heading (4), 75%heading (5) and 100%heading (6). The Degun gizia seed were sown at the seed rate of 10kg/ha in 3 m x 4 m prepared plot size using a randomized complete block design (RCBD) with four replications at the main rainy season of mid-June. To keep proper spacing and avoid nutrient competition, spacing used between rows were 30 cm. A blanket basal phosphorus fertilize was uniformly applied to all plots in the form of diammonium phosphate (DAP) at the rate of 100 kg/ha. All other necessary agronomic practices were done uniformly to all plots.

Data Collection and Measurement

Forage biomass yield

Plant height of the Degun gizia (PH): Ten plants height were randomly selected from each plot, measured using a steel tape from the ground level to the highest leaf, summed up and divided for ten selected plants to get the average value. For determination of biomass yield, each treatment was harvested from the total plot at 5cm above the ground level. Weight of the total fresh biomass yield (FBM) was recorded from one m^2 quadrant sample in each plot and converted to hectare. Afresh biomass representative sample weighing 300g was randomly taken.

Leaf to stem ratio (LSR): From each plot,300g fresh biomass weights were taken and splited in to leaf and stem.The fresh w eights of the separated leaf and stem were recorded on the fiel d using sensitive balance. After measuring leaf and stem fresh weight the sample were pooled and transferred to known weight paper bags and put in forced draft oven at 65°C to constant weight for 72 hours. The partial dried sample were measured in each plot and converted to hectare for calculating dry matter yield (DMY).

Forage chemical analysis

This was done at Holetta Agricultural Research Center Nutrition Laboratory. The dried sample were ground to pass 1mm Wiley mill sieve size and labeled for easy identification. Dry matter (DM), Ash, and Organic Matter (OM) according to the procedures of AOAC (1995). Neutral detergent fiber (NDF), Acid Detergent fiber (ADF) and Acid detergent lignin (ADL) were determined by the method of Van Soest and Robertson (1985). Invitro organic matter digestibility (IVOMD) of the sample was determined according to the procedure outlined by Tilley and Terry (1963). Hemicellulose and cellulose were calculated as NDF-ADF and ADF-(ADL+ADF ash), respectively. The N content of the samples was determined by the Micro Kjedhal method and CP was calculated as Nx6.25.

Statistical Analysis and Model

Mean DM yield components, agronomic parameters and chemical composition data for different treatments of Degun gizia were used for the statistical analysis. General Linear Model (GLM) procedure of SAS system computer software was employed for the analysis of variance (SAS;9.4.2019). Least significance difference (LSD) at 5% significance level was used for comparison of means. The data was analyzed using the following model: $Y_{ijk} = \mu + T_i + Y_j + (TY)_{ij} + B_k + e_{ijk}$; Where, Y_{ijk} = measured response of treatment i in block k of year j; μ = grand mean; T_i = effect of i^{th} treatment ; Y_j = effect of j^{th} year; TY= effect due to interaction between i^{th} treatment and j^{th} year; B_k (j) = effect of k^{th} block; e_{ijk} = random error effect of treatment i in block k of year j

III. Result and Discussion

Combined Mean squares ANOVA for treatments

The combined mean square values for treatments for three years for Ph, LSR, FBY DM, Ash, OM, CP, NDF, ADF, ADL and IVDMD are presented in Table 1: The effect of year is highly significant ($p<0.01$) differences among most traits except LSR and CP. The effect of replication is not significant ($p>0.05$) differences among all parameters except significant ($p<0.05$) differences on CP. The effect of treatment is highly significant ($p<0.01$) differences in Ph, DBY, DM and ADL, while significant($P<0.05$) difference in LSR, FBY and ADF. However, the effect of treatment was not significance($p>0.05$) difference among Ash, OM, CP, NDF and IVDMD. The effect of year*treatment is significant ($p<0.05$) differences on plant height, leaf to stem ratio, dry biomass yield, neutral detergent fiber and acid detergent lignin. But other parameters were not significance($P>0.05$) difference. According to Dixon and Nukenine (1997), the interaction is a result of changes in a treatments relative performance over years due to differential responses of the treatments to various edaphic, climatic and biotic factors. The mean value of LSR, DBY, CP and IVDMD were 2.1, 10.6(t/ha), 10.2% and 48.7% its respective order

