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EFFECTS OF COW DUNG, GRASSCUTTER DROPPINGS AND NPK FERTILIZER ON DRY MATTER YIELD AND NUTRITIONAL VALUE OF ELEPHANT GRASS (*PENNISETUM PURPUREUM*)

Felix Nmoandor [1], Ziblim Abukari Imoro [1]* and Timothy Khan Aikins [1]

ABSTRACT

The nutritional quality of forages is paramount in any forage-based livestock production. The current study was conducted at the Department of Biodiversity Conservation and Management, University for Development Studies, Ghana during the year 2019. This study compared the effect of fertilizers on the growth performance and nutritive value of elephant grass (*Pennisetum purpureum)*. The study determined the influence of cow dung, grasscutter droppings and NPK fertilizer on the levels of crude protein, crude fat, carbohydrate, moisture contents and dry matter yield of elephant grass. Randomized complete block design (RCBD) with four treatments and four replications were used. Stem cuttings containing three active nodes were planted on 2m x 2m beds with cow dung, NPK fertilizer, grasscutter droppings and control plots (no fertilization applied) as the treatments. Growth parameters including height, stem girth, number of leaves, number of sprouts, leaf length and width were measured four weeks after planting and afterwards on weekly basis. The measurement lasted for eight (8) weeks. The plants were then harvested, oven-dried and crushed for proximate analysis in the laboratory. The results showed no significant difference among the treatments for mean crude protein, crude fat, ash, moisture content and dry matter yield. However, mean carbohydrates levels were significantly different among the treatments. Furthermore, NPK treatment showed significantly higher levels of carbohydrates as compared to the cow dung and grasscutter dropping treatments. There was significant difference ($P < 0.05$) in plant girth and leaf area index among the treatments. The results gave a maximum plant girth and leaf area index under NPK fertilizer. The results suggested that, cow dung, NPK fertilizer and grasscutter droppings could be used in elephant grass production. However, for maximum performance, it is recommended that NPK fertilizer should be used to give maximum nutritive returns. Livestock farmers are therefore encouraged to incorporate fertilizers in the cultivation of elephant grass to feed their stocks.

KEYWORDS: Elephant grass; growth; fertilizer; nutrition; yield; biodiversity; Ghana.

[1] Lecturer, Department of Biodiversity Conservation and Management, Faculty of Natural Resources and Environment, University for Development Studies, Box TL 1350 Tamale-Ghana.

*Corresponding author email: zibso2@yaghoo.com/izimlim@uds.edu.gh

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INTRODUCTION

Forages are major assets and a foundation of livestock operation and diet. Forage accounts for one of the utmost cost of livestock production; hence they are framed to optimize animal output. The nutritive value of forage has influence on individual animal production whereas the yield of forage affects production per unit area. The nutritive value of forages are influenced by the physiological age, time of grazing or harvest, species and vegetative part (Tainton, 2000).

Natural pastures and crop residues which usually grow on marginal lands have low levels of nutrients which might not be able to provide for the nutritional needs of free ranging livestock. Grass-legume pasture development is one of the best approaches for increasing the quantity and quality of forage plants. The merits of grass-legume mixtures over pure stands is that it decreases the occurrence of stomach disorders as a results of high legume diet, reduces the risk of pest and diseases in the pasture and checks soil erosion (Tessema and Baars, 2006). With the problem of feed inadequacy in the livestock sector coupled with the decreasing biome space for grazing and the rising demand for animal material; the employment of outstanding land for cultivation of resilient forage to be utilized in stall feeding system could also be the paramount choice to increase animal production in densely inhabited areas (Rusdy, 2016).

Neglected wild plants like the elephant grass with promising nutritional potentials could constitute dietary diversity and contribute to feed security (Akah and Ani, 2014). Elephant grass is an important forage and very popular throughout the tropics, notably in cut-and-carry systems (FAO, 2015). According to Clayton *et al*. (2013) the plant is from tropical Africa and the sub-Saharan region.

