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NPK Briquette has Positive Effect on Jhum Rice Cultivation

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Authors' contributions

This work was carried out in collaboration between both authors. Author MZ designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Author AKP managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The study was undertaken to evaluate the efficacy of NPK briquette for increasing the yield of jhum rice. Two experiments were conducted at Ramery para, Bandarban sadar, Bandarban hill district in Chittagong under the AEZ 29 (Northern and Eastern Hills Tract) during March 2017 to November 2017 to study the effect of NPK briquette on growth and development of Jhum rice. In this experiment, Jhum rice was used as the test crop. The experiment was conducted in two field and designed on Randomized Completely Block Design (RCBD). The treatments consisted of 7(seven) levels of NPK briquette i.e. T_1: Control, T_2: 100% RFD (267.5 kg ha^{-1}), T_3: 120% RFD (320.8 kg ha^{-1}), T_4: 80% RFD (214.1 kg ha^{-1}), T_5: 100% NPK briquette (267.5 kg ha^{-1}), T_6: 120% NPK briquette (320.8 kg ha^{-1}), T_7: 80% NPK briquette (214.1 kg ha^{-1}). Ratio in 100 kg NPK briquette contain 50 kg urea: 30 kg TSP: 20 kg MoP and RFD value was N 60 $kgha^{-1}$, P 20 kg ha^{-1} and K 30 kg ha^{-1}. The growth and yield of Jhum rice were significantly influenced by different levels of NPK briquette. The highest plant height of jhum rice (138.3 cm), effective tillers $hill^{-1}$ (16.03), panicle length (30.10 cm), highest number of filled grain $panicle^{-1}$ (202.8), 1000 grain weight (27.67 gm), straw yield (4.13 t/ha) and grain yield (3.54 t/ha) were found from T_5 treatment receiving 100% NPK briquette (267.5 kg ha^{-1}) and for all cases lowest results were found in T_1 treatment receiving no fertilizer (control). Yield of Jhum rice mainly vary with RFD and NPK briquette but highest yield obtained from NPK briquette treatment compared with control.

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1. INTRODUCTION

Jhum cultivation, popularly known as shifting cultivation, is the most prevalent form of cultivation in the hills of tropical Asian countries including Bangladesh. Jhuming involves cutting of forests in March, left on the hill slopes for one month for drying and burning of the dried plants. Seeds of different crops are sown by dibbling the land in May. According to Arya LM et al. [1]. Crops are harvested in succession as they ripe between July and December. In Bangladesh, Jhum cultivation is practiced in the hilly areas of Chittagong Hill Tracts (CHTs). The CHTs are located in the southern part of Bangladesh bordering with India and Myanmar and are the home to 11 different ethnic communities [2]. In the hilly areas rice is the most common crop and at present rice cultivation is near 99% in Jhum farming and cultivated in rain fed condition. Average rice yield was recorded 1.15 t ha-1 under Jhum cultivation [3] which is much lower than national average of rice (3.78 t ha-1) [4]. Rasul and Thapa [5] reported that poverty is widespread in the CHT particularly in rural areas. Many rural families suffer from chronic food shortages. On average, per household per annum food (rice) shortage was found higher (0.87 ton) for non-ethnic and lower for ethnic households (0.49 ton) which constitutes 84.5% and 45.9% respectively [6].

Nowadays, the shrinkage of Jhum fields and reducing yields has created a challenge for the Jhumia families. Compared to this low return from the Jhum, still many of the people either partly or fully depend on Jhum for their livelihoods [7]. Productivity of hill soil is constrained by erosion, no or little use of fertilizers, fertility depletion, strong soil acidity, inappropriate cropping and faulty management practices [8]. The recent advances in nutrient management in rice have been primarily driven by the continuing need to increase rice production. In addition, the fact that it will not be possible to continue the way the plant nutrients have been managed so far because agriculture adds globally significant and environmentally detrimental amounts of N and P to terrestrial ecosystems [9], at rates that may triple if past practices are used to achieve another doubling in food production [10]. To meet up the food demand of indigenous people in Chittagong Hill Tracts, it is necessary to practice suitable NPK briquette for increasing the productivity of Jhum. If we are able to motivate indigenous people about NPK briquette for Jhum cultivation, the production will be increased 50% more than the existing production and increase the livelihood of indigenous people in Chittagong Hill Tracts [11].