The Performance of Treatment in Each Year

The performance of all treatments in each year are presented in Table 2. The performance of treatments in most traits in each consecutive year was different. Except leaf to stem ratio the rest three parameters were recorded higher value in third year of experiment, whereas lower treatment performance were recorded on the first and second year of experiment. This variation may be environmental factors that affect the performance of treatments like edaphic, climatic and biotic factors were not constant in each year.

TABLE 1: Combined mean squares for agronomic traits and chemical composition of different treatments evaluated over three consecutive years from 2016 to 2018.

Source of variation	DF	Ph	LSR	FBY	DBY	DM	Ash	OM	CP	NDF	ADF	ADL	IVDMD
Year	2	18995.3**	0.82	2157.1**	155.8**	1.40**	21.81**	21.81**	3.63	8.78**	195.49**	13.03**	326.01*
Replication	3	107.2	0.64	158.6	6.2	0.09	1.18	1.18	9.67*	1.54	1.05	0.08	63.87
Treatment	5	3089.9**	2.37*	213*	47.6**	0.46**	0.5	0.5	3.22	2.5	11.57*	0.53**	60.71
yr*trt	10	630.4**	1.94**	135.9	18.2*	0.16	0.54	0.54	2.97	2.89*	9.02	0.44**	60.58
Error	51	119.9	0.31	80.3	7.26	0.08	0.51	0.51	2.48	1.28	3.46	0.05	73
GM		163.3	2.1	41.3	10.6	90.6	13.1	86.8	10.2	71.3	43.08	6.8	48.7
CV%		6.7	26.4	21.7	25.2	0.32	5.4	0.8	15.3	1.5	4.3	3.5	17.5
LSD(0.05)		8.9	0.46	7.34	2.2	0.24	0.58	0.58	1.29	0.93	1.52	0.19	7
R2		0.90	0.68	0.64	0.67	0.61	0.68	0.68	0.39	0.49	0.75	0.92	0.32

*=significant at 5% **=highly significant at 5% Ph=plant height LSR= leaf stem ratio FBY=fresh biomass yield DMY=dry matter yield DM=dry matter OM=organic matter CP=crud protein NDF=neutral detergent fiber ADF=acid detergent fiber ADL= acid detergent lignin and IVDMD=invitro dry matter digestibility

TABLE 2. The performance of treatment in each year

Treatments	**PH**			**LSR**			**FBM**			**DBM**		
	2016	**2017**	**2018**	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**
Before Heading	134.5	116.6^{c}	169.9^{d}	3.8^{a}	2.5^{ab}	1.8	32.3	28.8	39.8^{c}	4.6^{b}	6.6	9.7^{c}
10%Heading	163	141.8^{b}	199.7^{b}	2^{b}	2.2^{b}	2.1	46.5	34.3	47.8^{bc}	11.3^{a}	8.2	11.5^{bc}
25%Heading	149.9	135.6^{b}	185.3^{c}	2^{b}	3.3^{a}	2	44	30	49.3^{bc}	10.6^{a}	8.2	13.5^{bc}
50%Heading	138.7	144.1^{b}	178.5^{cd}	3^{a}	1.6^{b}	2.3	40.5	35.3	48.8^{bc}	12.9^{a}	9.9	11.9^{bc}
75%Heading	155	176.1^{a}	215.4^{a}	1.7^{b}	2.1^{b}	1.6	45.8	38	55.3^{ab}	11.7^{a}	10.4	15.6^{ab}
100%Heading	141.4	169.4^{a}	226.5^{a}	0.7^{c}	2^{b}	1.7	37.8	25.3	64.5^{a}	9.7^{a}	7.5	18.7^{a}
GM	147.05	147.24	195.87	2.2	2.25	1.91	41.12	31.9	50.87	10.11	8.46	13.46
CV%	9.1	6.38	4.2	25.79	29.2	19.9	21.2	26.36	18.38	25.47	28.4	20.62
LSD(0.05)	-	14.16	12.49	0.85	0.99	-	-	-	14.09	3.88	-	4.18
R2	0.51	0.88	0.91	0.83	0.6	0.49	0.35	0.33	0.64	0.65	0.34	0.7
p-value	ns	**	**	**	*	ns	ns	ns	*	**	ns	**