In Ghana, elephant grass is found along the banks of water bodies like rivers, streams and along most highways. They are drought resistant and spread quickly when introduced in new environment. However, farmers do not utilize the elephant grasses in feeding of their livestock. They prefer to feed their livestock with crops residues, grasses like the *Panicum maximum, Cymbopogon gigantus, Andropogon gayanus, Setaria pallide-fusca* and some common browse species. However, elephant grass which is abundant and more drought resistant and high biomass production is rarely used by livestock farmers. The low level of use of elephant grass by these livestock farmers could be due to the fact that they lack knowledge on its nutritional and biomass production. This study therefore provided adequate knowledge about the nutritional contents and yield of elephant grass as well as helped in planning of hay based dry season feeding to sustain animal performance (Gadberry *et al.,* 2006). This study therefore compared the influence of cow dung, grasscutter dung and NPK fertilizers on the growth performance, nutrient content and dry matter yield (biomass) of elephant grass.

MATERIALS AND METHODS

Study area

The study was conducted at the University for Development Studies, Faculty of Natural Resources and Environment research field, Nyankpala in the Northern Region of Ghana during the month of September to February 2019. The study site is within the Guinea Savannah Agro-ecological zone. The District lies between latitude 9°15' and 10°02' N and longitude 0° 53' and 1° 25' W with an altitude of 183m above sea level (Imoro *et al*., 2014).

The study site experiences only one rainy season in the year which begins from April intensifies as the month progresses and halt in October or November. The dry season usually starts from November and ends in March with day temperatures ranging from 33°C to 39°C. Night temperatures range from 20°C to 26°C. The annual rainfall ranges from 950-1200 mm. The area occasionally experiences storms, which have implications for base soil erosion (Ghana Statistical Service, 2014).

Research design

The study used the randomized complete block design (RCBD) for the layout of the sample units (beds). A total of sixteen (16) beds of size 2m x 2m were prepared. Three kilograms (3kg) each of decomposed cow dung and grasscutter droppings, and 0.2kg of inorganic fertilizer (NPK) were incorporated into twelve (12) beds at random and irrigated. Four treatments; decomposed cow dung, grasscutter droppings, NPK fertilizer and control were replicated four times with each treatment appearing once in each block. The spacing of beds within blocks was 0.5 m while that of between blocks was 1m. In all plots, a total of 104.5m^2 (11m x 9.5m) plot size was maintained.

Planting was done using stem cuttings and each stem cutting had three active nodes. The stem cuttings were planted on the beds at an angle of 30 degrees, with two nodes buried into the soil and one above the ground. Four stem cuttings were planted on each bed at 1.4 m between rows and 1 m within rows. The plants were watered twice a day; morning and evening. Equal quantity of water was supplied to each bed using a watering cane.

Data collection

Two plants were selected randomly and tagged on each bed. Growth parameters such as height, plant girth, leaf length, leaf width, number of sprouts and number of leaves were measured after four (4) weeks of planting and subsequently on weekly basis.

Plant height was measured starting from the basal part on the ground surface to the uppermost unfolded matured leaf whose collar is visible using a tape measure. Young leaves without visible collars were not considered though they were part of the whorl. The mean heights from the two randomly selected plants were taken as the score for each bed.

The stem girth was measured at the base of the plant using a tape measure. The number of leaves was determined by counting the leaves starting from the base of the plant up to the upper leaf whose collar has been fully unfolded. Younger leaves were not counted though they were part of the whorl. Collars that were not visible were not counted because the leaves were not developed enough to emerge from the whorl. The mean of the two tagged plants were recorded for the number of leaves. Sprouts are the new shoots of the plant. The number of sprouts was determined by counting the number of additional sprouts to the randomly selected plants. The mean number of sprouts from the two selected plants was taken as the score from each plot.

Three (3) leaves each from the tagged plants were measured for their lengths and widths. Leaf length and maximum width were measured using a tape measure and a rule respectively from the bottom, middle and uppermost leaves whose collars are visible. Their averages were taken and the mean from the two selected plants were recorded as the leaf length and width for each bed.