Due to application of normal form of fertilizer in sloppy land, there were a huge loss of nutrient through runoff. Runoff nutrient loss also lead to environmental pollution or degradation. But loss of fertilizer nutrients can be minimized by using NPK briquette in sloppy hill area for better Jhum production. So, to restore the soil fertility and to increase the productivity of Jhum, a judicious application of fertilizer is a must. Considering these facts as stated, the present study will be undertaken to observe the effect of the NPK briquette for increasing the growth and development of Jhum rice.

2. MATERIALS AND METHODS

Two experiments were conducted at Ramery para, Bandarban sadar, Bandarban hill district in Chittagong under the AEZ 29 (Northern and Eastern Hills Tract) during March 2017 to November 2017. The selected land was slashed and burned and partially burnt plant parts was cleaned before final land preparation. The experiments were laid out in Randomized Completely Block Design (RCBD) because experimental plot was heterogeneous condition. The method was found by previous research and also inspired [12]. The experiment was conducted at Hill Agricultural Research Station, Bangladesh Agricultural Research Institute, Khagrachari, Bangladesh during the period from May 2014 to January 2015 to study the effect of different fertilizer packages on the performance of jhum crops.

NPK briquette was applied just after emergence of seedling of different Jhum crops by dibbling method. This chapter presents a brief description of the soil, crop, experimental design, treatments, plant samples and analytic methods followed in the experiment. To fulfill my objectives authors conducted two experiments in two hills of same area simultaneously.

2.1 Details of the Experimental Site

2.1.1 Climatic condition

The climate is tropical in Bandarban. Bandarban has significant rainfall during most of the months, with a short dry season. The average temperature in Bandarban is 25.9°C. About 2528 mm of precipitation falls annually. The muggier period of the year lasts for 8.8 months, from March 7 to December 1, during which time the comfort level is muggy, oppressive, or miserable at least 26% of the time.

2.1.2 Soil

General soil type of this areas is "Brown Hill Soils" during experimental period. The experimental land was above flood level, sloppy and sufficient sunshine was available. The Northern and Eastern Hills are underlain by sandstone, siltstone and shale of Tertiary and Quaternary ages. The soils developed on these parent materials are brown in color, usually loamy in texture and very strongly acidic in reaction.

2.1.3 Planting material

Most of the Jhumia families used their own local variety for Jhum cultivation. In rice cultivation they used mainly most of the areas Mymensingh and Cockrow as a local variety. Other crops also cultivate by their local collection of previous year Jhum cultivation. In my experiment we were used seed of Mymensingh local variety for rice cultivation and for the cultivation of other crops Jhumia families were use their previous year collected seed.

2.1.4 Crop

In Jhum areas rice cover about 90-95% of total area and other crops cover 5-10% area of the land. Cultivators use many traditional varieties for each of the above mentioned crops. In the past 15 to 20 crops used to be grown together, which used to supply almost all the necessities of food and fiber. At present 5 to 8 crops were usually grown in a Jhum field. Besides, few Jhum cultivators were more interested to produce cash crops like ginger and turmeric rather than paddy, which was the common feature throughout the CHT. Jhum Rice was used as test crop.

2.1.5 Land preparation

Land preparation usually starts from March. First, the standing vegetation and bushes were slashed and allowed to dry during the dry period. The dried vegetation and the fallen logs are burnt in the month of April and May. The partially burnt or unburned logs are then dragged out of the Jhum land and piled up. Some of these woods are used to create fences to keep wild animals away from the Jhum land. Then experimental plots were laid out as per treatment and design.

