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Research Article
Utility of Farmer's Fallow Lands for Fodder Production with High Phenotypic Growth and Yield

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Abstract
Background: Land scarcity is increasing day by day in Bangladesh because of rising population and industrialization. The available limited land is used for food crop production especially rice production. As a result, only very limited land is available for fodder production. **Objective:** The study presents method of utilizing farmer's fallow lands for fodder production to enhance availability of high quality fodder for their livestock. **Materials and Methods:** The treatments were replicated three times and the experiments were set up in Randomized Complete Block Design (RCBD). Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) test were performed to evaluate the significance of mean differences among the treatments. This experiment was conducted with three fodders i.e., Napier, Splendida and Andropogon. Phenotypic growth and yield data were recorded for three cuttings. **Results:** Among the three fodders, plant height, leaf length, number of tiller per plant and yield values had significant variation ($p<0.01$). Napier showed the highest value in plant height, leaf length and yield for all cuttings and Splendida had highest number of tiller per plant. Napier has highest biomass yield and growth parameters. In respect of fodder yield and phenotypic growth, Splendida was in between Napier and Andropogon fodder. **Conclusion:** Considering all parameters of this study it may be advocated to cultivate Napier and Splendida fodder at farmer's field. This study will help farmers to be motivated for utilizing their fallow land. It will help to produce more cultivated fodder for livestock and will also increase animal productivity. Therefore, now it is indispensable and vital need to motivate the farmers about cultivating fodder in fallow lands for increasing animal productivity in Bangladesh.

Key words: Yield, fodder, fallow land, farmer, livestock

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Bangladesh is predominantly an agricultural country where livestock plays a vital role in the traditional subsistent economy of the country. Livestock rearing is an important part of the rice-based farming system in Bangladesh. It is also preferred options for subsistent farmers to generate income and alleviate poverty. In Asian countries, intensive animal production systems are developing fast due to shortage of grazing land[1]. The scarcity of animal feed and fodder has been identified as a major constraint for the development of livestock in Bangladesh.

Livestock production must deal with (i) The increased competition between human food and animal feed, (ii) The greater demand for animal products globally and (iii) The resulting environmental impacts, as human populations increase and their dietary preferences change[2,3].

Livestock lives mostly on straw based ration in Bangladesh. So, here livestock development is mainly depends on the improvement of animal nutrition through improved feeding and availability of fodder. Around 90% of the cattle feed supply comes from poor quality roughage, mostly rice straw and a very small quantity of green grass with little concentrate[4]. Rice straw is deficient in readily fermentable carbohydrates, protein, minerals and vitamins. As a result, the animals consuming rice straw alone have low growth rate of milk and meat production and they shows only about 10% of their genetic potentiality[5]. So, supplementation of straw based diet by the ample amount of green grass is often recommended to fulfill the requirement of animal[6]. Due to continuous pressure of rising population, most of the lands become occupied with food crop production and habitats of human being. Scarcity of grazing lands reduced natural feeds of cattle in rural environment of Bangladesh[7]. Presently, about 83% of the total cultivable land in Bangladesh is used for cultivation of cereal crops and only 0.10% for cultivation of fodder crops and the rest for other crops[8]. Thus, fodder shortage for our animal is aggravating day by day. To face all these challenges, it is a better approach to use fallow lands around homesteads, even in small size, for cultivating different fodder crops. Research on production of exotic and local fodder germplasm are carried out at Bangladesh Livestock Research Institute and Bangladesh Agricultural University. Among those grasses, Napier (*Pennisetum purpureum*), Splendida (*Setaria splendida*) and Andropogon (*Andropogon gayanus*) are proved as highly nutritive as well as high yielding fodder having production capacity[9] of 150-200, 100-130 and 110-140 t ha^{-1}, respectively[10]. So, it is high time to disseminate the laboratory findings to the farmers.

To meet up the increasing need of green fodder, it is essential to find out some potential fodder variety that are recommended for extensive cultivation by the farmers. In this regard, this study was undertaken to study the feasibility of high yielding fodder cultivation at farmer's fallow land and to compare the production performance of three fodder in Bangladesh.

MATERIALS AND METHODS

Experimental period and experimental site: Field and laboratory experiments were conducted to achieve the objectives of the study, respectively on February-July and July-October of 2014.