Leaf Area Index (LAI) was determined using the relationship proposed by Watson (1952).

$$\text{LAI} = \frac{\text{Leaf length (cm) x leaf width (cm) x No. of leaves per plant x 0.72}}{\text{Area per plant}}$$

Chemical analysis

Proximate analysis was carried out on the elephant grass leaves harvested from each replication in the four treatments. These analysis were conducted in a food technology laboratory. The proximate analysis was done according to AOAC (2005) protocol. All analysis were conducted in triplicates.

Statistical analysis

Data obtained from the experiment were analyzed using one-way Analysis of Variance (ANOVA). Means were separated by using Fisher's LSD test at 5% significance level (Steel *et al.,* 1997). The analysis was conducted using GENSTAT software.

RESULTS AND DISCUSSION

Plant height

The treatments effect on the height of *Pennisetum purpureum* is illustrated in Fig. 1. Though statistically there was no significant difference (*P>0.05*) among the treatments, grasscutter droppings recorded the highest plant height at the end of the experiment while the control plot recorded the lowest. The numerical higher value of plant height under grasscutter droppings at the end of the research might be as a result of the gradual release of nutrients and late mineralization of organic manure at the later stage of growth of the plant. This assertion is in line with Ayeni (2011), who reported that organic manure contained higher amount of the macro nutrients as well as some levels of the micro nutrients. Similar findings reported by Ayeni and Adeleye (2011) showed that huge proportions of nutrients in organic manure were released between one to two months of incubation. The lowest plant height under the control at the end of the research might be due to low supply of nutrients at the later stage of growth which might have been used up by the plant at the beginning. This finding agrees with Goorahoo *et al.* (2005) who stated that elephant grass is a luxury feeder of nitrogen and phosphorus, thereby implying that it has good potential to absorb significant amount of nutrients.

Plant girth

Fig. 2 shows the treatment effects on the girth of *Pennisetum purpureum.* Plant girth showed no significant difference (P > 0.05) for the 4th, 5th, 6th and 8th weeks after planting. However, there was significant difference (P < 0.05) on the plant girth among the treatments on the 7th, 9th, 10th and 11th weeks after planting. Among the treatments, significant difference on the plant girth. NPK fertilizer showed the highest effect on plant girth while control plot showed the lowest. The differences among the treatments are illustrated in Table 1. The highest plant girth under NPK could be as a result of the readily release of N, P and K present in the NPK fertilizer. This is in line with the findings by Makinde *et al*. (2011) who observed that NPK fertilizer produced the highest number of stem girth in *Corchorusolitorus*.

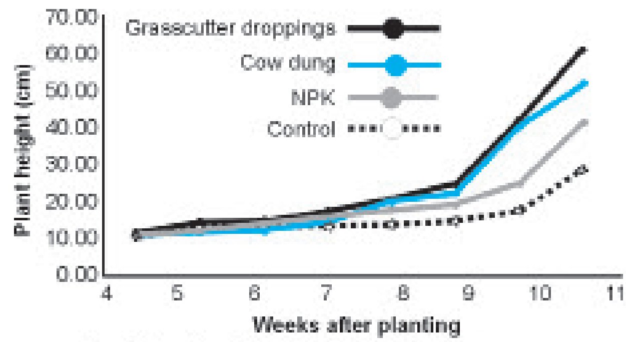


Fig. 1. Trend of plant height of *Pennisetum purpureum*

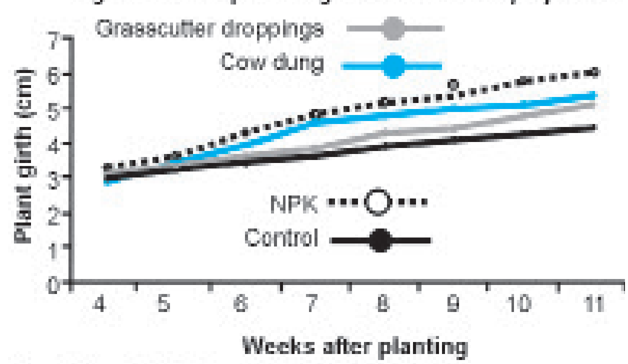


Fig. 2. Growth in plant girth of *Pennisetum purpureum* under fertilizaiton

Table 1. Significant means of plant girth of *Pennisetum purpureum*

Plant Girth	Treatments				P value
	Cow dung	NPK	Grasscutter droppings	Control	
7WAP	4.55	4.77	3.82	3.62	0.043
9WAP	4.95	5.32	4.40	4.05	0.034
10WAP	5.05	5.72	4.75	4.22	0.023
11WAP	5.33	5.98	5.08	4.42	0.023