Means within a column with different superscripts are significantly different. ns=non significance PH=plant height LSR= leaf stem ratio FBY=fresh biomass yield DMY=dry matter yield

Mean Performance of Treatments

Plant height at different cutting stage (Ph/cm)

Mean plant height performance of each treatments were highly significant ($p<0.05$) different Table 3. The plant height performance between 25% with 50% heading and 75% with 100% cut were not significance ($p>0.05$) different. The result indicated that the highest mean plant height was recorded at cutting of 75% heading followed by 100%heading, 10%heading, 25%heading, 50%heading, while the list plant height was recorded at before heading but ready to heading. This shows that when the plant was cut at early stage the plant height is lower as compared to when the plant cut at advanced maturity stage. The variation of treatments could be stage of growth, selection of sampled plant for plant height measurement in each plot. The current result variation of plant height due to stage of growth agreed with height at cutting is reported to affect the growth and productivity of Napier grass (Mureithi and Thrope, 1996). On the other hand plant height at cutting significantly affects the fodder yield of Napier grass in Kenya (Muinga *et al.*, 1992). Amongst the major agronomic practices required, harvesting of Napier grass at appropriate cutting height and defoliation frequencies are very important to improve DM yield and nutritive values of this plant (Tessema *et al.*, 2003).

Leaf to stem ratio (LSR)

The combined mean analysis for leaf to stem ratio indicated that there was a significance difference among treatments. The highest leaf proportion were recorded in before heading but ready to heading stage of cutting 25%, 50%, 10%, 75%heading ,whereas the list value of leaf proportion recorded in 100%heading stage of cutting. from this result it observed that when the plant was cut at early stage the proportion of leaf is higher as compared to when the plant cut at advanced maturity stage the proportion of leaf is lower. The presence of higher leaf proportion enables the nutritive value of the feed is higher.

Fresh biomass yield (FMY/t/ha)

Forage fresh biomass yield between before heading and the other five treatments showed significant ($p<0.05$) variation among the tested treatments, whereas there was no significance ($p>0.05$) difference among 10%, 25%,50%, 75% and 100%heading stage of cutting (Table 3). The fresh biomass yield (t/ha) ranged from 33.58 to 46.3. the highest fresh biomass were recorded in 75%heading stage of cutting followed by 10%, 100%, 50%, 25% and before heading but ready to heading. The higher fresh biomass enables for cut and carry system for using the higher herbage yield.

Dry matter yield (DMY /t/ha)

Forage Dry matter yield between before heading and the other five treatments showed significant ($p<0.05$) variation among the tested treatments, whereas there was no significance ($p>0.05$) difference among 10%, 25%,50%, 75% and 100%heading stage of cutting (Table 3). The dry matter yield (t/ha) ranged from 6.95 to 12.54. the highest dry matter yield were recorded in 75%heading stage of cutting followed by 10%, 100%, 50%, 25% and before heading but ready to heading. The higher dry matter biomass enables for cut and carry system for using the higher herbage yield. The different DM yield observed due to variation among stage of plant during cutting.