Location and agroecological region: Geographically the experimental field is located at 24°75′ N latitude and 90°50′ E longitude at an elevation of 18 m a.s.l. (Fig. 1). The experimental field belongs to the Agroecological region of the Old Brahmaputra Flood plain (AEZ-9). The region occupies a large area of Brahmaputra sediments which were laid down before the river shifted into its present Jamuna channel about 200 years ago[11].

Soil and climatic condition: The land was medium high, silt loam in texture and neutral in reaction with moderate drained condition. The land was medium high with sandy loam texture having a soil pH of 6.40, moderate in organic matter content. The experimental field is situated under sub-tropical climate. Usually the rainfall is heavy during April-September and scanty in October-March season. January-March season starts with low temperature and 8-10 h of sunshine, the atmospheric temperature increases from June-September (above 80%) and declined in winters.

Experimental details

Treatments, experimental design and layout: For this experiment, three farmers were selected and given cuttings of three perennial fodders as experimental treatments, from the 'Shahjalal Animal Nutrition Field Laboratory, BAU. The treatments were three perennial fodders viz., Napier (*Pennisetum purpureum*), Splendida (*Setaria splendida*) and Andropogon (*Andropogon gayanus*). This experiment was laid out in a completely randomized design with 3 replications (Fig. 2). The number of plots was 9 and size of the plot was 150 ft^2 (15×10 ft^2). The distance maintained between plants to plant and row to row were 1.0 ft and plot to plot distance was 2.0 ft.