Number of leaves

The number of leaves did not significantly differ (*P > 0.05*) among the treatments. However, cow dung and grasscutter droppings had the highest leaf number, whereas control plot had the lowest number of leaves at the end of the research. Like the plant height, the maximum number of leaves at the initial growth under NPK and control plots might be as a result of the readily supply of high amount of nutrients, but the supply declined as the plant absorbed the available nutrient (Fig. 3). This is similar to the findings of Goorahoo *et al*. (2005), who reported that *Pennisetum purpureum* has good potential to absorb excess nitrogen and phosphorus. However, the lowest number of leaves under cow dung and grasscutter droppings at the early growth and the highest at the later growth might be the gradual release of the nutrient during the early growth with larger proportion released during the late growth (Ayeni and Adeleye, 2011).

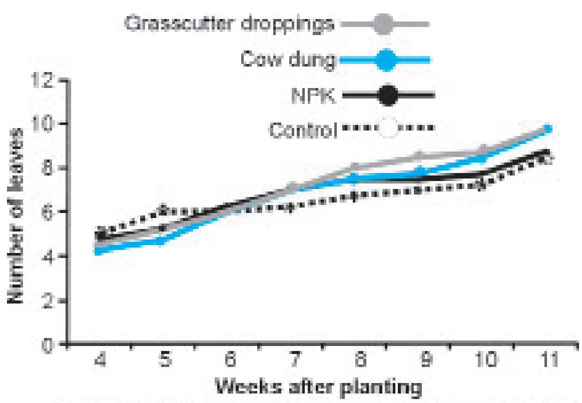


Fig. 3. Variation in number of leaves of *Pennisetum purpureum* under fertilization

Leaf area index

The effect of the treatments on the leaf area index was not significant from the 4th – 6th weeks after planting (Fig. 4). However, there was significant difference among the treatments on the leaf area index from 7th – 11th weeks after planting. Among the treatments, NPK treatment gave a significantly higher leaf area index while control plot gave the lowest leave area index. Table 2 indicates the significant means of treatments on the leaf area index. The highest leaf area index under NPK might be due to the larger amount of nitrogen present in NPK fertilizer. The results affirmed the findings reported by Cox *et al*. (1993) that development and maintenance of leaf area index was significantly influenced by N fertilization.

Number of sprouts

However, NPK and grasscutter droppings recorded a maximum number of sprouts while the control plot recorded a minimum number of sprouts at the end of the research (Fig. 5). This might be as a result of the release of high amount of nitrogen which increased the vegetative growth and chlorophyll formation for photosynthesis. This agrees with Zahid *et al*. (2002), who reported that increase in the number of sprouts was due to increase in N fertilization but not P or K.

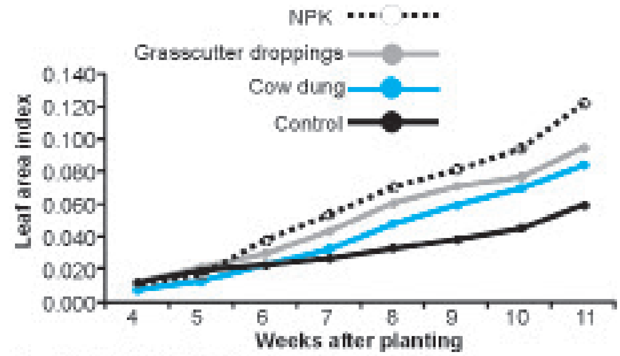


Fig. 4. Variation in leaf area index of *Pennisetum purpureum* under fertilization

