Forage Res., **48**(3) : pp. 307-314 (2022) **http://forageresearch.in**

QUALITY CHARACTERISTICS AND GREEN FODDER YIELD INFLUENCED BY THE SHEEP AND POULTRY MANURE IN THE HILL TRACT DISTRICTS OF BANGLADESH

MD. KHURSHID ALAM[1], MD. KABIRUL ISLAM KHAN[2,*], JANNATARA KHATUN[1] AND EMRAN HOSSAIN[1]

[1]Department of Animal Science and Nutrition
[2]Department of Genetics and Animal Breeding Chattogram Veterinary and Animal Sciences University, Khulshi, Chattogram - 4225, Bangladesh
**(e-mail : kkhan@cvasu.ac.bd)*

(Received : 18 December 2022; Accepted : 30 December 2022)

SUMMARY

The research was conducted to know the quality characteristics and biomass yield of fodder influenced by the sheep and poultry manure during the winter season of 2020 in the hill condition of Bangladesh. Among the experimental plots, a total of 16 maize, 16 cowpea and 4 maize+cowpea fodders were cultivated by applying the treatments (control (T0) = Fertilizer, N:P:K 1.6:0.90:0.30 (kg/decimal); T1 = Fertilizer + Sheep manure (80 kg/decimal); T2= Fertilizer + Poultry manure (80 kg/decimal) and T3 = Fertilizer + Combination of sheep and poultry manure (50:50) (80 kg/decimal)). The experimental data were collected from 4 uniform plots (4 decimals) from each experimental area. The results obtained that better values of morphometric parameters and fodder biomass yield were found in poultry manure (T2) were lower in the control group (T0) for both maize and cowpea and intermediate biomass yield was observed in sheep manure (T1) application. On the contrary, the highest CP, EE and lowest CF content in the cow dung application plot. So, we can be concluded that higher productivity with enhanced quality of green fodder with poultry manure rather than cow dung.

Key words : Green fodder, manure, cultivation, parameters

The Chittagong hill tract of Bangladesh has a diverse landscape which is mostly hilly areas and is different from the other parts of Bangladesh. Usually, the people of hilly areas, cultivate Jum as a rice crop production for their livelihood. However, nowadays in addition to crop production, people are cultivating other crops such as maize, cowpea and barseem. Moreover, they are rearing cattle, sheep and goat to bust up their livelihood. For rearing the ruminants, they have to feed those roughages and concentrate mixture and cultivate green fodder and forages, which would enhance the productivity of their livestock. Green fodder is the most important roughage for ruminant animal production throughout the world. An adequate and regular supply of green fodder is essential for the expression of the full genetic potential of productive and reproductive traits of ruminants (Grossi *et al.*, 2019; McGrath *et al.*, 2018). The areas of fodder crop are reducing due to urbanization and the shifting of cash crops by about two percent in each decade throughout the world (Swain and Teufel, 2017). For these reasons, a high-yielding of variety fodders should be cultivated to meet up the animal's feed requirements. Among the seasonal fodders, maize (*Zea mays*) is the third most important cereal crop in the world after wheat and rice (Olugbire, *et al.*, 2021; Sarwar and Biswas, 2021). Maize is a multipurpose crop that can be used for animal feed side by side with human consumption as a crop, maize can also be used as silage because of its high-yielding ability and excellent nutritional profile (Kumar *et al.*, 2017). Worldwide, maize is an ideal fodder crop, because of its quick-growing nature, succulence, palatability and excellent quality without any anti-nutritional factor; when harvested at any stage of crop growth (Reddy, 2018, Silva *et al.,* 2018). On the contrary, legumes are palatable and proteinous fodder crops, drought tolerant which have an important role in animal production. On the other hand, cowpea (*Vigna sinensis*) is a promising legume fodder crop, because its content has higher biomass and nutrient (Neda and Erena, 2020). It is also known as the southern pea or black eye pea is an important grain legume in the tropics. In addition to grain, it can produce good yields

of fodder for the ruminant feeding systems (Samireddypalle *et al.*, 2017; Arya *et al.*, 2019).

Though with the increasing human population, cultivable land is becoming scarce due to urbanization, the building of houses and crop production. Therefore, there is a competition arising between humans and animals for land utilization. If the maize and cowpea as fodder can be cultivated together as intercropping on the same land, which assists to utilize the land properly and economically. Aslam *et al.* (2020) stated that maize intercropping with legumes enhances growth, dry matter and its forage biomass yield under the deficit of irrigation. Arshadullah *et al.* (2018) also revealed that fodder quality improves through intercropping and fertilizer application. Sharif *et al.* (2017) discovered that incorporating maize and cowpea resulted in higher crude protein, dry matter and neutral detergent fiber degradability.

Currently, the hilly peoples are interested to rear sheep and poultry for their livelihood. Therefore, a huge amount of sheep and poultry (chicken) manure has been produced. These manures should be utilized as manure on the land otherwise it will produce more methane that would affect the climate. Generally, farmers cultivated maize and cowpea using cow dung and chemical fertilizers (nitrogen, phosphorus and potash) with different dose levels (Hossain *et al.,* 2017). However, the utilization of sheep and poultry manure and the combination of these two manure applications as manure for maize and cowpea production is very rare in Bangladesh. The current research was conducted, on whether single manure of sheep and goats and their combination with poultry manure is more suitable for fodder production. In this context, the present research was done with the objective to investigate the comparative performance of green fodder of maize, cowpea and intercropping of maize and cowpea under hilly conditions utilizing organic manures.