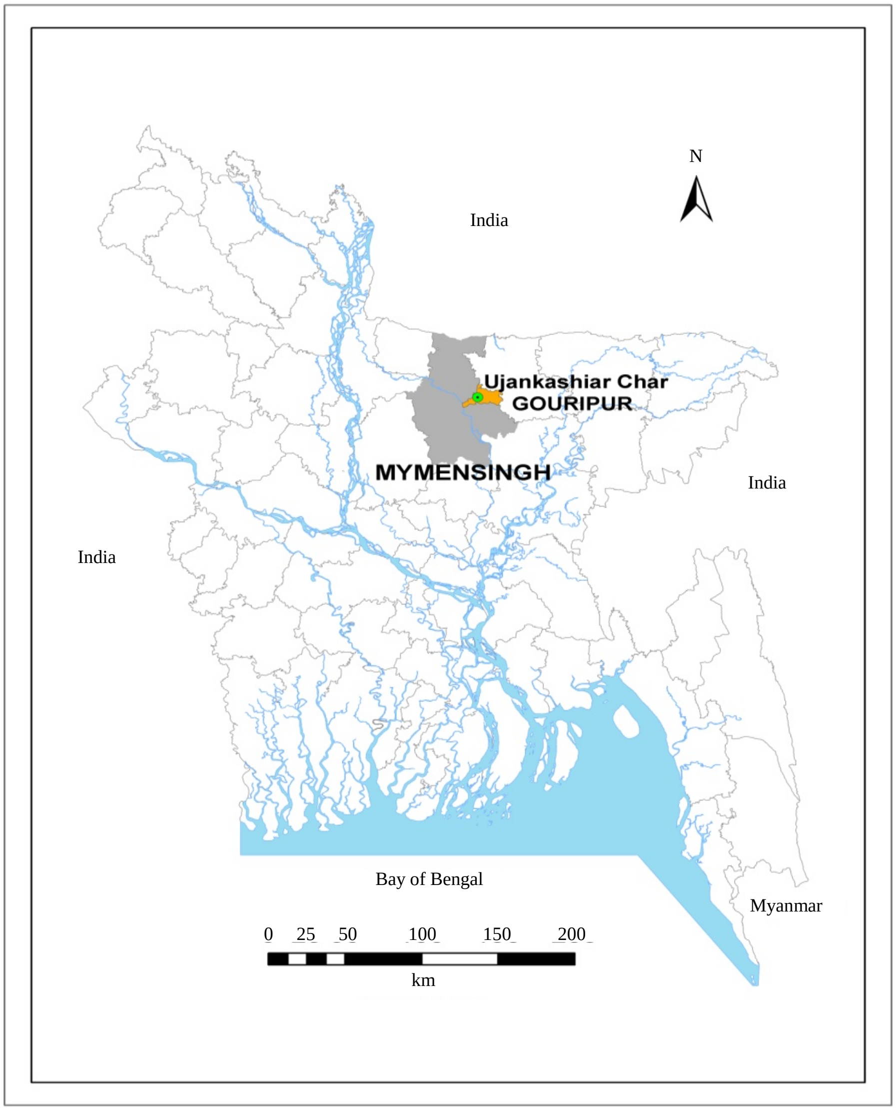

Fig. 1: Location of the experimental site

Conduction of the experiment

Preparation of land: The lands were prepared by ploughing and cross ploughing four times with tractor followed by laddering, harrowing, planking to obtain the desirable tilth. All the weeds and stubbles of the previous crop were removed. The corners of the land were spaded and visible larger clods were broken into small pieces.

Planting of cutting: After collection of cuttings, those were prepared with the help of sickle and lengths of cutting contain at least 3 nodes in its sheath. Cutting of these grasses were planted by line sowing method keeping one node under the soil with 45^0 angles and maintaining 1.0 ft distance between row to row and plant to plant spacing.

Fertilizer application: At the time of land preparation, a basal dose of cow dung (14 t ha^{-1}) was applied. After 20 days of plantation, urea and TSP was applied at a rate of 100 and 50 kg ha^{-1}, respectively in each plot and no fertilizer was applied further. All the fertilizer doses were applied in broadcast method.

Intercultural operations: Gap filling, weeding were done for ensuring and maintaining the vigorous growth of the fodders.

Harvesting and processing: The first cutting of fodder was done after one and a half month of plantation. Second and third cuttings were done in similar process after 1 month of 1st and 2nd cutting, respectively. Then the fresh yield was recorded in tons per hectare.

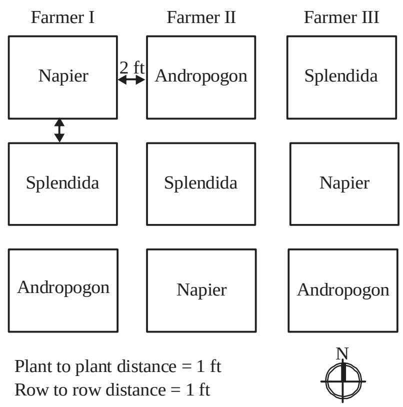

Fig. 2: Layout of the field experiment

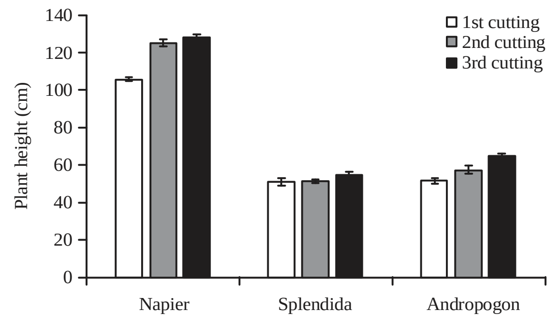

Fig. 3: Plant height of three fodders at three cuttings

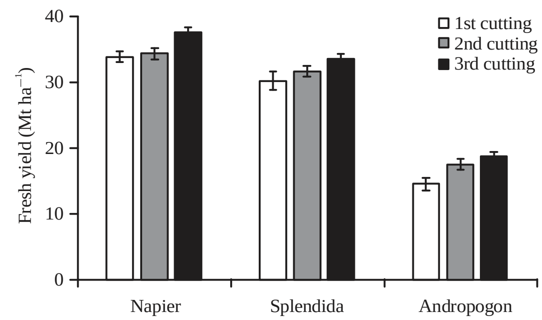

Fig. 4: Fresh yield of three fodders at three cuttings

Recording of field data

Phenotypic parameters (Growth)

Plant height (cm): From each plot 5 long, 5 medium and 5 short plants were randomly selected and marked with bamboo sticks. After that, plant height was measured using measuring tape. Similar process was done before each cutting.

Number of tillers per plant, leaf length (cm), number of leaf per tiller: Numbers of tillers of five randomly selected plants were counted. Tillers, which had at least one leaf visible were counted. Randomly selected five leaves from each plant were measured by using measuring tape. At first from a plant a tiller was selected randomly and then the numbers of leaves of a tiller were counted.