Table 2. Significant means of leaf area indices

Leaf Area Index (LAI)	Treatments				P value
	Cow dung	NPK	Grasscutter droppings	Control	
LAI @7WAP	0.033	0.054	0.044	0.027	0.039
LAI @8WAP	0.049	0.071	0.061	0.034	0.003
LAI @9WAP	0.060	0.082	0.072	0.039	0.002
LAI @10WAP	0.070	0.095	0.078	0.046	0.019
LAI @11WAP	0.084	0.123	0.096	0.060	0.044

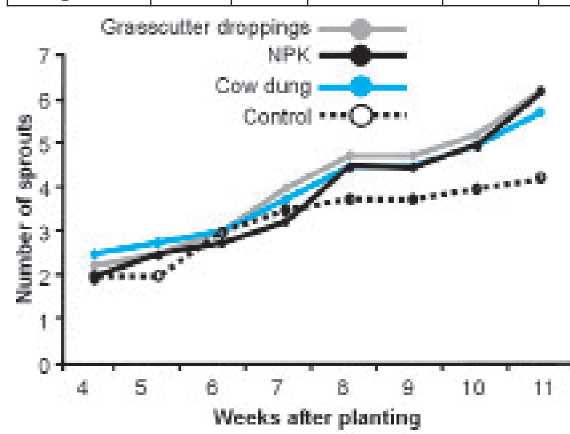


Fig. 5. Number of sprouts of *Pennisetum purpureum* for various weeks after planting

Proximate analysis of *Pennisetum purpureum*and dry matter yield

Statistically, there was no significant difference among the treatments for mean crude protein, crude fat, ash, moisture and dry matter yield. However, mean carbohydrate level was significantly different ($P < 0.05$) among the treatments (Table 3).

Table 3. Proximate analysis and dry matter yield of *Pennisetum purpureum* under different fertilizer treatments

Parameters (%)	Cow dung	NPK	Grasscutter droppings	Control	P value
Crude Protein	5.91^a	5.38^a	5.76^a	5.80^a	0.768
Crude Fat	1.88^a	1.75^a	2.13^a	2.00^a	0.631
Carbohydrate	7.49^a	16.05^b	8.19^c	7.60^c	0.026
Ash	13.56^a	10.90^a	13.34^a	13.19^a	0.089
Moisture	71.17^a	65.92^a	70.58^a	71.42^a	0.112
Dry Matter yield	94.5^a	86.1^a	92.2^a	92.7^a	0.768

*Treatment means with different superscripts within the same row are significantly different at 5 % probability level.

Crude protein and ash level in *Pennisetum purpureum*

The results showed a higher protein and ash level under cow dung as compared to the other treatments. This could be attributed to the access of high nitrogen and potassium contents since the amount of nitrogen and potassium in plants indicate the level of protein and ash respectively (Table 3). This agrees with Bumane (2010) and Min *et al.* (2002), who reported that cattle manure application on natural pasture provides available nitrogen and phosphorus to increase crude protein contents of the pasture. Flores *et al*. (2012) also indicated that the higher ash may be related to the higher K contents in the stems and leaves of elephant grass.

However, the low level of protein and ash under NPK could be deduced from the declined nitrogen and potassium contents at the later growth due to the trapping of nutrients within cell walls by fiber component as the plant mature. This assertion agrees with Bayble *et al*. (2007) and Wangchuk *et al.* (2015) who indicated that crude protein content of *Pennisetum purpureum* has significantly decreased at a cutting interval of 40 and 80 days by 28.2 and 8.8% respectively. With respect to ash, Maynard *et al.* (1981) stated that, decrease in total ash contents of the natural pasture in late maturity stage is related to dilution and translocation of mineral from vegetative portion of the plant to the roots.

Crude fat

The crude fat contents were highest under grasscutter droppings while lowest under NPK plots. The highest crude fat contents under grasscutter droppings and the lowest under NPK may be associated to the rate of growth of the fiber components of the plant (Table 3). Mature plants contain high fiber, hence may contain low fat content since plants put most of their energy in vegetative growth during early stage, while in maturity stage their fiber components trap the nutrients within the cell walls (Agza *et al.,* 2013).

