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Agro-economic performance of pea (*Pisum sativum* L.) varieties under rice-based relay and conventional tillage cropping systems

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Abstract: The experiment was conducted at the Agronomy Farm, Sylhet Agricultural University during November 2012 to February 2013 to know the performance of pea varieties under rice-based relay and conventional tillage cropping systems. There were two sowing methods; i. Relay with transplant aman rice and ii. Conventional through land preparation after harvest of transplant rice and four pea varieties; i. BARI motoshuti-1, ii. IPSA motorshuti-1, iii. Jhikorgacha local and iv. Natore local as treatments in the experiment. The experiment was conducted in a split plot design assigning sowing methods in the main plot and varieties in the sub-plots. The results revealed that the highest green pod yield (3333 kg/ha) was obtained from Natore local and this was statistically at par with that of Jhikorgacha local (3234 kg/ha) in the relay cropping system. The lowest green pod yield (1745 kg/ha) was obtained from BARI motorshuti-1 under conventional method of sowing. Due to lower number of pod/plant all varieties produced lower green pod yield in spite of higher plant population/m^2 in the conventional sowing method. Natore local motorshuti produced the highest fodder yield (4055 kg/ha) under relay cropping system which was significantly different from the others and BARI motoroshuti-1 produced the lowest (2220 kg/ha) under conventional sowing method. The maximum gross return (Tk 1,74,760 /ha) was obtained from the variety Natore local followed by Jhikorgacha local (Tk 1, 69, 218 /ha) in relay cropping system. Similar trends were found in case of gross margin.
Keywords: Agro-economic performance, *Pisum sativum*, relay, conventional tillage

INTRODUCTION

Domestic pulse production in Bangladesh satisfies only 30% of the country's needs. The rest 70% requirement of pulses is imported at a cost of huge amount of foreign currencies per annum [1]. Bangladeshis consume about 12.0 g of pulses per capita per day, far below the 45 g per day recommended by FAO/WHO [2]. With the expected improvement in living standards and consequential changes food habits, the per capita consumption is expected to rise, which necessitates production increases of pulses at present and in future. Pulses are rich in proteins and found to be main source of protein to vegetarian people of country. They can be grown on all types of soil and climatic conditions and also they give ready cash to farmer. Pulses supply additional fodder for cattle.

Pea (*Pisum sativum* L.) is one of the most important legume crops which is cultivated for the fresh green seeds, tender green pods, dried seeds and foliage [3]. Green peas are eaten cooked as a vegetable, and are marketed fresh, canned, or frozen while ripe dried peas are used whole, split, or made into flour [4]. As a forage, pea is a high-yielding, short-term crop with a high protein content [5]. Whole-crop pea hay contains 15-20 % DM protein, NDF 38-56 % DM, ADF 32-39 % and about 5 % ADL, depending on the maturity stage [6, 7]. Starch content is extremely variable (5-25 % DM), depending on seed maturity [8]. Pea silage is considered to be an excellent feed for ruminants, though it has a strong odour [9]. Pea forage can also be used for green manure [10, 11]. Peas are much valued in rotations with cereals because their cultivation breaks cereal disease cycles, facilitates weed control and improves soil condition and fertility [12]. Pea crop improves greatly soil fertility status. Pea crops decreases fertilizer requirements of the following crops by 30-50 kg/ha [13]. On a 3-year rotation including pea, average N savings were about 140 kg N/ha. However, it is important that the crops following pea undergo succession and cropping practices that limit nitrate losses [14].

At present, most of the research activities on lentil, blackgram, cowpea, mungbean, fieldpea and grasspea are concentrated in the parts other than Sylhet regions although there is an ample opportunity of growing pulses during rabi season. A range of grain legumes may be introduced in Sylhet region where single cereals: T. Aman-fallow-fallow is the common cropping pattern. Short duration fieldpea may be successfully grown in the cropping patterns T. Aman-