TABLE 3. Combined mean performance of Degun gizia in different cutting stage

Treatments	PH	LSR	FBY	DMY
Before Heading	140.3^{d}	2.68^{a}	33.58^{b}	6.95^{b}
10%Heading	168.1^{b}	2.08^{bc}	42.83^{a}	10.33^{a}
25%Heading	156.9^{c}	2.43^{ab}	41.08^{a}	10.73^{a}
50%Heading	153.7^{c}	2.27^{ab}	41.5^{a}	11.55^{a}
75%Heading	182.1^{a}	1.80^{cd}	46.3^{a}	12.54^{a}
100%Heading	179.1^{a}	1.45^{d}	42.5^{a}	11.94^{a}
GM	163.3	2.1	41.3	10.6
CV%	6.7	26.4	21.7	25.2
LSD(0.05)	8.9	0.46	7.34	2.2
R2	0.90	0.68	0.64	0.67
P-value	**	**	*	**

Means within a column with different superscripts are significantly different. PH=plant height LSR= leaf stem ratio FBY=fresh biomass yield DMY=dry matter yield

Chemical Composition

The chemical composition of Degun gizia in different cutting stage is shown in Table 4. The overall mean value of DM, ADF and ADL were significant ($p<0.05$) different among treatments, while Ash, OM, CP, NDF and IVDMD were not significant($p>0.05$) different among treatments. The higher value of DM was recorded in 100% heading cutting stage, whereas lower DM was recorded at before heading but ready to heading stage of cutting. This showed that when the plants is mature the dry matter content is higher. The higher ash content was recorded at early stage of plant maturity than advanced maturity stage. The higher OM content was recorded at late stage of plant maturity than early maturity stage.

TABLE 4. Chemical composition in different cutting stage of Degun gizia

Treatments	DM%	Ash%	OM%	CP%	NDF%	ADF%	ADL%	IVDMD%
Before Heading	90.41^{c}	13.35	86.64	10.72	71.1	42.48^{bc}	6.71^{b}	48.54
10%Heading	90.46^{bc}	13.20	86.79	10.71	71.67	42.81^{abc}	6.72^{b}	48.56
25%Heading	90.70^{a}	12.88	87.11	10.17	71.11	41.6^{c}	6.65^{b}	48.98
50%Heading	90.69^{ab}	13.41	86.58	10.30	70.64	43.44^{ab}	6.69^{b}	51.35
75%Heading	90.86^{a}	13.14	86.85	10.15	71.56	43.89^{ab}	7^{a}	50.20
100%Heading	90.88^{a}	12.97	87	9.30	71.88	44.26^{a}	7.17^{a}	44.71
GM	90.6	13.1	86.8	10.2	71.3	43.08	6.8	48.7
CV%	0.32	5.4	0.8	15.3	1.5	4.3	3.5	17.5
LSD(0.05)	0.24	-	-	-	-	1.52	0.19	-
R2	0.61	0.68	0.68	0.39	0.49	0.75	0.92	0.32
P-value	**	ns	ns	ns	ns	*	*	Ns

Means within a column with different superscripts are significantly different. ns =non-significant BH= before heading but ready to heading DM=dry matter OM=organic matter CP=crud protein NDF=neutral detergent fiber ADF=acid detergent fiber ADL= acid detergent lignin and IVDMD=invitro dry matter digestibility

The overall CP content was 10.2%, this shows that the CP content higher than the minimum threshold level (7%) for optimal rumen microbial activity. According to Lonsdale (1989), feeds that have <120,120-200 and >200gCP/kg DM and <9, 9-12 and >12 MJ ME/kg DM are classified as low, medium and high protein and energy source, respectively. Even though, the value of CP among treatments were not significance ($p>0.05$) difference but higher value of CP was recorded at early stage of cutting than late maturity stage of cutting. The mean value of NDF (71.3%), ADF (43.08%) and ADL (6.8%) was recorded from tested treatments. From this result it observed that when the plant is matured the value of All fibers like NDF, ADF and ADL is higher. The presence of high content of fiber in each treatment could affect the digestibility of the sample and it requires supplementary protein source.

The high fiber content and low CP content of different Degun gizia hay could be explained by different factor affecting the nutritive value of Napier grass hay. This factor could be varietal difference, location or climate, fertility of the

Volume 4, Issue 4, pp. 7-11, 2020. *ISSN (Online): 2456-7361*

land, stage of maturity at harvest, morphological fractions (e.g leaf to stem), harvesting and transporting practices, length and condition of storage time (Archimede *et al.*, 2000; Ru and Fortune, 1999 and preston and Leng, 1984). The combined mean value of IVDMD content of the Degun gizia at different stage of cutting were 48.7%. The presence of higher IVDMD enables nutritive value of the feed is high for better digestion.