MATERIALS AND METHODS

A field study was carried out from December, 2019 to April, 2020 (winter) in the two upazillas (sub-district) hilly districts of Bandarban and Khagrachari, Bangladesh. The soil texture of the experiment site was sandy clay loam and brown in color. Composite soil samples were taken to a depth of 20 cm at the beginning of the study and were sent to Regional Soil Research Centre at Hathazary, Chattogram for laboratory analyses before manure application. Sheep and poultry manure were collected from the sheep and poultry farmers on the project site (Increasing livestock production in the Hills through better husbandry, health services and improving market access through value and supply chain management, project). Cowdung was also collected from the farmers in the same areas. All of the organic manure was decomposed at the farmers' households for utilization in the soil. The chemical characteristics of soil in the studied area are given in Table 1.

Land preparation, fertilizer application and experimental design

The land was prepared properly using a power tiller, three times and then by ploughing and spade as needed. Organic manure and fertilizer doses were applied before the final land preparation. A total of 36 plots of fodder were cultivated. Among them, 16 maize and 16 cowpea and 4 maize+cowpea plots were cultivated. The experimental data were collected from 4 uniform plots (4 decimals) from each experimental area were used. The experiment was conducted following the model Randomized Block Design (RBD) by applying four treatments in two locations. Furthermore, one of the plots of each site was selected for intercropping of maize and cowpea. The treatments were applied in different organic manure and fertilizers are shown in Table 2, however equal amount of cow dung was applied in all treated groups of land. The fertilizer application was done by the broadcast method. All phosphorus and potassium were applied at the time of sowing and urea fertilizer was divided into three doses. The first dose was given before the last ploughing. The second and third dose of fertilizer was

TABLE 1
Chemical characteristics of soil in the studied area

Characteristics	Maize fodder site	Cowpea fodder site	Mixed (Maize+Cowpea) site
Nitrogen (%)	0.12 (low)	0.12 (low)	0.11 (low)
Phosphorus (µg/g soil)	19 (optimum)	20 (optimum)	21 (optimum)
Potassium (meq/100g)	0.20 (medium)	0.22 (medium)	0.23 (medium)
P^H (%)	5.9 (slightly acidic)	6.1 (slightly acidic)	6.0 (slightly acidic)

applied 30 and 50 days after sowing respectively, for both fodder species.

The crop hybrid maize (*Zea mays*) and cowpea (*Vigna sinensis*) was sown on 24 December, 2019 using seed rates 40 kg and 25 kg per hectare in 70 cm and 45 cm apart rows and 30 cm and 15 cm intra row, respectively with the help of a single row drill and harvested in April, 2020.

Intercropping of maize with cowpea planting and agronomic practices

The intercropping of maize with cowpea was shown on 16 December, 2020 with row to row distance of 70 cm and seed to seed distance 30 cm and seed rate for maize and cowpea were 30 and 15 kg/hac respectively, and cowpea was cultivated between two rows. All other agronomic practices were followed as described above. The first, second and third weeding was done at 20, 45 and 60 days respectively after plantation. The fodder was harvested on 14 February, 2020 for cowpea and on 16 March, 2020 for maize.

Weeding, Watering, fertilizer and insecticide application and other intercropping activities

Weeding was done several times by the farmer's indigenous weeder (Khurpy). Usually, irrigation has given twice, but more was applied where necessary. Insecticides also were applied one time for maize and two times for cowpea fields.

Morphometric parameters

Morphometric parameters of fodders (such as number of tillers, plant length, stem length, leaf per plant, leaf length, leaf width, the weight of leaf, stem length, stem diameter, stem weight) were taken and recorded at 30, 60 and 90 days for maize fodder and 30, 45 and 60 days for cowpea fodders.

Maize and cowpea fodder samples were collected from different locations of plot at 30 and 60 days respectively and during harvesting. The chemical analyses (dry matter, DM; crude fat, CF; crude protein, CP; Ash, and nitrogen free extract, NFE) of these collected fodders were done in the Animal Nutrition Laboratory of Chattogram Veterinary and Animal Sciences University, Bangladesh using AOAC (1990) method.

Proximate components

Maize and copy at 60 days and again at 90 days from only maize fodder were collected from different locations of plots and after cutting and chopping (1-2 cm) the sample was mixed well and 500-600 were taken separately for the leaves, stem and whole plant. The sample was dried in the sunlight for about 2-3 days and milled and grind using a grinder and filled in a polythene bag and prepared the sample for proximate analysis.