fallow-fallow after harvest of transplant aman rice. Farmers could be able to get high net return by inclusion of grain legumes in their cropping pattern. A huge land area Rice-Fallows could be brought into winter legumes through development of suitable technologies and its dissemination and policy reforms for the promotion of legumes. Relay cropping is a general practice of the farmers in the West Bengal India to sow various winter pulse crops like lentil (*Lens culinaris* L.), lathyrus (*Lathyrus sativus* L.), chickpea (*Cicer arietinum* L.) and fieldpea (*Pisum sativum*) in the standing rice crop field, just before the harvest to ensure germination using the residual moisture and to avoid tillage operations during pulse growing season. Such a relay cropping operation (known by the terms utera or paira) is very popular for growing lathyrus [15]. Average cropping intensity of greater Sylhet regions is only 163% while 191% in the country. Triple cropped area, double cropped area and single cropped area are 5.5%, 26.3% and 30.8%, respectively of the total cultivated land of the greater Sylhet. Having vast area of fallow land after rice harvest in the greater Sylhet regions, there is an ample scope for the horizontal expansion of area and production of grain legumes like pea. Pea can be sown as relay crop [16] and relay cropping of pea with T. Aman rice may be a good option for increasing cropping intensity as well as farm productivity and income, and food security of the local people. Keeping the views in mind mentioned above the present experiment was conducted to know the agro-economic performance of pea (*Pisum sativum* L.) varieties under rice-based relay and conventional tillage cropping systems.

Materials and Methods

The experiment was conducted at the Agronomy Research Field, Sylhet Agricultural University to observe the growth and yield performance of four varieties pea under relay and conventional methods of cultivation with T. Aman (transplant aman) rice during November to March 2012-2013. Geographically the experimental field is located at 24.8917 °N 91.8833 °E, in the north eastern region of Bangladesh in the Sylhet district. The location is 32 m above the mean sea level [17]. Pea can be grown on a wide range of soils from sandy loams to heavy clays provided they are well-drained [18]. Ideal soil pH for pea is 5.5-6.5. Soil pH 7-7.5 may not hamper growth if the soil is not overlimed and prone to manganese deficiency [18, 11]. Acidic soils, high aluminum soils and waterlogged areas are deleterious to pea growth [19]. Soil of the experimental plot was red, silty clay loam in texture and organic matter content of soils is high. Soil pH was 5.2 containing K 0.07 meq/100g of soil, P 25 mg/g of soil and S 10 µg/g of soil under the AEZ-20 [20]. The experimental field was a medium high land with well drained condition. So soil of the experimental plot was suitable for pea cultivation. The climate of the area is humid subtropical with a predominantly hot and humid summer, a relatively cool winter with scanty rainfall during rabi season (October to March) and heavy precipitation with occasional gusty winds in kharif season (April to September). The locality is within the monsoon climatic zone, with annual average highest temperature of 23 $^{\circ}$C (August–October) and average lowest temperature of 7 $^{\circ}$C (January). It is found that there was 11.9 mm rainfall occurred in the month of November and there was no rainfall occurred in the months of December 2012 and January 2013. Scanty rainfall of 2.3 mm and 1.9 mm occurred in the months of February and March 2013 respectively. Minimum temperature was 11.8 $^{\circ}$C prevailed in January 2013. Average minimum temperature 19.8 $^{\circ}$C was also recorded in January 2013. Temperature started to increase onward February 2013. The experimental land usually remains fallow after T. Aman rice. BRRI dhan32 was transplanted on 13 August 2012 in the experimental field. Two sowing methods and four varieties of pea were included as treatments in the experiment. So, two factors were included in the experiment namely, sowing method and variety. The sowing methods were relay and conventional while the varieties were BARI motorshuti-1, IPSA motorshuti-1, Jhikorgacha local and Natore local. The experiment was laid out in a split plot design with four replications. Sowing methods were assigned in the main plot and varieties were assigned in the sub-plot randomly. In case of conventional method land was prepared by spade after harvest of T. Aman rice. Relay cropping was grown under rainfed condition utilizing the residual soil moisture in both methods. Germination test were carried out and it was found that seed germination percentages were 94% in BARI motorshuti-1, 92% in IPSA motorshuti-1, 95% in Jhikorgacha local and 97% in Natore local. Seeds were sown on 13 November, 2012 as relay cropping before 15 days of harvesting T. Aman rice while seeds were sown on 2 December 2012 for conventional method after T. Aman harvest following land preparation after overnight soaking of seed in water. Seed rate was 60 kg ha^{-1} and seeds were sown in broadcast method in both conventional and relay methods. T. Aman was harvested leaving 15-18 cm straw height from the ground level of the relay plots so that upper portion of relay crop plants of pea may not prunned. But for conventional sowing method T. Aman was harvested at the ground level leaving no straw above the ground. Before transplanting of T. Aman fertilizers at the of 45-21-30-9-1.4 NPKSZn kg/ha through urea, TSP, MoP, gypsum, $ZnSO_4$ and boric acid, respectively along with Dolochun @ 4 kg per decimal were applied [21]. It was assumed that residual effect of fertilizers applied in T. Aman rice would have enough sufficient residual effect for growth and development of pea. No thinning was done for both sowing methods. No weeding was done during crop growing period for relay cropping but one hand weeding was done at 25 days after sowing (DAS) in conventional sowing method. A very light irrigation