2.1.6 Experimental design and treatments

The experiments were laid out in a Randomized Completely Block Design (RCBD) with three replications. The total number of plots was 21(3*7). The unit plot size was 4 m x 3 m. Block to block distance was 0.5 m and plot to plot distance was 0.5m. There were 7 treatment combinations. The treatment combinations were as follows: T_1 = Control, T_2 = 100% RFD*, T_3 = 120% RFD, T_4 = 80% RFD, T_5 = 100% NPK briquette, T_6 = 120% NPK briquette, T_7 = 80% NPK briquette. RFD: N 60 kgha^{-1}, P 20 kg ha^{-1} and K 30 kg ha $^{-1}$.

2.1.7 Seed sowing

Sowing commences as soon as the monsoons starts and the ground is saturated, generally in the months of May and June. In Jhum cultivation dibbling method is used for sowing the seed with the help of Da. Sometimes Khurpi, tagol (knife) is also used. In this method seeds are sown directly in the soil without disturbing the soil. The quantity of rice seed near 99 % which is greater than that of other types sown by this process, as rice is the staple food and cultivator aim to maximize growth of this crop.

Table 1. Morphological distinctiveness of the experimental field

Morphology	Characteristics
Location	Ramery Para (Bandarban)
Agro-ecological zone	Northen and Eastern Hills (AEZ-29)
General soil type	Brown Hill soil(loamy and acidic)
Topography	Sloppy and Steep
% Slope	30-35%
Drainage	Well drained
Flood level	Above flood level

2.1.8 Application of fertilizers (RFD) and NPK briquette

Generally In the experiment Urea, TSP, MoP and Gypsum were used as a source of N, P and K. Half urea and full amount of TSP and MoP and some amount of gypsum were applied at the time of final land preparation by dibbling method. After that seed were sown in the field. When seedling emergence, after 8-10 days of seed sowing NPK briquette were used every plot by dibbling method without control. The amounts of nitrogen, phosphorus and potassium fertilizers required per plot were calculated from NPK briquette ratio rate per hectare. T_5:100%NPK briquette (267.5 kg ha^{-1}), T_6: 120% NPK briquette (320.8 kg ha^{-1}), T_7: 80% NPK briquette (214.1 kg ha^{-1}).

2.1.9 Data collection

The data on the following growth and yield contributing characters of the Jhum rice were recorded: i) Plant height (cm), ii) Number of effective and ineffective tillers hill^{-1}, iii) Panicle length (cm), iv)Total number of grain per panicle, v) Number of unfilled and filled grains panicle^{-1}, vi)1000-grain weight (g) and vii) Grain and straw yields (t ha^{-1}).

2.1.10 Statistical analysis

Different characters of jhum crops and N, P, K, S content in post-harvest soil of jhum cultivation were done following the ANOVA technique and the mean results in case of significant F-values were adjusted by the Least Significant Difference (LSD) [13].

3. RESULTS AND DISCUSSION

Two experiments were conducted to examine the influence of NPK briquette levels on the growth and development of Jhum rice in hilly areas. The experiments results were conducted under field conditions which are presented in several tables. Treatments effect of NPK briquette on all the studied parameters have been presented and discussed under the observation of field 1 and field 2.

3.1 Effect of NPK Briquette on Growth and Yield Components of Jhum Rice

3.1.1 Plant height

In field 1, the plant height of Jhum rice was significantly influenced by the application different levels of NPK briquette. The tallest plant height of Jhum rice (138.3 cm) was found in treatment T_5 which was statistically different from all other treatments. The shortest plant height (116.5 cm) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e control treatment **(**Table 2). In field 2, the plant height of Jhum rice was significantly influenced by the application different levels of NPK briquette. The tallest plant height of Jhum rice (134.3 cm) was found in treatment T_5 which was statistically different from all other treatments. The shortest plant height (107.3 cm) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e control treatment **(**Table 2).

3.1.2 Effective tillers hill^{-1}

Both in field 1 and field 2 effect of NPK briquette treatments was significant for effective tiller per hill compared with normal recommended fertilizer dose. In field 1, effective tiller of Jhum rice was significantly influenced by the application different levels of NPK briquette. The highest number of effective tiller hill^{-1}of Jhum rice (16.3) was found in treatment T_5 which was statistically different from all other treatments. The lowest number (10.9) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e. control treatment (Table 2). Similar results were found by [14].