Statistical analysis

Data on fodder growth, botanical fraction,

TABLE 2
Treatments were applied in different organic manure and fertilizers

Treatments	Replication	Manure and fertilizer doses		
		Maize	Cowpea	Maize + cowpea
T0	R1 R2 R3 R4	Cow dung 30 kg + Fertilizer N:P:K 1.6:0.90:0.30 (kg/decimal)	Cow dung (30 kg) + N:P 0.80:2 (kg/decimal)	Cow dung (30 kg) + N:P:K 0.5:0.4:0.3 (kg/decimal)
T1	R1 R2 R3 R4	Cow dung (30 kg+ Sheep manure (80 kg) + N:P:K 1.6:0.90:0.30 (kg/decimal)	Cow dung (30 kg) + Sheep manure (60 kg) + N:P 0.80:2 (kg/decimal)	Cow dung 30 kg + Sheep manure (60 kg) + N:P:K 0.5:0.4:0.3 (kg/decimal)
T2	R1 R2 R3 R4	Cow dung (30 kg) Poultry manure (80 kg) + N:P:K (1.6:0.90:0.30 (kg/decimal)	Cow dung (30 kg) Poultry manure (60 kg) + N:P 0.80:2 (kg/decimal)	Cow dung (30 kg) Poultry manure (60 kg) + N:P:K 0.5:0.4:0.3 (kg/decimal)
T3	R1 R2 R3 R4	Cow dung (30 kg) Combination of sheep and poultry manure (50:50) (80 kg) + N:P:K 1.6:0.90:0.30 (kg/decimal)	Cow dung (30 kg) Combination of sheep and poultry manure (60 kg) + N:P 0.80:2 (kg/decimal)	Cow dung (30 kg) Combination of sheep and poultry manure (60 kg) + N:P:K 0.5:0.4:0.3 (kg/decimal)

leaf length and chemical composition of maize and cowpea were recorded and analyzed by Randomized Block Design (RBD) using PROC GLM of SAS (SAS, 2010). Treatment means were compared by using the least significant difference test at P > 0.05.

RESULTS AND DISCUSSION

Growth parameters and fresh yield (kg/decimal) of maize fodder

The growth parameters of maize (*Zea mays*) are presented in Table 3. The average value of plant height of maize was increased with the increases of the age of the plant, however, at the cutting times (30, 60 and 90 days) it differed between treatments within a location. It is indicated that the different organic manure affected the plant height significantly (P<0.05) between the treatment. All the treatments applied with poultry manure produced significantly (P<0.05) taller plants as compared to control and other treatment groups in both locations. Treatment received poultry manure (@ 80 kg/decimal) produced the tallest maize plants (71 and 68.9 cm in the Bandarban and Khagrachari, respectively) at 30 days followed by mixed of sheep and poultry manure (T3), sheep manure (T1) and control group (T0). But there were no significant differences found between the sheep manure (T1) and the control group (T0) in the Khagrachari and Bandarban sites. The minimum plant height in T0 at an early stage of fodder growth might be due to the decreased amount of nitrogen in the soil, which happened due to the absence of sheep and poultry manure in the soil.

The highest stem length of maize plants was observed at both Bandarban and Khagrachari at 30 days in T2. The minimum stem length of maize fodder at 30 days in the control group (T0). There were no significant differences in T0 at the Bandarban and Khagrachari in 30 days of stem length of the maize plant. In that period, the tallest leaf length of maize plants was recorded in T3 in Bandarban and T2 in Khagrachari. The highest stem diameter was observed in T2 at both sites. The maximum leaf per plant at 30

TABLE 3
Effect of different types of organic manure on botanical parameter of maize fodder