as drizzle using hose pipe and prilled urea at the rate of 45 kg/ha was top dressed in the field at late afternoon so that it could be dissolved in dew fall overnight after one month of sowing for both sowing methods as the crop growth was found poor. To control aphid Sumithion (insecticide) was sprayed once in both relay and conventional crops on 08 February 2012.

Data collection

Growth parameters

Plant height (cm)

Five plants were marked using tags in each unit plot after 15 DAS and plant height was measured at 15 day intervals starting from 20 days after sowing up to harvest.

Dry matter weight (mg & g)

Five plants were collected from each plot by uprooting at 30 and 45 DAS, and at maturity. Collected samples were dried in an oven at 72 $^{\circ}$C until reach a constant weight. Then dry matter weight/plant in milligram (mg) and gram (g) was calculated. At maturity dry matter/plant was calculated excluding the green pod.

Yield attributes

Plant population/m^2 was recorded from each plot. Five plants marked for measuring plant height at regular interval were collected at maturity from each unit plot to collect data on crop characters and yield components viz. days to 50% flowering, plant height at harvest (cm), number of pod/plant, number of seed/pod and 100 seed weight (g). Green pods were weighed of each plot immediately after picking by hand. Then pod weight of individual plot was converted into kg/ha. Green plants (fresh) obtained from each unit plot after separation of pod were weighed to record green fodder yield/plot. Finally, fodder yield of each plot was calculated in kg/ha. People in Bangladesh usually like to eat well developed seeds of pea pod as vegetable at green stage. So the crop was harvested at green stage by hand picking which can serve as green vegetables and supply nutrients like pulses. Green pods were harvested at different dates on the basis of pod maturity. Variety BARI motorshuti-1 was harvested at 92 & 84 DAS, IPSA motorshuti harvested at 89 & 83 DAS, Jhikorgacha local at 87 & 80 DAS and Natore local motorshuti at 90 & 84 DAS, respectively for relay and conventional methods, respectively.

Statistical analysis

Collected data were tabulated as per treatment and replication and analyzed statistically by using computer based software MSTAT. Then mean separation was done following LSD (Least Significant Difference) test at 5% level of significance wherever F values were significant at 5% level of probability.

Partial budget analysis

Cost of cultivation, gross return and gross margin were calculated. Cost of cultivation was calculated including only the cost that varied for production of crop. Local labor wages along with other materials and non-materials costs were taken into consideration for calculation of total cost of cultivation. To calculate gross returns from the product and by-product market prices of pea pod and fodder at the harvesting time were considered.

RESULTS AND DISCUSSION

Growth parameters

Plant height at 15 day intervals

Effect of sowing methods

There were significant differences between the sowing methods irrespective of varieties at 15, 30 and 45 DAS, and at harvest. The results indicated that there was taller plant in relay sowing method from the first measurement date of 15 DAS and it continued up to harvest (Figure-1). Due to shading effect given by rice plant, growth of pea seedling might be higher in relay sowing method. Plant height increment was slower up to 45 DAS but then it was faster onward up to harvest in both sowing methods.

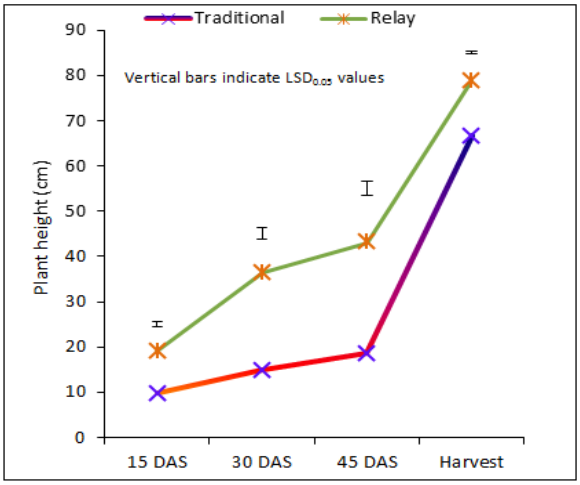

Fig-1: Mean plant height of pea as influenced by the traditional and relay sowing methods during rabi 2012-2013