Biomass yield of fodder

Fresh yield (MT ha^{-1}) and dry yield (Mt ha^{-1}): Immediately after cutting the fodder, fresh yield was recorded by weighing using balance and yield was expressed in Mt ha^{-1}. After calculating the DM content, the dry yield was calculated and expressed in Mt ha^{-1}.

Statistical analysis: The recorded data and collected data were statistically analyzed using "Analysis of variance" technique with the help of computer program, MSTAT. Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) test were performed to evaluate the significance of mean differences among the treatments[12].

RESULTS AND DISCUSSION

Phenotypic parameter (Growth) of three fodder germplasm

Plant height (cm): Plant height of three fodders viz., Napier, Splendida and Andropogon were significantly ($p<0.01$) differenent in all the cuttings (Table 1). The highest plant height was obtained by Napier, the lowest by Splendida and Andropogon showed average value between Napier and Splendida at all cuttings (Fig. 3). The average plant height of Napier, Splendida and Andropogon was 106.07±1.00 and 51.00±2.00 and 51.67±1.20 cm in the 1st cutting, 125.54±2.00, 51.51±1.00 and 57.50±2.20 cm in the 2nd cutting and 128.28±1.90, 55.00±1.10 and 65.00±1.00 cm in the 3rd cutting, respectively (Table 1). The highest plant height of Napier might be due to high genetic potentiality of this fodder to utilize soil nutrients more effectively than other grasses[13].

Rahman *et al.*[10] worked with three varieties of Napier and found 170.18, 195.58 and 142.41 cm plant height which was higher than this study. Plant height 56.28 and 64.25 cm was also found for Splendida and Andropogon, respectively which were almost similar to this study. Aderinola *et al.*[14] worked with Andropogon fodder and found the higher plant height than this study may be due to decreased response with minimum dose of organic manure. Pikar[15] observed Napier had highest plant height (130-135 cm) among Para, Splendida, Andropogon, German and Guinea grass.

Leaf length (cm): Significant ($p<0.01$) values of leaf length were observed in Napier, Splendida and Andropogon at all the three cuttings (Table 1). The average leaf length of Napier, Splendida and Andropogon was 53.72±1.10, 25.00±1.00 cm and 35.00±1.33 cm in the 1st cutting, 56.44±1.44, 26.50±0.90 and 35.33±2.00 cm in the 2nd cutting and 56.77±1.20, 26.56±1.10 and 37.00±1.00 cm in the 3rd cutting, respectively (Table 1). So, it is observed that the highest leaf length was found in Napier and the lowest in Splendida fodder at all cuttings and Andropogon showed middle value in between Napier and Splendida. The highest leaf length of Napier might be due to higher sunlight absorbing capacity and higher growth of this grass more effectively than other grasses.

Rahman *et al.*[10] worked with Splendida and found lower leaf length that varied from 22-25 cm and also worked with Andrpogon and found the similar result to this study. Horne and Stur[16] conducted an experiment with Andropogon and found 37 cm leaf length for three cuttings. Pikar[15] worked on Napier and found the similar result i.e., highest leaf length in Napier varied from 50-55 cm.

Number of tillers per plant: Napier, Splendida and Andropogon had significant ($p<0.01$) variation in number of tillers per plant in all the three cuttings (Table 1). The average number of tillers of Napier, Splendida and Andropogon was 26.98±1.00, 41.00±1.00 and 24.33±1.33 in the 1st cutting, 27.91±1.00, 42.33±2.33 and 26.00±1.00 in the 2nd cutting and 29.58±0.80, 45.00±1.00 and 26.50±0.50 in the 3rd cutting, respectively (Table 1). So, it is distinctly visible that number of tillers per plant was highest in Splendida and lowest in Andropogon and Napier was in the between at all cuttings. The highest number of tillers of Splendida might be due to superior genetic quality of this fodder among three grasses.

Rahman[10] and Pikar[15] reported that Splendida showed highest number of tillers per plant in an experiment among Para, Napier, Andropogon and German grass. Jansen *et al.*[17] worked on Andropogon and got the similar result and they found 27 tiller per plant.