Carbohydrate

There was significant difference among the treatments for carbohydrate contents. Carbohydrate concentration from the results (Table 3) was highest under NPK whiles lowest under Cow dung plots. The highest carbohydrate contents under NPK may be attributed to the low moisture contents of *Pennisetum purpureum* which might have led to the fast drying of the sample. This is because plant tissues continue to respire and use up sugars in the drying process (Kathryn *et al.,* 2016). The lowest level of carbohydrate under cow dung may be attributed to the highest dry matter contents of the sample. These attributes are in line with Lorlornyo (2012) who indicated that three-fourth of the dry matter in plants consist of carbohydrates.

Dry matter yield

The findings showed no significant difference in percentage dry matter yield among the treatments at the end of the experiment. However, dry matter yield was relatively highest under cow dung but lowest under NPK plots. The relatively high dry matter under the cow dung could be attributed to the age of plant, high number of leaves and sprouts (Table 3). This is in concordance with Tessema *et al.* (2010) who indicated that time, frequency of harvesting and botanical composition are some major factors that determine biomass yield of pastures. The lowest dry matter yield under NPK may be due to low nutrients available for the growth of vegetative components during later stage of growth. The NPK fertilizer is known to release nutrients at a faster rate. This means that it might not be able to provide sufficient nutrients for vegetative development during the later growth. This result might be the luxurious feeding on nitrogen and phosphorus by the grass (Goorahoo *et al.,* 2005).

CONCLUSION

It is concluded that fertilization affects vegetative growth, biomass production and nutrient contents of elephant grass. Also, the nutrients composition of the elephant grass was within the requirement for livestock. The high dry matter yield observed in this experiment indicates that elephant grass has good potential for forage production for use by livestock. Both organic (cow dung and grasscutter droppings) and inorganic fertilizer (NPK) could be used in growing elephant grass.

REFERENCES

Agza, B., B. Kassa, S. Zewdu, E. Aklilu and F. Alemu. 2013. Forage yield and nutritive value of natural pastures at varying levels of maturity in North West Lowlands of Ethiopia. World Journal of Agricultural Sciences, 1(3):106-112.

Akah, N.P. and J.C. Ani. 2014. The role of elephant grass (*Pennisetum purpureum* L. Schumach) “achara” in global food security. International Conference on Biodiversity and the UN MDGs: Biodiversity and Food Security. Aix-en-Provence, France

AOAC. 2005. Official Methods of analysis: Association of Official Analytical Chemists. 18th Edition. Washington DC, USA.

Ayeni, L.S. 2011. Effect of sole and combined cocoa pod ash, poultry manure and NPK 20:10:10 fertilizers on soil organic carbon, available P and forms of nitrogen on alfisols in southwestern

Nigeria. International Research Journal of Agricultural Science and Soil Science, 1(3):77-82.

Ayeni, L.S. and E.O. Adeleye. 2011. Soil Nutrient Status and Nutrient Interactions as Influenced by Agro Wastes and Mineral Fertilizer in an Incubation Study in the South West Nigeria. Journal of Soil Science, 6:60-68.

Bayble, T., S. Melaku and N.K. Prasad. 2007. Effects of cutting dates on nutritive value of Napier (*Pennisetum purpureum*) grass planted sole and in association with Desmodium (*Desmodiumintortum*) or Lablab (*Lablab purpureus*). Livestock Research for Rural Development.19(1):120-136.

Bumane, S. 2010. The influence of NPK fertilization on *Loliumperenne* L. forage quality. Agronomy Research. 8:531-536.

Clayton, W.D., R. Govaerts, K.T. Harman, H. Williamson and M. Vorontsova. 2013. *World checklist of Poaceae*. Richmond, UK: Royal Botanic Gardens, Kew.

Cox, W., S. Kalonge, D. Cherney, W. Reid, W. Cox, S. Kalonge, D. Cherney, and W. Reid. 1993. Growth, yield, and quality of forage maize under different nitrogen management practices. Agronomy Journal 85: 341-347.

FAO. 2015. Grassland Index, a searchable catalogue of grass and forage legumes. FAO,Rome, Italy.