Effect of variety

Plant height differed significantly among the varieties at 15, 30 and 45 DAS, and at harvest of the crop. From the Figure-2 it was found that initially at 15 DAS, the tallest plant was produced by the variety Natore local but finally at maturity Jhikorgacha local produced the tallest plant (Figure-2). BARI motorshuti-1 produced the shortest plant throughout the growing period up to harvest. Plant height increment was found slower up to 45 DAS and then it increased rapidly onward up to harvest.

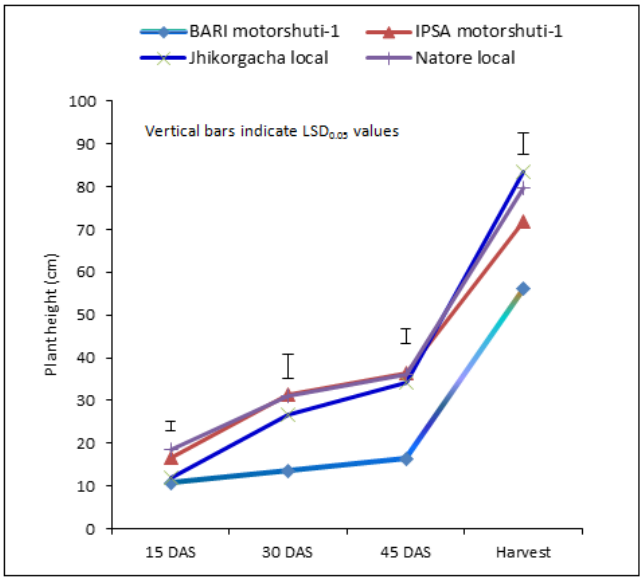

Fig-2: Mean plant height of pea varieties at 15 day intervals during rabi 2012-2013

Interaction effect of sowing method and variety

Interaction effect was found significant for plant height at all measurements of 15, 30, 45 DAS, and at harvest. The results indicated that all varieties had shorter plant stature under conventional sowing method compared to relay cropping. BARI motorshuti-1 always produced the shorter plant than all other combinations of sowing methods and varieties (Figure-3). The variety Jhikorgacha local showed rapid increment from 15 DAS and at harvest it also gave the tallest plant at relay sowing method. All combinations of sowing method and variety showed slower rate of increment of plant height up to 45 DAS but onward 45 DAS plant height increased sharply up to harvest (Figure-3).

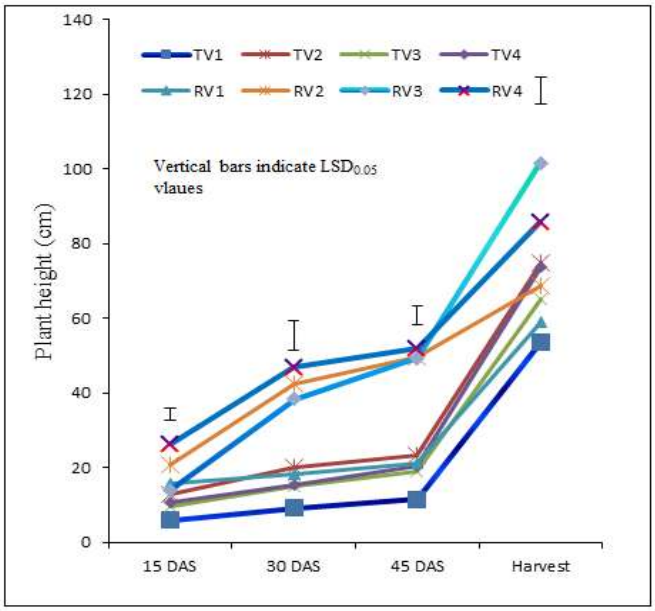

Fig-3: Plant height of pea at 15 day intervals as influenced by the interaction of sowing method and variety during rabi 2012-2013

Dry matter (DM) accumulation at 30 and 45 DAS, and at harvest

Effect of sowing method

Methods of sowing exerted significant variation in terms of DM/plant at 30 and 45 DAS, and at harvest. The results showed that relay method accumulated significantly higher DM/plant at all sampling dates. Dry matter was 5.16 g/plant in relay method while 4.40 g/plant in conventional method at harvest (Table-1).