Number of leaf per tiller: Number of leaf per tiller of three fodders i.e., Napier, Splendida and Andropogon were not significant ($p>0.05$) in any of the three cuttings (Table 1). But the highest number of leaf per tiller was obtained by Napier and the lowest by Andropogon at all cuttings. The average number of leaf per tiller of Napier, Splendida and Andropogon was 11.23±1.10, 10.10±1.00 and 10.00±1.00 in the 1st cutting, 12.02±1.00, 11.31±1.10 and 11.00±2.00 in the 2nd cutting and 12.30±1.10, 11.50±1.00 and 11.52±1.10 in the 3rd cutting, respectively (Table 1). Similar results also found by Wangchuk *et al.*[18] who worked on Napier and found 10-12 leaf per tiller. The highest number of leaf per tiller of Napier might be due to higher growing efficiency of this fodder more than other grasses[19].

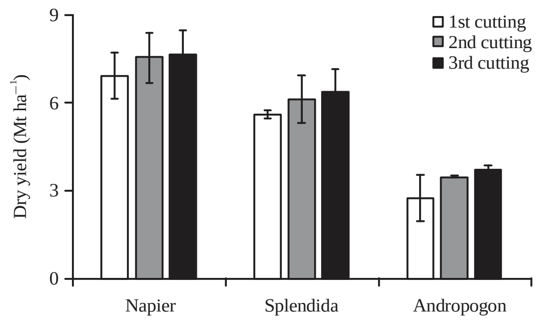

Fig. 5: Dry yield of three fodders at three cuttings

Biomass yield of three fodder germplasm

Fresh yield (Mt ha^{-1}): Napier, Splendida and Andropogon had significant ($p<0.01$) variation in fresh yield in all the three cuttings (Table 2). The average yield of Napier, Splendida and Andropogon was 33.91±0.79, 30.26±0.79 and 14.46±0.79 Mt ha^{-1} in 1st cutting, 34.39±1.44, 31.73±0.79 and 17.37±0.79 Mt ha^{-1} in 2nd cutting and 37.54±0.95, 33.59±0.79 and 18.61±0.72 Mt ha^{-1} in 3rd cutting (Table 2). It is observed that the highest yield was found in Napier and the lowest in Andropogon and Splendida showed middle value among other two fodders at all cuttings (Fig. 4). The highest fresh yield of Napier might be due to the highest plant height, leaf length and number of leaf per tiller of this fodder than the others. Positive response of Napier to organic manure and nitrogen fertilizer as nitrogen enhances growth of fodder might be another reason for highest yield[20].

Pikar[15] conducted an experiment with different fodder germplasm including Napier, Splendida and Andropogon. He found 42-45 Mt ha^{-1} fresh yield of Napier and 29.10 Mt ha^{-1} fresh yield of Andropogon which are higher than present study. Islam[9] found similar result like this study and that is fresh yield of Napier was 35.70-38.82 Mt ha^{-1}. Rahman *et al.*[10] also found similar result. He worked on Napier and Splendida grass and found 30-35 and 28-30 Mt ha^{-1}.

Dry yield (Mt ha^{-1}): Significant ($p<0.01$) difference in dry yield of Napier, Splendida and Andropogon was found in all the three cuttings (Table 2). The highest dry yield was found in Napier and the lowest in Andropogon fodder and Splendida maintained an average value at all cuttings (Fig. 5). The average dry yield of Napier, Splendida and Andropogon was 6.91±0.79, 5.59±0.14 and 2.75±0.07 Mt ha^{-1} in the

Table 1: Plant height, leaf length, tiller per plant (No.) and Leaf per tiller (No.) of the three fodder germplasm at different cuttings