Parameters	Bandarban						Khagrachari					
	T0	T1	T2	T3	Avg	SEM	T0	T1	T2	T3	Avg	SEM
Maize (at 30 days)												
Plant height (cm)	63.5^{a}	63.6^{a}	71.0^{b}	64.6^{a}	65.7	1.79	64.8^{a}	64.9^{a}	68.9^{b}	67.6^{b}	66.6	1.02
Stem length (cm)	16.6^{a}	22.0^{b}	22.9^{b}	18.0^{a}	19.9	1.53	14.6^{a}	17.5^{b}	19.6^{c}	18.2^{bc}	17.5	1.05
Leaf length (cm)	43.4^{ab}	40.3^{a}	43.1^{ab}	49.6^{b}	44.1^{a}	1.96	40.8^{a}	43.7^{a}	53.1^{c}	52.8^{b}	47.6^{b}	3.15
Stem diameter (mm)	17.0^{a}	22.6^{bc}	23.3^{c}	21.5^{b}	21.1^{a}	1.42	18.3^{a}	26.0^{bc}	27.0^{c}	25.9^{b}	24.3^{b}	2.02
Tiller No.	1.1^{b}	1.1^{b}	1.1^{b}	1.0^{a}	1.08	0.03	1.5^{a}	1.8^{b}	2.2^{c}	1.9^{bc}	1.85	0.14
Leaf/plant	7.3^{a}	9.3^{b}	9.5^{b}	8.7^{b}	8.7	0.49	8.0^{a}	8.8^{ab}	10.4^{c}	9.0^{b}	9.1	0.49
Maize (at 60 days)												
Plant height (cm)	87.1^{a}	90.5^{c}	88.6^{b}	89.5^{c}	88.9	0.72	87.8^{a}	91.9^{b}	88.3^{a}	91.4^{ab}	89.9	1.05
Stem length (cm)	22.3^{a}	25.9^{bc}	25.2^{b}	26.6^{c}	25.0^{a}	0.94	26.8^{a}	25.9^{a}	29.5^{b}	30.1^{b}	28.1^{b}	1.02
Leaf length (cm)	58.3^{a}	59.4^{a}	60.6^{b}	60.4^{b}	59.7	0.53	58.9^{c}	57.9^{b}	56.9^{a}	$57.^{6ab}$	57.8	0.42
Stem diameter (mm)	28.7^{a}	29.4^{b}	29.5^{b}	31.8^{c}	29.9^{a}	0.67	30.9^{a}	31.5^{a}	32.8^{b}	33.9^{b}	32.3^{b}	0.67
Tiller No.	1.1^{b}	1.1^{b}	1.1^{b}	1.0^{a}	1.08	0.03	1.5^{a}	1.8^{b}	2.2^{c}	1.9^{bc}	1.85	0.14
Leaf/plant	10.6^{b}	10.1^{a}	11.2^{c}	10.9^{bc}	10.7	0.23	11.4^{b}	11.6^{bc}	10.9^{a}	12.1^{c}	11.5	0.22
Maize (at 90 days)												
Plant height (cm)	108.2^{a}	118.3^{b}	107.2^{a}	114.8^{b}	112.1	2.66	107.3^{a}	119.2^{b}	106.7^{a}	115.7^{c}	112.2	3.10
Stem length (cm)	31.4^{a}	35.9^{b}	28.8^{a}	34.8^{b}	32.7	1.62	31.4^{a}	35.8^{bc}	36.7^{c}	34.9^{b}	34.7	1.16
Leaf length (cm)	60.0^{a}	68.2^{b}	67.6^{b}	62.3^{a}	64.5	2.01	62.0^{a}	$68.^{6bc}$	66.5^{b}	62.7^{a}	64.9	1.57
Stem diameter (mm)	32.3^{b}	28.4^{a}	35.0^{c}	32.8^{b}	32.1	1.37	32.3^{a}	34.4^{b}	35.2^{bc}	36.9^{c}	34.7	0.96
Tiller No.	1.1^{b}	1.1^{b}	1.1^{b}	1.0^{a}	1.08	0.03	1.5^{a}	1.8^{b}	2.2^{c}	1.9^{b}	1.85	0.14
Leaf/plant	12.0^{a}	12.6^{ab}	12.9^{b}	13.3^{c}	12.7	0.27	11.7^{a}	12.8^{c}	12.6^{bc}	12.5^{b}	12.4	0.24
Fresh Yield (kg/Decimal)	160.5^{a}	165.2^{b}	168.3^{c}	166.6^{bc}	165.2^{b}	167	152.7^{a}	158.5^{b}	157.8^{b}	159.4^{c}	157.1^{a}	150.0

Means with different superscripts in the same row differ significantly (P < 0.05) among the treatment groups. SEM is the number of rams in each treatment.
Control (T0) =Fertilizer, N: P: K 1.6:0.90:0.30 (kg/decimal); T1 = Fertilizer + Sheep manure (80 kg/decimal); T2= Fertilizer + Poultry manure (80 kg/decimal) and T3 = Fertilizer + Combination of sheep and poultry manure (50:50) (80 kg/decimal).

days of maize fodder was observed in T2 at both sites. The maximum tiller number also was found in T0, T1 and T2 in Bandarban and in T2 at the Khagrachari site, respectively.

The mean value regarding plant height of maize fodder at 60 days indicated that the tallest maize plants were obtained in sheep manure (T1) in both Bandarban and Khagrachari (90.5 and 91.9 cm, respectively). This was not supported by Enujeke (2013), who found the plant height of maize plant at 8 weeks of duration was 209.3 cm in Nigeria. The highest stem and leaf length of maize at 60 days in poultry manure (T2) and a combination of sheep and poultry manure (T3) were obtained from both sites. The highest stem diameter at 60 days also was observed in T3 at both sites. The maximum tiller number was also found in T0, T1 and T2 treatments at the Bandarban and in T2 at the Khagrachari site. The highest leaf per plant at the same age was observed in poultry manure (T2) at the Bandarban (11.2 no) and a combination of sheep and poultry manure (T3) at the Khagrachari (12.1 no.), which was more or less similar to the study of Enujeke (2013), who found 13.1 at the same age of maize plant.

The mean value concerning plant height of maize fodder at 90 days indicated that the tallest maize plants were found in sheep manure (T1) at both Bandarban and Khagrachari (118.3 and 119.2 cm, respectively). The highest stem of the maize plant at 90 days was found in sheep manure (T1) at the Bandarban and in poultry manure (T2) at the Khagrachari, respectively. The tallest leaf length at the same time was also obtained in T2 at both sites. The highest stem diameter at 90 days was observed in T2 at the Bandarban and T3 at the Khagrachari, respectively. At this stage, the maximum tiller number was found in T0, T1 and T2 treatments at the Bandarban and in T2 at the Khagrachari. The maximum

TABLE 4
Effect of different types of organic manure on botanical parameter of cowpea fodder