Table-1: Dry matter (DM) accumulation of pea at 30 and 45 DAS, and at harvest as influenced by the sowing methods during rabi 2012-2013

Sowing method	DM/plant		
	30 DAS (mg)	45 DAS (mg)	Harvest (g)
Conventional	39.75 b	76.13 b	4.40 b
Relay	101.69 a	153.63 a	5.16 a
CV(%)	7.00	11.85	6.14
$LSD_{0.05}$	3.712	10.202	0.219
Level of significance	**	**	**

Note: ** indicates mean values are significantly different at 1% level of probability.

Effect of variety

There was significant variation at all sampling dates in respect of DM/plant among the pea varieties. The highest DM/plant was recorded from the same variety Natore local at both 30 and 45 DAS (90.75 & 154.75 mg /plant, respectively). BARI motorshuti-1 accumulated the lowest DM/plant at 30 DAS (60.50 mg/plant) and Jhikorgacha local at 45 DAS (98.88 mg/plant) (Table-2). Finally at harvest, the highest DM/plant (6.71 g) was recorded in the variety BARI motorshuti-1 which was significantly different from that of others while the lowest DM/plant (2.73 g) was found in the IPSA motorshuti-1. The rest two varieties of Jhikorgacha local and Natore local accumulated statistically similar quantity of DM/plant.

Table-2: Dry matter (DM) accumulation of pea varieties at 30 and 45 DAS, and at harvest during rabi 2012-2013

Variety	DM/plant		
	30 DAS (mg)	45 DAS (mg)	harvest (g)
BARI motorshuti-1	60.50 c	105.88 b	6.71 a
IPSA motorshuti-1	63.38 bc	100.00 bc	2.73 c
Jhikorgacha local	68.25 b	98.88 c	4.79 b
Natore local	90.75 a	154.75 a	4.89 b
CV(%)	7.02	4.94	8.03
$LSD_{0.05}$	5.212	5.955	0.403
Level of significance	**	**	**

Note: ** indicates mean values are significantly different at 1% level of probability.

Interaction effect of sowing methods and varieties

Interaction of sowing method and variety produced significant variation in terms of DM/plant at 30 DAS and harvest but not at 45 DAS. Accumulation of DM/plant was recorded the highest (135.25 g/plant) in Natore local in combination with relay method of sowing and the lowest DM/plant (33.50 g) was recorded from Jhikorgacha local similar to that of IPSA motorshuti (38.75 g/plant) in combination with the same conventional sowing method (Table-3). The variety Jhikorgacha local produced the second highest DM/plant (103.00 g) with relay sowing method which was also significantly different from other combinations. At harvest the highest DM/plant (7.73 g) was obtained from the variety BARI motorshuti-1 with relay method of sowing. At this stage the lowest DM/plant (2.20 g) was obtained from the variety IPSA motorshuti-1 with conventional sowing method.

Table-3: Dry matter accumulation of pea at 30 and 45 DAS, and at harvest as influenced by the interaction of sowing method and varieties during rabi 2012-2013

Sowing method × Variety	DM/plant		
	30 DAS (mg)	45 DAS (mg)	Harvest (g)
TV_1	40.50 ef	64.50	5.69 b
TV_2	38.75 f	62.25	2.20 e
TV_3	33.50 f	60.50	5.45 b
TV_4	46.25 e	117.25	4.28 c
RV_1	80.50 d	147.25	7.73 a
RV_2	88.00 c	137.75	3.27 d
RV_3	103.00 b	137.25	4.13 c
RV_4	135.25 a	192.25	5.51 b
CV(%)	7.02	4.94	8.03
$LSD_{0.05}$	7.370	-	0.569
Level of significance	**	NS	**

Note: T= Conventional method of sowing (after land preparation), **R=** Relay cropping with T. aman rice, **V_1=** BARI motorshuti-1**,** **V_2=** IPSA motorshuti-1, **V_3=** Jhikorgacha local, **V_4=** Natore local; ****** indicates mean values are significantly different at 1% level of probability; * indicates mean values are significantly different at 5% level of probability**;** **NS–**Non-significant.