In field 2, the highest number of effective tiller hill^{-1}of Jhum rice (15.26) was found in treatment T_5 which was statistically different from all other treatments. The lowest number (111.6) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e. control treatment **(**Table 2). Rama et al. [15] observed that effective tiller increased significantly when NPK briquette level increased from 40 to 120 kg N ha^{-1} as different modified NPK briquette.

3.1.3 Non-effective tillers hill^{-1}

Effect of NPK briquette on non-effective tiller per hill was significant compared with normal recommended fertilizer dose. In field 1, the lowest number of non-effective tiller hill^{-1} of Jhum rice (1.0) was found in treatment T_5 which was statistically different from all other treatments. The highest number (1.88) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e. control treatment. In field 2, the lowest number of non-effective tiller hill^{-1}of Jhum rice (0.93) was found in treatment T_5 which was statistically different from all other treatments. The highest number (2.2) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e. control treatment. Several authors [16,17] also found similar result of non-effective tiller and panicle length.

3.1.4 Panicle length

NPK briquette had a significant effect on panicle length. In field 1, the highest panicle length of Jhum rice (30.1 cm) was found in treatment T_5 which was statistically different from all other treatments. The lowest panicle length (22.8 cm) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e. control treatment. Das [18] conducted that the adequate supply of NPK briquettes significantly increase the panicle length, number of primary and secondary branches panicle^{-1}. In field 2, the highest panicle length of Jhum rice (29.7 cm) was found in treatment T_5 which was statistically different from all other treatments. The lowest panicle length (23.2 cm) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e. control treatment.

3.1.5 Filled grains panicle^{-1}

In field 1, the maximum number of filled grain of Jhum rice (195.03) was found in treatment T_5 which was statistically different from all other treatments. The minimum number of filled grain (113.2) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e. control treatment (Table 2). In field 2, the maximum number of filled grain of Jhum rice ranged over control was observed (Treatment 1) from 104.7 to 202.8. The maximum number of filled grain of Jhum rice (202.8) was found in treatment T_5 which was statistically different from all other treatments. The minimum number of filled grain (104.7) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e. control treatment (Table 2). Afroz [19] observed that placement of urea, TSP, MoP fertilizer in the form of NPK briquette @ 100,50,30 kg NPK ha^{-1} produced the highest number of filled grains panicle^{-1} which ultimately gave the higher grain yield than split application of fertilizers.

3.1.6 Unfilled grains panicle^{-1}

Number of unfilled grain panicle^{-1} was also affected by using NPK briquette in the Jhum cultivation. In field 1, the minimum number of unfilled grain of Jhum rice (20.6) was found in treatment T_5 which was statistically different from all other treatments. The maximum number of unfilled grain (37.6) of Jhum rice was found in T_6 treatment where used normal recommended fertilizer. In field 2, the minimum number of unfilled grain of Jhum rice (22.06) was found in treatment T_5 which was statistically different from all other treatments. The maximum number of unfilled grain (42.3) of Jhum rice was found in T_1 treatment where no fertilizer was applied i.e. control treatment. Masum et al. [20] observed that placement of urea, TSP, MoP fertilizer in the form of NPK briquette@ 100,50,30 kg NPK ha^{-1} produced the highest number of effective tillers hill^{-1}, filled grains panicle^{-1}.

3.1.7 1000 grain weight

The effects of NPK briquette on 1000 grain weight were insignificant in case of field 1 and field 2. In field 1, 1000 grain weight was ranged from 21.6 to 27.7 gm. The highest 1000 grain weight was 27.7 gm on treatment T_5. In field 1, the highest 1000 grain weight was found in T_5 treatment. Similar results, Nori et al. [21] conducted that, Nitrogen, P, K affect rice production and its physiological activity. The lowest grain weight of 21.6 gm was found in T_1 (control) treatment having no fertilizer. 1000 grain weight was statistically identical in T_6 and T_7 treatment by receiving 120% and 80% NPK briquette. Peterson [22] observed that placement of compound NPK fertilizer increased the grain yield and the quality parameters like grain size and grade. The effect of fertilizer placement on grain yield and quality decreased. 1000 grain weight per treatment was ranked in field 1, $T_5>T_7>T_6>T_2>T_4>T_3>T_1$.