Parameters	Bandarban						Khagrachari					
	T0	T1	T2	T3	Avg	SEM	T0	T1	T2	T3	Avg	SEM
Cowpea (at 30 days)												
Plant height (cm)	15.12^{a}	15.37^{a}	17.75^{c}	16.87^{b}	16.27	0.62	15.75^{a}	16.00^{a}	16.12^{b}	16.37^{b}	16.06	0.12
Stem length (cm)	7.37^{a}	7.62^{b}	8.62^{b}	7.37^{a}	7.74	0.29	7.75^{b}	7.87^{b}	7.75^{b}	7.37^{a}	7.68	0.10
Leaf Length (cm)	6.62^{a}	7.50^{b}	7.62^{b}	7.37^{b}	7.27	0.22	7.37^{b}	7.25^{b}	7.37^{b}	7.00^{a}	7.24	0.08
Leaf width (mm)	20.50^{a}	22.62^{b}	25.62^{c}	22.5^{ab}	22.81^{b}	1.05	21.12^{a}	21.25^{a}	21.5^{b}	22.00^{b}	21.46^{a}	0.19
Leaf weight (gm)	1.58^{b}	1.56^{a}	1.61^{c}	1.57^{a}	1.58	0.01	1.66^{b}	1.65^{b}	1.65^{b}	1.58^{a}	1.63	0.01
Tiller No.	2.37^{a}	2.25^{a}	2.87^{b}	2.25^{a}	2.43	0.14	3.12^{b}	2.37^{a}	3.12^{b}	2.37^{a}	2.74	0.21
Leaf/plant	8.75^{a}	8.62^{a}	9.12^{b}	8.75^{a}	8.81	0.10	9.25^{a}	9.25^{a}	9.37^{b}	8.75^{a}	9.15	0.13
Cowpea (at 45 days)												
Plant height (cm)	40.62^{a}	42.50^{b}	45^{c}	43.62^{bc}	42.93	0.92	41.25^{a}	41.5^{ab}	41.25^{a}	42.12^{b}	41.53	0.20
Stem length (cm)	34.87^{a}	35.75^{ab}	36.75^{b}	37.12^{c}	36.12	0.50	35.87^{a}	36^{a}	36.00^{a}	37.12^{b}	36.24	0.29
Leaf Length (cm)	7.37^{a}	7.75^{ab}	8.5^{c}	8.25^{b}	7.96	0.25	7.87^{a}	8^{a}	7.75^{a}	8.25^{b}	7.96	0.10
Leaf width (mm)	39.25^{a}	40.37^{a}	43.5^{b}	43.75^{b}	41.71	1.12	39.5^{a}	39.75^{a}	39.00^{a}	43.12^{b}	40.34	0.93
Leaf weight (gm)	1.75^{b}	1.61^{a}	1.90^{c}	1.75^{b}	1.75	0.05	1.81^{b}	1.80^{b}	1.76^{a}	1.73^{a}	1.77	0.01
Tiller No.	8.25^{a}	8.37^{a}	10.00^{b}	8.75^{a}	8.84	0.40	9.25^{b}	9.12^{b}	8.87^{a}	9.00^{a}	9.06	0.08
Leaf/plant	26.75^{a}	27.5^{a}	28.12^{b}	28.62^{b}	27.74	0.40	27.5^{ab}	27.5^{a}	27.37^{a}	27.75^{b}	27.53	0.07
Cowpea (at 60 days)												
Plant height (cm)	41.87^{a}	44.25^{b}	46.87^{c}	45.37^{bc}	44.59^{b}	1.05	42.12^{a}	43.75^{b}	43.12^{b}	44.37^{b}	42.12^{a}	0.49
Stem length (cm)	38.25^{a}	38.25^{a}	40.5^{b}	39.62^{b}	39.15	0.55	38.75^{a}	38.62^{a}	38.62^{a}	40^{b}	38.75	0.29
Leaf Length (cm)	8.37^{a}	8.12^{a}	9.12^{b}	8.75^{ab}	8.59	0.21	8.50^{bc}	8.37^{b}	7.75^{a}	9.00^{c}	8.50	0.22
Leaf width (mm)	39.87^{a}	41.75^{b}	45.37^{c}	44.87^{c}	42.96^{b}	1.30	40^{a}	40.12^{a}	40.87^{ab}	44.37^{b}	40.00^{a}	0.93
Leaf weight (gm)	1.81^{ab}	1.75^{a}	1.98^{b}	1.98^{b}	1.88	0.05	1.81^{a}	1.8^{a}	1.81^{a}	2.06^{b}	1.81	0.05
Tiller No.	8.25^{a}	8.25^{a}	9.87^{b}	8.75^{a}	8.78	0.38	9.12^{ab}	8.87^{a}	9.87^{c}	9.5^{b}	9.12	0.19
Leaf/plant	27.25^{a}	29.25^{c}	28.75^{c}	28.12^{b}	28.34	0.43	27.75^{a}	28^{b}	28.25^{c}	27.75^{a}	27.75	0.11
Fresh Yield (Kg/Decimal)	68.00^{a}	69.00^{a}	72.00^{c}	71.00^{b}	70.00	1.52	67.00^{a}	68.00^{a}	70.00^{b}	69.00^{ab}	68.4	1.47

Means with different superscripts in the same row differ significantly ($P < 0.05$) among the treatment groups. SEM is the number of rams in each treatment.