Yield and yield contributing characters

Effect of sowing methods

Plant population per unit area also differed significantly between the two methods of sowing. Conventional method recorded higher plant population/m^2 compared to the relay cropping. The land was prepared by spading and big clods were broken into small pieces. This brought about favorable condition for germination of seed in conventional method resulting establishment of higher plant population per unit area while seed sown in the relay method did not receive similar condition as conventional method of sowing. Some seeds may be placed in between sheath and stem of rice plant and some may be placed on the stubble which did not get the favourable conditions for germination in the relay method of sowing. Thus relay method of sowing gave lower plant population/m^2. The results presented in Table 1 exhibited that there was considerable variation between the two sowing methods in respect of plant height. Relay method produced the taller plant compared to conventional method. Crop plants of relay method grew in the shade of rice plants. The shading effect of rice plant enhanced the growth of pea plants under relay cropping but the crop plants of conventional sowing method did not experience shade and thus discrepancy developed between the two methods in this parameter. Number of pod /plant differed significantly between the two sowing methods. The results revealed that relay cropping produced higher number of pod/plant which was about twice than that of conventional sowing method (Table-4). There was no significant variation between the two sowing methods. A little bit higher number of seed of 4.91/pod was obtained in the relay method than that of conventional sowing method which produced 4.53 seed/pod (Table 4). A considerable variation was found between the two sowing methods in terms of 100 seed weight. The crop of relay method produced larger sized seed (12.47 g/100 seed) than that of conventional method (11.15 g/100 seed) (Table-4). Yield of green pod differed significantly between the two sowing methods and it was revealed that relay method produced the higher green pod yield of 2872 kg/ha while conventional method produced green pod yield of 2485 kg/ha. Higher green pod yield produced in relay cropping system was possibly attributed by the higher number of pod/plant and larger seed size in spite of lower plant population/m^2 [21]. Variation of fodder yield was observed significantly different between the two sowing methods. Significantly higher fodder yield (3552 kg/ha) was found in relay method while the lower fodder yield (3101 kg/ha) was obtained from the conventional sowing method (Table 4). Taller plant than conventional method of sowing might be ascribed to produce higher fodder yield in relay method.

Table-4: Yield and yield attributes of pea varieties grown in conventional and relay methods of sowing with T. Aman rice during rabi (winter) 2012-2013

Sowing method	Plant population /m^2	Plant height (cm)	Number of pod/plant	Number of seed/pod	100 seed weight (g)	Green pod yield (kg/ha)	Fodder yield (kg/ha)
Conventional	97.88	66.73	3.97	4.53	11.15	2485	3101
Relay	68.75	78.80	6.86	4.91	12.47	2872	3552
CV(%)	5.97	2.18	12.23	13.07	6.47	6.06	2.33
$LSD_{0.05}$	1.78	0.57	0.24	-	0.27	58.07	27.26
Significance Level	**	**	*	NS	*	**	*

Note: ** indicates mean values are significantly different at 1% level of probability; * indicates mean values are significantly different at 5% level of probability; **NS** – Non-significant.