In field 2, 1000 grain weight was ranged from 21.6 to 27.6 gm. The highest 1000 grain weight was 27.6 on treatment T_5. In field 2 the highest 1000 grain weight was found T_5 treatment by receiving 100% NPK briquette. The lowest grain weight of 21.6 gm was found in T_1 (control) treatment having no fertilizer. 1000 grain weight was statistically identical in T_4, T_6 and T_7 treatment. 1000 grain weight per treatment was ranked in field 2, $T_5>T_7>T_6>T_4>T_2>T_3>T_1$. Naseem et al. [23] conducted that lower 1000-grain weight in the control treatment than in the plots received NPK briquette fertilizers.

3.2 NPK Briquette Increase the Yield of Jhum Rice

3.2.1 Grain yield

The grain yield of Jhum rice was significantly influenced by the application of different levels of NPK briquette. The highest grain yield of Jhum rice (3.51 t ha^{-1}) was found in treatment T_5, which was statistically different from all other treatments. The lowest grain yield of Jhum rice (1.77 t ha^{-1}) was found in T_1 treatment where no fertilizer was applied i.e. control treatment (Table 3). Jahan et al. (2014) conducted that application of USG and NPK briquette was more effective in producing higher rice yield. Dubey [24] reported that omission of S produced the highest straw yield of 7.14 t ha^{-1} which was statistically identical with complete fertilization (6.79 t ha^{-1}) and P omission plot (6.47 t ha-1). Golden [25] reported that pre-plant incorporated NPK briquette increased rice grain yield. In field 2, the highest grain yield of Jhum rice (3.54 t ha^{-1}) was found in treatment T_5, which was statistically different from all other treatments. The lowest grain yield of Jhum rice (1.87 t ha^{-1}) was found in T_1 treatment where no fertilizer was applied i.e. control treatment (Table 3). Kapoor [26] reported that significantly higher grain yield was observed with deep placement of NPK briquette compared to broadcast application that's significantly influenced. Bhuiyan [27] observed the effects of N and K fertilizer on the yield and quality of rice by same effects.

3.2.2 Straw yield

In field 1, the highest straw yield of Jhum rice (4.13 t ha^{-1}) was found in treatment T_5, which was statistically different from all other treatments. The lowest straw yield of Jhum rice (2.42 t ha^{-1}) was found in T_1 treatment where no fertilizer was applied i.e control treatment (Table 3). Bhuiyan [27] reported that the deep-point placement of N, P and K briquettes significantly increased grain and straw yields. In field 2, the highest straw yield of Jhum rice (4.10 t ha^{-1}) was found in treatment T_5, which was statistically different from all other treatments. The lowest straw yield of Jhum rice (2.67 t ha^{-1}) was found in T_1 treatment where no fertilizer was applied i.e. control treatment. Tahura [28] reported by Fertilizer management differences regarding grain yield and Straw yield were also. Mahendra [29] observed that placement of urea super briquette in the reduced zone of soil recorded more grain and straw yield compared to the commercial urea application by broadcasting. Placing fertilizer N at about 10 cm below the soil surface after puddling has long been known to improve plant uptake of NPK briquette.

4. DISCUSSION

When NPK briquette were applied in Jhum rice cultivation plant height was significantly influenced. All the treatment of NPK briquette observed the higher plant height comparative the treatment of normal recommended fertilizer dose.

The growth and yield of Jhum rice were significantly influenced by different levels of NPK briquette. In case of field 1&2 the highest plant height of jhum rice (138.3 cm), effective tillers $hill^{-1}$ (16.03), panicle length (30.10 cm), highest number of filled grain $panicle^{-1}$ (202.8), 1000 grain weight (27.67 gm), straw yield (4.13 t/ha) and grain yield (3.54 t/ha) were found from T_5 treatment treatment receiving 100%NPK briquette (267.5 kg ha^{-1}) and for all cases lowest results were found in T_1 treatment receiving no fertilizer (control). Most of the time the grain and other related yield value was ranked T_5>T_7>T_6> T_2>T_4>T_3>T_1.