Control (T0) = Cow dung (60 kg/decimal); T1 = Sheep manure (60 kg/decimal); T2= Poultry manure (60 kg/decimal) and T3 = Combination of sheep and poultry manure (50:50) (60 kg/decimal).

leaf per plant at 90 days of maize fodder was found also in T3 at the Bandarban and T1 at the Khagrachari. The highest fresh yield of green maize was harvested at 90 days in sheep manure (T1) at the Bandarban and in poultry manure (T2) at the Khagrachari, which was 168.3 and 159.4 kg per decimal, respectively. Similar results were obtained by other researchers (Shaheenuzzamn *et al.* 2015), who found 161.90 kg per decimal (39/99 t/ha) maize fodder from Ramgarh, Khagrachari.

Growth parameters fresh yield (kg/decimal) of cowpea fodder

The growth parameters of cowpea fodder (*Vigna sinensis*) are presented in Table 4. The mean value concerning plant height of cowpea fodder at 30 days showed that the tallest cowpea plants were found in poultry manure (T2) at the Bandarban and a combination of sheep and poultry manure (T3) at the Khagrachari site. The tallest stem length of cowpea fodder was revealed at 30 days in T2 at Bandarban and in sheep manure (T1) at the Khagrachari. The tallest leaf length of cowpea fodder at the same age was observed in T2 at both sites. The biggest leaf width of cowpea fodder at the same stage was found in T2 at the Bandarban and in T3 at the Khagrachari. The highest leaf weight of cowpea fodder at 30 days was observed in T2 at the Bandarban and T0 at the Khagrachari. The highest leaf per plant at 30 days was observed in T2 at the Bandarban and T0 and T1 at the Khagrachari sites, respectively.

Mean value regarding plant height of cowpea plant at 45 days in T2 at both sites than other groups. The tallest stem length was revealed at the same age in a combination of sheep and poultry manure (T3) both at the Bandarban and Khagrachari. The tallest leaf length of cowpea fodder at the same age was taken in poultry manure (T2) at Bandarban and in a combination of sheep and poultry manure (T3) at Khagrachari. The biggest leaf width was found at the same age in T3 at both sites. The highest leaf weight was found in T2 at Bandarban and in T0 in Khagrachari. The highest tiller number at 45 days it was observed in T2 at Bandarban and in T0 at Khagrachari. Maximum leaf per plant at 45 days was observed in T3 at both sites.

At 60 days, the tallest cowpea fodder and the tallest stem length were found in poultry manure (T2) and a combination of sheep and poultry manure (T3) respectively both in the Bandarban and Khagrachari. The highest leaf length also was observed in T2 at the

TABLE 5
Effect of different types of organic manure on botanical parameter of maize-cowpea intercropping fodder

Parameters	Bandarban						Khagrachari					
	T0	T1	T2	T3	Avg	SEM	T0	T1	T2	T3	Avg	SEM
Maize (at 90 days)												
Plant height (cm)	110.2^{a}	119.3^{b}	109.2^{a}	116.8^{b}	112.1	2.66	109.3^{a}	118.2^{b}	110.7^{a}	117.7^{c}	112.2	3.10
Stem length (cm)	32.4^{a}	36.6^{b}	29.9^{a}	35.8^{b}	32.7	1.62	30.6^{a}	36.7^{bc}	37.8^{c}	35.8^{b}	34.7	1.16
Leaf length (cm)	63.2^{a}	69.2^{b}	68.7^{b}	63.4^{a}	64.5	2.01	64.2^{a}	69.6^{bc}	67.5^{b}	65.7^{a}	65.9	1.57
Stem diameter (mm)	30.2^{b}	26.1^{a}	34.2^{c}	30.7^{b}	32.1	1.37	31.3^{a}	32.3^{b}	33.2^{bc}	34.8^{c}	34.7	0.96
Tiller No.	1.0^{a}	1.1^{b}	1.1^{b}	1.0^{a}	1.08	0.03	1.2^{a}	1.4^{b}	1.5^{c}	1.5^{b}	1.6	0.14
Leaf/plant	10.0^{a}	11.2^{ab}	11.6^{b}	12.2^{c}	12.7	0.27	10.6^{a}	11.6^{c}	11.4^{bc}	11.4^{b}	11.2	0.24
Fresh Yield (kg/Decimal)	150.4^{a}	154.1^{b}	156.3^{c}	155.6^{bc}	165.2^{b}	1.67	150.5^{a}	152.4^{b}	154.7^{b}	156.5^{c}	157.1^{a}	1.50
Cowpea (at 60 days)												
Plant height (cm)	38.36^{a}	41.32^{b}	42.26^{c}	44.27^{bc}	41.59^{b}	1.05	40.11^{a}	41.43^{b}	42.56^{b}	41.25^{b}	42.12^{a}	0.49
Stem length (cm)	36.12^{a}	37.23^{a}	38.12^{b}	37.32^{b}	37.15	0.55	38.75^{a}	38.62^{a}	38.62^{a}	40^{b}	38.75	0.29
Leaf Length (cm)	8.12^{a}	7.32^{a}	8.44^{b}	8.15^{ab}	8.25	0.21	8.24^{bc}	8.25^{b}	7.15^{a}	8.252	8.43	0.22
Leaf width (mm)	38.25^{a}	40.15^{b}	44.31^{c}	43.82^{c}	41.92^{b}	1.30	39.2^{a}	39.10^{a}	38.10^{ab}	42.30^{b}	38.70^{a}	0.93
Leaf weight (gm)	1.61^{ab}	1.55^{a}	1.78^{b}	1.88^{b}	1.88	0.05	1.71^{a}	1.7^{a}	1.80^{a}	2.00^{b}	1.8	0.05
Tiller No.	8.11^{a}	8.16^{a}	9.2^{b}	8.5^{a}	8.25	0.38	8.50^{ab}	8.15^{a}	9.26^{c}	9.15^{b}	8.25	0.19
Leaf/plant	25.28^{a}	27.12^{c}	26.15^{c}	27.10^{b}	28.34	0.43	26.25^{a}	28^{b}	27.24^{c}	24.65^{a}	26.15	0.11
Fresh Yield (Kg/Decimal)	62.00^{a}	67.00^{a}	70.00^{c}	69.00^{b}	68.00	1.52	66.00^{a}	67.00^{a}	69.00^{b}	68.00^{ab}	67.4	1.47

