Study on Forage Crop Production on Sloping Land and in Bangladesh

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ABSTRACT : Three perennial grasses, Napier (*Pennisetum purpureum*), Andropogan (*Andropogan gayanus*) and Para (*Brachiria mutica*), were grown at different hill heights dividing the hill slope into three regions (top, middle and bottom). The first two grasses gave the highest biomass yields (29.9 and 37.6 tonnes/ha/harvest, respectively) followed by Para (20.5 t/ha). No significant ($p>0.05$) changes in biomass yields of the grasses were found due to differences in hill heights. The grasses were harvested three times in the first year of cultivation. Maize and cowpea as sole crops or their intercrops were cultivated in the plain land and the intercrop gave the highest biomass yield (46.7 t/ha, $p<0.05$). The biomass produced was successfully ensiled in the underground pits at the hill tops.
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Key Words : Biomass Yield, Forage Crop, Sloping Land

INTRODUCTION

Bangladesh is a sub-tropical country with a total land area of 14.12 million hectares (m ha), including 2.46 m ha tropical forest area of which only 5.40% has tree coverage. Shifting cultivation (slash and burn/swidden cultivation) was in practice for crop cultivation in the hill forests (Ahsan and Begum, 1992). This practice leads to the loss of wild species through the destruction, degradation or depletion of natural habitats. Shifting cultivation accounts for an estimated 50% of the deforestation in Asia, 70% in Africa and 30% in Latin America (IRRI, 1992). FAO also reported that when forests decline or are removed, the animals and plants living in them also disappear (The Bangladesh Observer, Oct 29, 1995). However, the practice is further increased by the high population pressure as the land-to-man ratio of the country is only 0.11 ha, and the net per capita cropped area is only 0.08 ha.

The majority of the tribal people live in the hilly forests with primitive ways of life and practice traditional agriculture which is predominantly integrated farming systems including crop production under shifting cultivation together with homestead garden, livestock, horticulture and forest trees (Alam et al., 1993). Introduction of livestock may play a vital role in the integrated agroforestry system especially in the hilly districts (Chittagong Hill Tracts, Chittagong Districts and the northern part of the greater Sylhet District) as it converts a part of crop residues into a high quality food for humans and into a high quality nutrient for the plants. Moreover, the rain fed forest offers a huge amount of natural biomass during the monsoon, which may be conserved to feed livestock. The integrated agroforestry system, on the other hand, may be enriched with the introduction of grasses, which may reduce soil erosion as well as produce biomass for feeding livestock. The experience of the Mindanao Baptist Rural Life Centre in Bansalan, Davaodel Sur, The Philippines tends to show that this technology may minimize erosion, improve soil fertility and provide a satisfactory income for upland families.

In view of the above facts, this study was designed to determine the productivity of different forages on hill slopes.

MATERIALS AND METHODS

Environment of the experimental station

The experiment was conducted on hill slopes and their bases at the Bangladesh Livestock Research Institute (BLRI), Regional Station, Naikhongchari, Bandarban during 1994-95. Most of the hills have variations in height from 50 to 100 m and in slope of about 40 to 45%. Their soil texture varies from sandy to clay loam with a pH value ranging between 4.5 to 6.5 and the annual rainfall varies from 2,500 to 5,000 mm. Weekly average minimum and maximum temperature and rainfall throughout the year were taken at Meteorological section of Cox's Bazaar district, near the experimental station. Most of the rainfalls in the area occur in May to October which may be called the wet season; the other six (6) months remain dry or semi-dry and may be called the dry season. During the wet season (May to October), the rainfall and temperatures varied from 175 to 950 mm and 30°C to 43°C, respectively and in the dry season (November to April) they varied from nil to 200 mm and 15.6°C to 30°C.