Flores, A., S. Urquiaga, B.J.R. Alves, L.S. Collie and R.M. Boddey. 2012. Yield and quality of elephant grass biomass produced in the cerrados region for bioenergy. Eng. Agric. 32(5):831-839.

Gadberry M.S., T.R. Troxel, J.A. Jennings and G.V. Davisl. 2006. Influence of Crude Protein Content of Bermuda grass Hay on in vitro Organic Matter Digestibility and the Arkansas TDN Equation, University of Arkansas Cooperative Extension Service. AAES Research Series. p. 535.

Ghana Statistical Service. 2014. Population & Housing Census: District Analytical Report: Tolon District. Ghana Statistical Service.

Goorahoo D., F.S. Cassel, D. Adhikari and M. Rothberg 2005. *In*: Proceedings, California Alfalfa and Forage Symposium, Visalia, CA, USA.

Imoro Z.A., J. Adusei-Boateng and T.K. Aikins. 2014. Comparison of Soil Fertility Improvement Ability of *Voandzeia subterranea* and *Arachis hypogea*. Journal of Agricultural Reserach, 52(4):489-498.

Kathryn, J.F., R.L. Chen, E.M. Milner and L.C.H. Fernald. 2016. Agricultural interventions for improved nutrition: A review of livelihood and environmental dimensions. Global Food Security 8:39-47.

Lorlornyo, F.A. 2012. *Assessing the nutritional quality of Bermuda grass*. BSc Dissertation (unpublished), University for Development Studies, Ghana. 27pp.

Makinde, S.O., M.I. Usilo, E.A. Makinde and L.S. Ayeni. 2011. Comparative effect of mineral fertilizer and organic manures on growth, nutrient content and yield of Chorcorusolitorus and Celosia argentia. Research Journal of Biology. 6:150-156.

Maynard, L.A., H.F. Hintz, J.K. Loosli and R.G.Warner.1981. Animal nutrition, 7th Ed. McGraw-Hill, publishing company limited, New Delhi, India.

Min, D.H., L.R. Vough and J.B. Reeves. 2002. Dairy slurry effects on forage quality of orchardgrass, reed canarygrass and alfalfa-grass mixtures. Animal feed science and technology, 95(3-4):143-157.

Rusdy, M. 2016. Elephant grass as forage for ruminant animals. Livestock Research for Rural Development. 28(4).

Steel, R.G.D., J.H. Torrie and D.A. Dickey. 1997. Principles and procedures of statistics: A biometrical approach. 3rd Ed. McGraw Hill Book Co. Inc. New York.

Tainton, N. M. 2000. *Pasture Management in South Africa*. University of Natal Press.

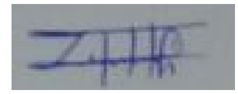
Tessema, Z. and R.M.T. Baars. 2006. Chemical composition, dry matter production and yield dynamics of tropical grasses mixed with perennial forage legumes. Tropical Grasslands.40(3): 150.

Tessema, Z., A. Ashagre and M. Solomon. 2010. Botanical composition, yield and nutritional quality of grassland in relation to stages of harvesting and fertiliser application in the highlands of Ethiopia. African Journal of Range and Forage Science, 27(3):117-124.

Wangchuk, K., K. Rai, H. Nirola, C. Dendup and D. Mongar. 2015. Forage growth, yield and quality responses of Napier hybrid grass cultivars to three cutting intervals in the Himalayan foothills. Tropical Grasslands-ForrajesTropicales, 3(3):142-150.

Watson, D. J. 1952. The physiological basis of variation in yield. Advanced Agronomy, 4:101-145.

Zahid, M.S., A.M. Haqqani, M.U. Mufti and S. Shafeeq. 2002. Optimization of N and P fertilizer for higher fodder yield and quality in mottgrass under irrigation-cum rainfed conditions of Pakistan. Asian Journal of Plant Sciences, 1(6):690-693.

S. No.	Author name	Contribution	Signature
1.	Ziblim A Imoro	Designed and monitored the research work and critically reviewed the manuscript	
2.	Felix Nmoandor	Collected the data and prepared the manuscript	
3.	Timothy Khan Aikins	Analyzed the data and edited the manuscript