Means with different superscripts in the same row differ significantly ($P < 0.05$) among the treatment groups. SEM is the number of rams in each treatment.

Control (T0) = Cow dung (60 kg/decimal); T1 = Sheep manure (60 kg/decimal); T2= Poultry manure (60 kg/decimal) and T3 = Combination of sheep and poultry manure (50:50) (60 kg/decimal).

TABLE 6
Proximate component (%) of maize and cowpea fodder

Traits	Khagrachari		Bandarban	
	Maize fodder	Cowpea fodder	Maize fodder	Cowpea fodder
		60 days		
DM	22.34±1.18	14.2±0.87	21.5±1.15	15.1±0.92
CP	8.4±0.75	24.4±1.11	8.6±0.54	23.9±1.37
CF	12.6±0.83	13.1±0.43	13.5±0.76	14.2±0.38
EE	1.7±0.05	5.3±0.154	1.9±0.07	5.1±0.54
Ash	4.5±0.04	6.7±0.08	4.27±0.033	6.9±0.07
NFE	25.46^{b}±1.52	43.0^{b}±1.31	23.2^{a}±2.25	40.7^{a}±1.90
Energy MJ	8.9^{b}±0.65	8.7±0.82	8.1^{a}±0.61	9.0±1.54
		90 days		
DM	28.54^{a}±1.23		31.6^{b}±1.44	
CP	10.2±0.73		9.8±0.65	
CF	16.3±0.98		17.3±0.88	
EE	2.0±0.07		2.1±0.09	
Ash	5.8±0.06		5.97±0.043	
NFE	34.66^{b}±1.67		31.2^{a}±2.87	
Energy MJ	10.1±0.99		10.4±0.57	

Legends: DM = Dry matter, CP = Crude protein, CF = Crude fat, EE = Ether extract, NFE = Nitrogen free extract, MJ = Megajoule. Means with different superscripts in the same row differ significantly ($P < 0.05$) between the locations.

Bandarban and in T3 at the Khagrachari. The biggest leaf width was observed at the same age in T2 at Bandarban and in T3 at Khagrachari. The highest leaf weight of the above stage was found in T2 and T3 jointly at the Bandarban and in T3 at the Khagrachari. The highest tiller number at the mentioned period was found in T2 at both sites. The highest leaf per plant at 60 days was observed in T2 at both sites. The highest fresh yield of green cowpea was found in T2 (72 and 70 kg at the Bandarban and Khagrachari, respectively. The result was lower than the result of Iqbal *et al.,* (2018) who found 36.55 kg per decimal dry matter of biomass yield of cowpea fodder in Pakistan.

In comparison to the growth parameters and fresh yield, it was observed that the treatment T4 that is the combination of sheep and poultry manure was better than other treatments and it was suggested if the farmers use the combination of sheep and poultry manure they can be more biomass for fodder.

Proximate Components of maize and Cowpea fodder

The proximate components of the maze and cowpea fodder at different ages were presented in Table 6. The dry matter (DM), crude protein (CP), crude fat (CF), ether extract (EE), and Nitrogen free extract (NFE), of the maize plant increase with the increase of the age of the plant. Most of the nutrients were similar in both locations except NFE and Energy at 60 days of age for maize and cowpea. On the other hand, the DM of maize fodder at 90 days also differed significantly ($P<0.05$) between locations. The fodder production location also influences the yield and nutrient composition of fodder was also reported by Hanif *et al.* (2020) and Khatun *et al.* (2014).

CONCLUSION

The obtained results indicated that better values of morphometric parameters and fodder biomass yield were found in poultry manure than in the control group for both maize and cowpea production and intermediate biomass yield was observed from the sheep manure application field. The nutrient contents of maize and cowpea fodder did not differ significantly between locations. Therefore, it can be suggested if the farmer applies poultry manure instead of other manures they will be more economically benefited as the biomass yield of maize and cowpea was higher. The location has an influence on fodder yield and nutrient composition. Such research has a positive impact on under-livestock production in hilly areas.