Growth of grasses on hill slopes

About 1.5 ha of hill slopes was cleared and the bushes were burnt. At the beginning of the monsoon tree saplings were planted by spade on the cleared hill slope followed by the establishment of perennial grasses viz., *Pennisetum purpureum*, *Andropogan gayanus* and *Brachiria mutica*. To select a suitable grass or grasses for cultivation on the hill

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slope, the above perennial grasses were cultivated dividing the slope of a hill into three regions (blocks) viz., i) the top, ii) the middle, and iii) the bottom. The regions were divided by contour lines. Ipil ipil (*Leucaena leucocephala*) saplings were planted in contour lines. Each region was divided into three experimental plots and was planted with the selected grasses. The size of the individual plot was 4 m×4 m. Tree saplings were planted in the 3rd week of May 1994 at a depth of 4-5 cm with a row to row spacing of 70 cm and plant to plant spacing of 45 cm. The plots were fertilized with urea at the rate of 57 kg N/ha, and fertilizer application was done about 25 days after planting. Similar rate of fertilizer was used after each cutting. The initial growths of grasses were harvested at 60 days of age at about 15 cm above the ground using a sickle, and the regrowth was cut after 45 days. Data were recorded on biomass yield, plant height, number of leaves and tillers per plant.

Growth of maize and cowpea on the plains

About 0.4 ha of the plain land available at the hill foot was divided into three blocks, and each block was further divided into three experimental plots. The land was prepared well and maize or cowpea separately, or maize with cowpea seeds were sown randomly in the plots in the 2nd week of February 1995. The fertilizer application (57 kg N/ha) was about 20 days after sowing at the time of first irrigation. The forages were harvested at 60 days.

Preparation of silage

After cutting, the plants were immediately chopped into about 10-15 cm lengths manually. Before ensiling, the plant materials were mixed with molasses (3% DM basis). Napier and Para silages were made in underground pits, people compressed the materials, and the pits were covered by plastic film at the top and bottom. The heap of the silo pit was 125 cm height above ground level. A similar method of silage making was described by Huque et al. (1995).

Chemical analysis

Dry matter (DM), organic matter (OM), ash and crude protein (CP) were determined according to the standard procedure of AOAC (1970) while acid detergent fibre (ADF) was determined according to the method described by Georing and Van Soest (1970). Rumen degradability of the grasses was determined by placing two grams of chopped sample into nylon bags of 7.5×10 cm size, made of polymide cloth with a pore size of 36 μm and 2,400 holes/cm^2, and tied to a nylon tube for incubation up to 72 h. Dry matter degradability was determined according to the method described by Bhargava and Ørskov (1987). The data were analyzed using the exponential mathematical model described by McDonald (1981).

Statistical analysis:

The biomass production of the three grasses (Napier, Para and Andropogan) and yield responses at different hill heights of the grasses were analyzed for significant differences in an ANOVA of a randomized block design. The significant difference in the biomass production of the three crops (maize, cowpea and their intercrops) were determined in an ANOVA of a simple design.

RESULTS AND DISCUSSION

Biomass yields of perennial and seasonal grass

Out of the three grasses cultivated on the hill slope, Napier, Para and Andropogan grew well and were harvested three times in the first year of cultivation. Their fresh biomass yields from a harvest (tonnes, t/ha) on the hill slope and the yields of the grasses at different regions (top, middle and bottom) in the monsoon are shown in table 1 and 2, respectively. Table 1 shows that Andropogan gave the highest yield followed by Napier and Para. The yields of Napier and Andropogan at the three hill heights did not differ significantly. However, Para gave a lower biomass yield at the top or the bottom region than the middle. The yields of Napier and Andropogan at different regions were 32.5, 28.5 and 35.8 t/ha, respectively and 31.9, 25.1 and 24.3 t/ha, respectively. Plant height was higher (258 cm) at the middle region than the bottom (252 cm) or the top (248 cm). Number of leaves/plant was less (11.7) at the bottom region than the middle (12.3) or the top (13.5). But number of tillers/plant was more (11.5) at the top region than the bottom (10.3) or the middle (8.7). Ipilipil cultivated on the contour line could not be grown. Soil acidity (pH varied from 4.5 to 6.5) may be one of the causes as the plant grows well in the alkaline soil.

Table 3 shows the biomass yield of maize, cowpea and

Table 1. Biomass yields (t/ha) of perennial grasses cultivated on the hill slope on Naikhongchari

Items	Grasses			Significance	
	Napier	Para	Andropogan	SED	Level
Fresh biomass	29.9	20.5	37.6	5.04	p<0.05
Dry matter	5.5	4.1	10.5	0.58	p<0.001

Table 2. Fresh biomass yields (t/ha) of perennial grasses cultivated at different regions of the hill at Naikhongchari

Grasses	Regions			Significance	
	Top	Middle	Bottom	SED	Level
Napier	32.5	28.5	35.8	3.35	NS
Para	14.4	28.6	17.1	5.37	p<0.05
Andropogan	31.9	25.1	24.3	7.55	NS

NS: not significant.