	1st cutting				2nd cutting				3rd cutting			
	Mean±SD				Mean±SD				Mean±SD			
Fodders name	Plant height (cm)	Leaf length (cm)	Tiller per plant (No.)	Leaf per tiller (No.)	Plant height (cm)	Leaf length (cm)	Tiller per plant (No.)	Leaf per tiller (No.)	Plant height (cm)	Leaf length (cm)	Tiller per plant (No.)	Leaf per tiller (No.)
Napier	106.07±1.00^{a}	53.72±1.10^{a}	26.98±1.00^{b}	1.23± 1.10	125.54±2.00^{a}	56.44±1.44^{a}	27.91±1.00^{b}	12.02±1.00	128.28±1.90^{a}	56.77±1.20^{a}	29.58± 0.80^{b}	12.30±1.10
Splendida	51.00±2.00^{b}	25.00±1.00^{c}	41.00±1.00^{a}	10.10±1.00	51.51±1.00^{c}	26.50± 0.90^{c}	42.33±2.33^{a}	11.31±1.10	55.00±1.10^{c}	26.56±1.10^{c}	45.00±1.00^{a}	11.50±1.00
Andropogon	51.67±1.20^{b}	35.00±1.33^{b}	24.33±1.33^{c}	10.00±1.00	57.50±2.20^{b}	35.33±2.00^{b}	26.00±1.00^{c}	11.00±2.00	65.00±1.00^{b}	37.00±1.00^{b}	26.50±0.50^{c}	11.52±1.10
LSD	1.69	1.33	1.91	1.19	2.09	1.75	1.00	1.23	1.61	1.27	1.08	1.66
CV (%)	13.13	11.08	8.33	4.44	14.58	11.02	9.39	3.31	14.51	11.44	7.07	4.80
Level of significance	**	**	**	NS	**	**	**	NS	**	**	**	NS

In a column, the values having common letter(s) did not differ significantly whereas those with dissimilar letter(s) differed significantly as adjusted by DMRT, **Significant at 1% level of probability, NS: Not significant

Table 2: Fresh yield, dry yield, crude protein yield and crude fiber yield of the three fodder germplasm at different cuttings

	1st cutting				2nd cutting				3rd cutting			
	Mean±SD				Mean±SD				Mean±SD			
	(Mt ha^{-1})				(Mt ha^{-1})				(Mt ha^{-1})			
Fodders name	Fresh yield	Dry yield	Crude protein	Crude fiber	Fresh yield	Dry yield	Crude protein	Crude fiber	Fresh yield	Dry yield	Crude protein	Crude fiber
Napier	33.91±0.79^{a}	6.91±0.79^{a}	0.78±0.03^{a}	2.14±0.14^{a}	34.39±1.44^{a}	7.51±0.86^{a}	0.84±0.10^{a}	2.19±0.19^{a}	37.54±0.95^{a}	7.65±0.79^{a}	0.85±0.10^{a}	2.37±0.20^{a}
Splendida	30.26±0.79^{b}	5.59±0.14^{b}	0.61±0.10^{b}	1.74±0.10^{b}	31.73±0.79^{b}	6.11±0.79^{b}	0.72±0.02^{b}	1.75±0.05^{b}	33.59±0.79^{a}	6.34±0.79^{a}	0.72±0.02^{b}	1.94±0.04^{b}
Andropogon	14.46±0.79^{c}	2.75±0.07^{c}	0.35±0.02^{c}	0.90±0.02^{c}	17.37±0.79^{c}	3.48±0.01^{c}	0.44±0.02^{c}	1.12±0.20^{c}	18.61±0.72^{c}	3.72±0.14^{c}	0.47±0.02^{c}	1.23±0.10^{c}
LSD	0.98	0.58	0.071	0.136	1.21	0.74	0.073	0.196	0.83	0.75	0.071	0.115
CV (%)	20.85	21.51	20.90	21.26	17.59	18.62	17.37	17.87	16.54	16.87	16.72	16.74
Level of significance	**	**	**	**	**	**	**	**	**	**	**	**

In a column, the values having common letter(s) did not differ significantly whereas those with dissimilar letter(s) differed significantly as adjusted by DMRT, **Significant at 1% level of probability

1st cutting, 7.51±0.86, 6.11±0.79 and 3.48±0.01 Mt ha^{-1} in the 2nd cutting and 7.65±0.79, 6.34±0.79 and 3.72±0.14 Mt ha^{-1} in the 3rd cutting (Table 2). The highest fresh yield of Napier may be the reason of getting the highest dry yield from this fodder in this study.