ACKNOWLEDGMENTS

The authors acknowledge Krishi Gobeshona Foundation (KGF) for funding this research (CRP-IV: Increasing livestock production in the hills through better husbandry, health service and improving market access through value and supply chain management, project). They also acknowledge the field assistance of the project and the farmers in the project sites for their active support, collaboration, and data creation. Last but not least the authors thank the authority of Chattogram Veterinary and Animal Sciences University and the staff of the Department of Genetics and Animal Breeding and Dept. of Animal Sciences and Nutrition and the project collaborative institutes.

REFERENCES

Arshadullah, M., N. Hussain, H. Schmeiskyc and M. Rsahid, 2018: Fodder quality improvement through intercropping and fertilizer application. *Pakistan J. Agric. Sci.,* 55: 549-554. doi: 10.21162/PAKJAS/18.4579.

Arya, R. K., R. Panchta, Nguyen, N. V. and S. K. Pahuja, 2019 : Meteroglyph analysis of owpea (*Vigna unguiculata* L. Walp) elite genotypes. *Ekin J.* **5**: 97-102.

Aslam, A., A. Naeem, A. Rehman and A. Zafar, 2020 : Maize (*Zea mays*) intercropping with legumes enhances growth, dry matter and its forage yield under deficit irrigation. *Inter. J. Agric. Biol.,* **25** : 89-97.

Enujeke, E. C., 2013 : Effect of poultry manure on growth and yield of improved maize in Asaba area of Delta state. *Nigeria J. Agric. Vet. Sci.,* **4** : 24-30.

Grossi, G., P. Goglio, A. Vitali, and A. G. Williams, 2019: Livestock and climate livestock and climate change: impact of livestock on climate and mitigation strategies. *Anim. Front.* **9** : 1-8. https://doi.org/10.1093/af/vfy034.

Hanif, N. Q. and N. Akhtar, 2020 : Nutritional evaluation of maize plant fodder grown in spring and autumn season in Punjab. *Pakistan J. Biores. Managt.*, **7**: 74-93. doi: https://doi.org/10.35691/JBM.0202.0123.

Hossain, M. A. S., M. J. Miah, H. Akter and M. F. Islam, 2017 : Growth and yield of cowpea under integrated nutrient management practices. *J. Sylhet Agril. Univ.,* **4**:191-198.

Khatun, M.J, M. K. I. Khan and S. M. S. Sharir, 2014 : Effect of various levels of nitrogen and phosphorus fertilizer with sheep and goat manure on morphology, yield and chemical composition of Jamboo fodder production. *Wayamba Journal of Animal Science*, **6** : 910-920.

Kumar, R., M. Singh, B. S. Meena and S. Kumar, 2017 : Quality characteristics and fodder yield of maize as influenced by seeding density and nutrient levels. *Indian J. Agric. Sci.,* **87**: 1203-1208.

McGrath, J., S. M. Duval, L. F. M. Tamassia 2018: Nutritional strategies in ruminants: A lifetime approach. *Res. Vet. Sci*., **118** : 28-39.

Neda, E. K. and Z. B. Erena, 2020 : Expounding the production and importance of cowpea (*Vigna unguiculata* -L Walp) in Ethiopia. *Cogent Food Agric.* **6**: 1769805.

Okike, I. and M. Blummel, 2017 : Cowpea and groundnut haulms fodder trading and it's lessons for multidimensional cowpea improvement for mixed crop livestock systems in West Africa. *Frontiers Plant Sci*., **8**. doi: 10.3389/fpls.2017.00030.

Olugbire, O. O., S. Olorunfemi, and D. O. Oke, 2021 : Global utilization of cereals: sustainability and environmental issues. *Agro-Sci.,* **20** : 9-14.

Reddy, J. 2018 : Green Fodder Production Information Guide, Agrifarming. *https://www.agrifarming.in/green-fodder-production.*

Samireddypalle, A., O. Boukar, E. Grings, C. A. Fatokun, P. Kodukula, R. Devulapalli, I. Okike, and M. Blummel. 2017 : Cowpea and groundnut haulms fodder trading and it's lessons for multidimensional cowpea improvement for mixed crop livestock systems in West Africa. *Frontiers Plant Sci., **8**. doi: 10.3389/fpls.2017.00030.*

Sarwar, A. K. M. G. and J. K. Biswas, 2021: Cereal grains of Bangladesh- Present status, constraints and prospects, Cereal Grains, 6th April, 2021.

SAS (Statistical analytical Software), 2010. Users' Guide Ver. 9.4. SAS Institute Inc., Cary, NC.

Shaheenuzzamn, M., R. R. Saha, B. Ahmed and J. Rahman, 2015 : Green cob and fodder yield of sweet corn as influenced by sowing time in the hilly region. *Bangladesh J. Agric. Res.,* **40** : 61.

Sharif, M., M. Subhani, and S. I. Zamir, 2017: Evaluation of intercropping maize with cowpea for chemical composition and in situ digestion Kinetics in Nili Ravi Buffalo Bulls. pp. 1-135.

Silva, A. C. D., D. D. C. Santos, D. L. T. Junior and P. B. D. Silva, 2018 : Cowpea : A strategy legume species for food security and health. Legume Seed Nutra. Res., doi: 10.5772/intechopen.79006.

Swain, B. B. and N. Teufel, 2017 : The impact of urbanization on crop-livestock farming system: a comparative case study of India and Bangladesh. *J. Social Econ. Devel.,* **19** : 161-180.