IV. Conclussions and Recommendations

Degun gizia in different stage of cutting respond differently for measured agronomic performance across the testing year due to different responses of the treatments to various edaphic, climatic and biotic factors. Measured agronomic traits showed variations among the tested treatments and the years. When the plant is mature the plant height, DM yield and all fiber content (NDF, ADF, ADL) of the plant is higher, whereas the CP and Ash content of the plant is reduced. It is suggested that Degun gizia should be harvested at appropriate time in order to have high nutritive values with relatively high biomass production. Thus, compromising the good quality of hay with higher biomass yield were selected for this experiment. Therefore, among tested treatments Degun gizia was cut at 10%heading for good quality of hay and biomass will be promoted in the study area and similar environment.

References

[1] Alemayehu Mengistu. 2002. Forage Production in Ethiopia: A Case Study with Multiplications

[2] Archimede H., Boval M. and Alexandre G., 2000. Effect of regrowth ag e on intake and digestion of Digitaria decumbens consumed by BlackBel ly sheep. Animal Feeds Science and Technology. ELSEVIER Science.

[3] Association of Analytical chemists (AOAC), 1990. Official methods of a nalysis, 15th edition Association of Analytical Chemists (AOAC). In C, Artington, Verginia, USA.

[4] McDonald, P., R.A. Edwards, J.F.D. Greenhangh and C.A. Morgan, 200 2. Animal Nutrition. 6th ed. Prentice Hall, London. pp 583- 59

[5] Muinga, R. W. ,Thorpe, W. and Topps, J. H. (1992): Voluntary food intake, live-weight change and lactation performance of crossbred dairy cows given ad libitum Pennisetum purpureum (napier grass var. Bana) supplemented with leucaena forage in the lowland semi-humid tropics. Anim. Prod., 55 (3): 331-337.

[6] Mureithi J.G and W. Thorpe. (1996): The effects of herbaceous legume intercropping and mulching on the productivity of Napier grass (Pennisetum purpureum) and total forage yield in coastal lowland Kenya. In: Jean Ndikumana and Peter de Leeuw (eds.) Sustainable Feed Production and Utilization for Smallholder Livestock Enterprises in Sub-Saharan Africa. African Feed Resources Network (AFRNET) Workshop held in Harare, Zimbabwe 6-10 December 1993. AFRNET, Nairobi, Kenya, 45-50. New York

[7] Preston, T.R. and R.A. Leng, 1984. Supplementation of diets based on fi brous residues and byproducts. pp. 373409. In: F. Sundstol and E. owen (eds.). Straw and other fibrous byproducts feed. Elsevier Publishing Co mpany. Amsterdam.

[8] Ru Y.J and J.A.Fortue, 1999. Sward characteristics and nutritive value o f two cultivars of subterranean clover. Asian Aus. J. Anim. Scie. Vol. 12; No. 8; 1192-1199

[9] Tessema Zewdu and Alemayehu Mengistu. (2010): Management of Napier Grass (Pennisetum Purpureum (L.) Schumach) for High Yield and Nutritional Quality in Ethiopia: A Review. Eth. J. Animal. Prod. 10(1) – 2010: 73 –94. ©Ethiopian Society of Animal Production (ESAP) EJAP ISSN: 1607-3835 Volume 10, Number 1, 2010.

[10] Tessema Zewdu, Baars R, Alemu Yami, Dawit N. (2003): Effect of plant height at cutting and fertilizer on growth of Napier grass (Pennisetum purpureum (L.) Schumach.). Tropical science 43: 57-61.

[11] Tilley, J.M.A. and Terry, R.A, 1963. A two stage technique for invitro di gestion of forage crops. Journal of the British Grassland society 18:104.

[12] Van Soest, P.J. and Robertson, J.B., 1985. Analysis of forage and fibrou s foods. A laboratory manual for Animal Science 613 cornell university, Ithaca, New York, USA.