Table 3. Biomass yields (t/ha) of maize or cowpea as sole crops or their intercrops cultivated on the plain land of the hill foots during the dry period (February to April)

Items	Crops			Significance	
	Maize	Cowpea	Maize +Cowpea	SED	Level
Fresh biomass	21.3	25.0	46.7	3.35	p<0.001

Table 4. Chemical composition of silage

Chemical composition	Silage		Significance	
	Napier	Para	SED	Level
Dry matter (g/kg)	942	952	2.24	p<0.05
Ash (g/kgDM)	104	81	11.43	p>0.05
Organic matter (g/kgDM)	896	919	11.43	p>0.05
Crude protein (g/kgDM)	52	61	3.06	p<0.05
Acid detergent fibre (g/kgDM)	645	538	9.10	p<0.001

Table 5. The rumen DM degradability (g/kg) of silages fed to Gayals

Hours of incubation/ constant of the equation $y = a + be^{-ct}$	Silage		Significance	
	Para	Napier	SED	Level
8	272	172	3.4	p<0.001
16	360	205	6.9	p<0.001
24	434	265	7.8	p<0.001
48	558	422	5.3	p<0.001
72	603	506	5.5	p<0.001
a	144	102	5.4	p<0.01
b	498	388	5.4	p<0.001
c	3.66	2.78	0.1	p<0.001
a+b	622	490	7.4	p<0.001

a=water soluble fraction, b=potential digestible fraction, c=digestion rate and (a+b)=Extent of digestion.

the maize with cowpea intercrop cultivated on the plain land at the hill foot. The intercrop gave the highest biomass yield (46.7 t/ha, p<0.001) followed by the single crop of maize or cowpea (25.0 or 21.3 t/ha). The results were similar to the findings of Ahuja et al. (1991) who observed the green matter yield of maize, cowpea and maize with cowpea intercrop were 40, 24 and 36 t/ha, respectively. A similar effect of the maize and cowpea intercropping on a higher biomass yield than their sole crop was reported by Huque et al. (1995).

The quality of Napier and Para silages

The CP and ADF content of the silages varied from 52 to 61 g·kg^{-1} DM and 645 to 538 g·kg^{-1} DM, respectively. Anindo and Potter (1994) found a CP content of 82 to 148 g·kg^{-1} DM and a neutral detergent fibre (NDM) content of 629 to 742 g·kg^{-1} DM of 55 days mature Napier grass. Goldson (1977) stated that earlier cutting yields forage materials of high nutritive value but low dry matter content, while harvesting later gives relatively more dry matter but of poorer quality. Table 5 shows the rumen degradability of the silage dry matter. The rate (c, %/h) and the extent (a+b, g·kg^{-1} DM) of digestion or the potential (b, g·kg^{-1} DM) digestible fraction of Para and Napier silage were 3.66 and 622 or 498, respectively and 2.78 and 490 or 388, respectively. The dry matter degradability of the two grasses at 48 h of rumen incubation was 422 and 558 g·kg^{-1} DM, respectively. The *in vivo* dry matter digestibility of 55 days mature Napier grass cultivated in Kenya was about 720 g·kg^{-1} DM in the wet season (Anindo and Potter, 1994). Napier grass cultivated at Naikhongchari was also harvested in the wet season but the longer growth period gave a lower dry matter degradability in the rumen as compared to the results above.

CONCLUSION

The perennial grasses such as Napier, Para and Andropogan may be grown on the hill slope up to a hill height of 50 to 100 m having slopes up to 50%. At the first year of cultivation the grasses were harvested three times in the monsoon and survived without any irrigation in the dry season. The introduction of high yielding varieties of fodder in the Chittagong Hill Tract's region may play a vital role in increasing fodder production. The plain land at the hill foot may be cultivated with maize with cowpea intercrop for a higher biomass production than maize or cowpea as sole.

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