Pikar[15] conducted an experiment with Napier, Splendida and Andropogon and found that 7.17, 6.60 and 7.14 Mt ha^{-1} dry yield, respectively which was almost similar with Napier and Splendida but higher in case of Andropogon in the present study. Rahman *et al.*[10] found 7.56 Mt ha^{-1} dry yield of Napier in an experiment which is similar to this study. Jansen *et al.*[17] worked with Napier and found similar result which was 5-8 Mt ha^{-1} dry yield. Researchers also worked with Andropogon grass and found 6.89 Mt ha^{-1} dry yield which is higher from this study.

Crude protein yield (Mt ha^{-1}): Crude Protein (CP) yield of Napier, Splendida and Andropogon were significant ($p<0.01$) in all the three cuttings (Table 2). The average CP yield of Napier, Splendida and Andropogon found 0.78±0.03, 0.61±0.10 and 0.35±0.02 Mt ha^{-1} in the 1st cutting, 0.84±0.10, 0.72±0.02 and 0.44±0.02 Mt ha^{-1} in the 2nd cutting and 0.85±0.10, 0.72±0.02 and 0.47±0.02 Mt ha^{-1} in the 3rd cutting (Table 2). The highest CP yield was found in Napier and the lowest in Andropogon. Present study showed that Napier had the highest CP yield in every cutting and the reason might be the highest yield of this fodder and in case of Andrpogon the reason is vice versa.

The results of present study are in conformity with Rahman *et al.*[10] in case of CP yields of Napier. Pikar[15] worked on Napier, Para, German, cowpea, Sorghum in the farmer's field and found similar result which was 0.85 Mt ha^{-1} CP yield. But he found the lowest CP yield from Napier grass and in this study Napier showed highest CP yield in each cutting.

Crude fiber (CF) yield: Significant ($p<0.01$) variation in Napier, Splendida and Andropogon in CF yield was found in all the three cuttings (Table 2). The average CF yield of Napier, Splendida and Andropogon were 2.14±0.14, 1.74±0.10 and 0.90±0.02 Mt ha^{-1} in the 1st cutting, 2.19±0.19, 1.75±0.05 and 1.12±0.20 Mt ha^{-1} in the 2nd cutting and 2.37±0.20, 1.94±0.04 and 1.23±0.10 Mt ha^{-1} in the 3rd cutting (Table 2). The highest CF yield was found in Napier and the lowest in Andropogon fodder at all cuttings. Splendida maintained an average value at all cuttings.

Pikar[15] conducted an experiment with Napier and found 2.33 Mt ha^{-1} CF yields which were similar to this study. Rahman *et al.*[10] worked with Napier, Splendida and Andropogon and found 2.50 Mt ha^{-1} CF yields which were almost similar to the present study. Hacker and Minson[21] worked on Splendida and found 2.00 Mt ha^{-1} CF yields which were higher from this study. Horne and Stur[16] conducted an experiment with Andropogon and Napier and found highest amount of CF yield in Andropogon among them.

CONCLUSION

In this study, phenotypic (growth) parameter included plant height, leaf length, number of tiller per plant and number of leaf per tiller. Except one parameter i.e., the number of leaf per tiller, the rest three were differed significantly ($p<0.01$) among the fodders. The Napier grass has highest plant height, leaf length and number of leaf per tiller in each cutting. But the Splendida has highest number of tiller per plant in all cutting, which was statistically significant ($p<0.01$).

The yield parameter included fresh yield, dry yield, crude protein yield and crude fiber yield. Yield parameters have significant ($p<0.01$) difference among the fodders. Napier grass shows the highest yield values for all parameters in all cutting while Andropogon shows the lowest.

Considering all the parameters studied it may be advocated to cultivate Napier and Splendida fodder at farmer's field. Due to the low productivity, Andropogon could not be recommended under less management and low input. After completion of this study process the three selected cultivators along with the other people of that village were inspired and interested to cultivate fodder in their homestead fallow lands. Therefore, now it is indispensable and vital need to motivate the farmers about cultivating fodders in fallow lands. This approach will mitigate the green grass requirements of their animals as well as increase animal productivity which can contribute greatly the farming system of Bangladesh.