Proper nutrition is essential for satisfactory crop growth and production. Plants need to be fertilized because most soil does not provide the essential nutrients required for optimum growth especially hilly areas. There are numerous building blocks of life that plants need for healthy and optimum growth. Without these nutrients, plants cannot grow to their full potential, will provide lower yields, and be more susceptible to disease. In cases where soils are lacking, nutrients must be put back into the soil in order to create the ideal environment for optimal plant growth. Each of the primary nutrients is essential in plant nutrition, serving a critical role in the growth, development, and reproduction of the plant [30]. Found that furrow irrigation method with band placement of N considerably increased leaf area $plant^{-1}$, crop growth rate, net assimilation rate, number of grains cob^{-1}, 100-grain weight and grain yield (6.72%) than broadcast method.

Experimental evidences in the use of nitrogen, phosphorus and potassium showed an intimate effect on the yield and yield attributes of jhum crops. Yield and yield contributing characters of jhum crops are considerably influenced by different doses of NPK briquettes. So, the requirement of NPK briquette for any crop varies with the cultivars, season and soil types in different agro ecological zones. A few numbers of works has so far been done pertaining to the influence of NPK briquette dose on the yield and yield contributing components of jhum crops in the world and considerable extent in Bangladesh. Saha et al. [31] to bring an experiment for model of rice in 2002-2003 to create and compare a suitable fertilizer recommendation. Models were

Table 2. In field 1 and 2, effect of NPK briquette on plant height, effective tiller hill^{-1}, non-effective tiller hill^{-}1, panicle length (cm), filled grain panicle^{-1}, unfilled grain panicle^{-1} and 1000 grain weight (gm)

Treatments	Plant height (cm)		Effective Tiller Hill^{-1}		Non –Effective Tiller Hill^{-1}		Panicle length (cm)		Filled grain Panicle^{-1}		Unfilled Grain panicle^{-1}		1000 grain weight (gm)	
	Field 1	**Field 2**	**Field 1**	**Field 2**	**Field 1**	**Field 2**	**Field 1**	**Field 2**	**Field 1**	**Field 2**	**Field 1**	**Field 2**	**Field 1**	**Field 2**
	116.50^{f}	107.37^{d}	10.93^{g}	11.60^{e}	1.88^{a}	2.20^{a}	22.83^{e}	23.20^{e}	113.23^{d}	104.70^{g}	32.96^{c}	42.30^{a}	21.66	21.6
T_2	122.37^{e}	123.33^{b}	13.56^{d}	12.83^{cd}	1.56^{b}	1.83^{bc}	24.83^{d}	25.63^{c}	127.23^{c}	122.50^{d}	35.96^{b}	37.06^{c}	23.33	25.0
T_3	132.97bc	114.80^{c}	12.40^{e}	12.66^{d}	1.76^{a}	1.93^{b}	22.86^{e}	24.53^{d}	128.60^{c}	112.00^{f}	28.63^{e}	38.50^{b}	22.66	24.0
T_4	126.27^{cd}	112.67^{c}	11.80^{f}	13.06^{cd}	1.43^{c}	1.66^{cd}	21.70^{f}	24.80^{cd}	128.57^{c}	116.33^{e}	31.70^{d}	35.60^{d}	22.67	26.0
T_5	138.37^{a}	134.13^{a}	16.03^{a}	15.26^{a}	1.00^{e}	0.93^{e}	30.10^{a}	29.73^{a}	195.03^{a}	202.87^{a}	20.63^{f}	22.06^{f}	27.67	27.6
T_6	123.90^{de}	123.07^{b}	14.53^{c}	13.16^{c}	1.26^{d}	1.96^{b}	25.90^{c}	27.26^{b}	154.15^{b}	177.03^{c}	37.60^{a}	31.73^{e}	25.00	26.0
T_7	128.00^{c}	122.20^{b}	15.00^{b}	14.23^{b}	1.53^{bc}	1.56^{d}	26.90^{b}	26.53^{b}	151.60^{b}	186.20^{b}	28.47^{e}	32.33^{e}	26.0	25.6
LSD	1.10	1.38	0.18	0.19	0.05	0.08	0.36	0.39	4.52	1.74	0.42	0.61	1.02	0.39
CV%	1.06	1.41	1.65	1.79	4.86	6.31	1.77	1.85	3.89	1.46	1.69	2.21	5.20	1.94

Means in a column followed by same letter(s) are not significantly different at 5% level of significance by RCBD

Table 3. Effect of NPK briquette on the grain and straw yields (t ha^{-1}) of Jhum rice in field 1 and 2

Treatments	Grain yield (t ha^{-1})		Straw yield (t ha^{-1})	
	Field 1	**Field 2**	**Field 1**	**Field 2**
T_1	1.77^{f}	1.87^{g}	2.42^{d}	2.67^{e}
T_2	2.95^{c}	2.34^{f}	3.70^{c}	3.95^{ab}
T_3	2.84^{d}	2.43^{e}	4.3.84^{b}	3.61^{c}
T_4	2.66^{e}	2.62^{d}	3.91^{b}	3.33^{d}
T_5	3.51^{a}	3.54^{a}	4.13^{a}	4.10^{a}
T_6	2.93^{cd}	2.84^{c}	3.83^{bc}	3.91^{b}
T_7	3.08^{b}	2.93^{b}	4.05^{a}	3.84^{b}
LSD $_{(0.01\%)}$	0.03	0.02	0.04	0.08
CV%	1.34	1.15	1.43	2.71

Means in a column followed by same letter(s) are not significantly different at 5% level of significance by RCBD tested and compared with one check plot with five different fertilizer proposal. Results observed that the application of different packages estimated by different fertilizer models significantly influence panicle length, panicle numbers, spikelet number per panicle, total grains panicle-1.The highest result was 120-70-80-20 kg ha-1 NPKS by the combination of NPK briquette that gave.

For growing of rice cultivation nitrogen, phosphorus and potassium is most important by increasing vegetative growth. Riaz et al. [32] Reported that efficiency of applied NPK could be increased by point placement of NPK briquette in the subsoil particularly in soils of low permeability and increase growth rate. The loss of NPK briquette was 20 per cent less from normal fertilizer.

Yaqub et al. [33] reported that Urea Super Briquette (USG) and NPK briquette fertilizers provide a better effect on LAI and Dry matter production. The highest result for LAI and Dry matter were observed in USG treated plots (2.97 and 24.18 g per hill) followed by NPK briquette applied plots (2.85 and 23.93 g per hill). The absolute control plots showed the lowest results (2.34 and 21.39 g per hill). Azam et al. [34] Studied that fertilizer management significantly affected plant height at all stages of rice plant. Significantly highest plant height (75.08, 112.2 and 128.6 cm) was found in NPK briquette treated plots (74.8, 109.5 and 128.6 cm) and lowest (65.92, 102.5 and 116.3 cm) in absolute control (N5) at 30, 50 and harvesting time respectively. They found that the application of NPK briquette increased the plant height significantly.

5. CONCLUSION

Rice production in Bangladesh needs to be increased to feed 215.4 million people in 2050. This can be done in two ways: expanding the rice growing area and increasing productivity, or both. Crop productivity can be increased by supplying nutrients as per crop requirement or soil fertility management. So from the above experimental result we can say that hilly areas is great opportunity to sustain our livelihood and Jhumia communities. Normally recommended fertilizer dose increased the yield of Jhum crops but highest yield obtained from NPK briquette treatment by receiving 100% NPK briquette (267.5 kg ha^{-1}) to maintain soil fertility, soil erosion and to sustain the environment in hilly areas. So considering the present experiment following recommendations may be suggested:

1. Such kinds of study may be conducted in different sites of Chittagong Hill Tracts and different seasons of hilly areas for exploitation of regional adaptability and other performances.
2. Some other levels of fertilizer management practices may be included in future program.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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