REFERENCES

1. Sheen, S.Y. and C.M. Hong, 1999. Disposal of animal waste-the magnitude of the problem in Asia and Australasia-review. Asian-Aust. J. Anim. Sci., 12: 597-603.
2. Delgado, C., M. Rosegrant, H. Steinfeld, S. Ehui and C. Courbois, 2001. Livestock to 2020: The next food revolution. Outlook Agric., 30: 27-29.
3. Cassidy, E.S., P.C. West, J.S. Gerber and J.A. Foley, 2013. Redefining agricultural yields: From tonnes to people nourished per hectare. Environ. Res. Lett., Vol. 8.
4. Tareque, A.M.M. and M. Saadullah, 1988. Feed Availability, Requirements for Animals and Current Pattern of Utilization in Bangladesh. International Development Research Centre (IDRC), Canada.

5. Leng, R.A., 1995. Trees-their role in animal nutrition in developing countries in the humid tropics. University of New England, Armidale, N S W 2351. Australia.
6. Ranjhan, S.K. and K. Singh, 1993. Nutrient Requirements, Feeding Standards and Feeding of Ruminants and their Relevance to Indian Condition. In: Feeding of Ruminants on Fibrous Crops Residues, Singh, K. and J.B. Schiere (Eds.). Indian Council of Agricultural Research, New Delhi, India, pp: 117-130.
7. Haque, M.M. and M.R. Amin, 1992. Feeds and feeding of livestock-a study at the farming systems research site, Palima, Tangail. Bangladesh J. Anim. Sci., 5: 10-14.
8. BBS., 2014. Statistical year book of Bangladesh 2014. Statistics Division, Bangladesh Bureau of Statistics, Ministry of Planning, Government of Bangladesh, Government of the People's Republic of Bangladesh.
9. Islam, N., 2007. Effect of different doses of nitrogen and phosphorus fertilizer on yield, chemical composition and nutritive value of Napier grass (*Pennisetum purpureum*). Master's Thesis, Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh, Bangladesh.
10. Rahman, M.D., J. Khan and M. Abdullah, 2009. Fodder Germplasm in SAARC Countries. SAARC Agriculture Information Centre, Dhaka, ISBN: 9843000025045, Pages: 212.
11. Brammer, H., J. Antoine, A.H. Kassam and H.T. van Velthuizen, 1988. Land resources appraisal of Bangladesh for agricultural development. Report No. 3, Land Resources Data Base, Food And Agriculture Organization of the United Nations, Rome.
12. Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research. 1st Edn., John Wiley and Sons Inc., New York.
13. Adane, K., 2003. Effect of stage of growth and fertilizer application on dry matter yield and quality of natural grassland in the highlands of North Shoa, Oromia Region. Ph.D. Thesis, Alemaya University, Ethiopia.
14. Aderinola, O.A., J.A. Akinlade, A.A. Akingbade, R. Binuomote and J.A. Alalade, 2011. Performance and nutritional composition of *Andropogon tectorum* during a minor wet season as influenced by varying levels of inorganic fertilizer. J. Agric. For. Soc. Sci., 9: 129-142.
15. Pikar, 2010. A study on phenotypic characteristics and nutrient content of different fodder germplasm. Bangladesh Agricultural University, Mymensing.
16. Horne, P.M. and W.W. Stur, 1999. Developing forage technologies with smallholder farmers: How to select the best varieties to offer farmers in Southeast Asia. Australian Centre for International Agricultural Research. http://aciar.gov.au/publication/mn062.
17. Jansen, P.C.M., E. Westphal, J. Kartasubrata, L. t'Mannetje and R.M. Jones, 1992. Plant Resources of South-East Asia No. 4: Forages. Prosea/Pudoc, Bogor/Wageningen, Pages: 300.
18. 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. Trop. Grasslands, 3: 142-150.
19. Anderson, W.F., B.S. Dien, S.K. Brandon and J.D. Peterson, 2008. Assessment of bermudagrass and bunch grasses as feedstock for conversion to ethanol. Applied Biochem. Biotechnol., 145: 13-21.
20. Wadi, A., Y. Ishii and S. Idota, 2003. Effects of the level of fertilizer input on dry matter productivity of napiergrass (*Pennisetum purpureum*) and kinggrass (*Pennisetum purpureum*). J. Jpn. Soc. Grassl. Sci. Jpn., 48: 15-20.
21. Hacker, J.B. and D.J. Minson, 1972. Varietal differences in *in vitro* dry matter digestibility in *Setaria* and the effects of site, age and season. Crop Pasture Sci., 23: 959-967.