Performance of varieties

A significant variation was found for plant population/m^2 among the varieties of pea. The highest plant population (101.0/m^2) was found in Jhikorgachha local which was at par with that of Natore local (92.00/m^2) and the lowest (62.50/m^2) was found in BARI motorshuti-1(Table-5). Moderate plant population (77.75/m^2) was found in IPSA motorshuti-1. Actually seed rate depends on the seed size, germination percentage, moisture content of soil etc. Same seed rate with above 90% germination percentage was used for all varieties in this experiment and they belonged to the similar environment in the field. In spite of that Jhikorgacha local produced the highest plant population per unit area might be because of its smaller size of seed while BARI motorshuti-1 produced the lowest might be because of its larger size of seed. Similarly, other two varieties produced plant population corresponding to their seed size. Plant height is an important parameter for suitability of relay cropping in the standing crop. Taller plant of relay crop varieties at early stage is more suitable for its establishment as they needed to compete with the standing crop. The taller plant may come out earlier exceeding the stubbles of the previous crop and hence the plant able to produce healthy plant utilizing more sunlight by the process of photosynthesis. The results presented in Table 5 revealed that statistically similar plant height was found in Jhikorgacha local and Natore local having the tallest plant in Jhikorgacha local (83.35 cm). Shortest plant stature (56.25 cm) was obtained from BARI motorshuti-1whilst IPSA motorshuti-1 showed the moderate plant height (71.75 cm). Hence the two varieties of Jhikorgacha local and Natore local may be considered as more suitable than the others for relay cropping. There was significant difference among the pea varieties in terms of number of pod/plant. Natore local had the highest number of pod (5.95/plant) which was similar to that of IPSA motorshuti-1 (5.88/plant). BARI motorshuti-1 had the lowest number of pod plant (4.55/plant). Number of seed/pod varied significantly among the varieties. BARI motorshuti-1 had the highest number of seed (5.19/pod) followed by IPSA motorshuti-1 (4.94/pod). The lowest number of seed (4.16/pod) was found in Jhikorgacha local which was significantly different from that of all others. Results exhibited that 100 seed weight variation was significant among the pea varieties. Significantly highest 100 seed weight (14.75 g) was obtained from BARI motorshuti-1. Jhikorgacha local produced the smallest size of seed (9.74 g/100 seed) while both the varieties IPSA motorshuti-1 and Natore local produced statistically similar and moderate size of seed (Table-5). Variation among the varieties was found significant in respect of green pod yield. The highest green pod yield (3030 t/ha) was obtained from Jhikorgacha local which was not significantly different from that of Natore local (3008 kg/ha) (Table-5). IPSA motoshuti-1 produced the moderate green pod yield (2801 kg/ha) and it was significantly different from the others while the lowest (1874 kg/ha) was obtained from BARI motorshuti-1. Green pod yield in the variety Jhikorgacha local was attributed mainly by the higher number of pod/plant concomitant with higher plant population per unit area. But in case of the variety Natore local, higher green pod yield was possibly attributed by the higher plant population per unit area, number of pod/plant and larger sized seed. Fodder yield also varied significantly among the varieties and it was found that Natore local produced significantly highest fodder yield (3856 kg/ha) possibly attributed by more plant height and population per unit area and healthy plants also. The second highest fodder yield (3648 kg/ha) was obtained from Jhikorgacha local while the lowest (2536 kg/ha) was obtained from BARI motorshuti-1 (Table 5). Plant stature and population/m^2 play vital role for biomass production and these parameters were found the lowest in BARI motorshuti-1 which in turn produced the lowest fodder yield.

Table-5: Yield and yield attributes of pea varieties irrespective of sowing methods during rabi (winter) 2012-1013

Variety	Plant population /m^2	Plant height (cm)	Number of pod /plant	Number of seed/pod	100 seed weight (g)	Green pod yield (kg/ha)	Fodder yield (kg/ha)
BARI motorshuti-1	62.50 c	56.25 c	4.55 c	5.19 a	14.75 a	1874 c	2536 d
IPSA motorshuti-1	77.75 b	71.75 b	5.88 ab	4.94 ab	11.41 b	2801 b	3266 c
Jhikorgachha local	101.0 a	83.35 a	5.28 b	4.16 c	9.738 c	3030 a	3648 b
Natore Local	92.00 a	79.70 a	5.95 a	4.60 b	11.34 b	3008 a	3856 a
CV(%)	12.28	6.55	11.26	7.69	7.63	5.60	2.33
$LSD_{0.05}$	10.75	5.009	0.6398	0.3817	0.947	157.5	81.38
Level of significance	**	**	**	**	**	*	**

Note: ** indicates mean values are significantly different at 1% level of probability; * indicates mean values are significantly different at 5% level of probability.

Interaction effect of sowing methods and varieties

The results showed that significantly highest plant population/m^2 was established in both the varieties Jhikorgacha local and Natore local varieties under conventional method of sowing. Actually all varieties produced more plant in conventional method corresponding their population under relay cropping. Such result might be obtained because of prevailing better environment for germination of seed and stand establishment in conventional method than relay cropping. Plant height varied significantly due to interaction of sowing method and variety. The tallest plant was found in Jhikorgachha local variety with relay cropping system followed by Natore local. The shortest and statistically similar plant was found in BARI motorshuti-1 in both the sowing methods (Table-6). Number of pod/plant significantly differed among the treatment combinations of method of sowing and variety. The results revealed that Natore local produced the highest number of pod/plant which was statistically at par to that of IPSA motorshuti under relay cropping (Table-6). The lowest number of pod/plant was found in BARI motorshuti-1 which was statistically at par to those of other varieties under the same conventional method of sowing. There was no significant difference among the treatment combinations of method of sowing and variety (Table-6). However, BARI motorshuti-1 had the maximum number of seed/pod followed by IPSA motorshuti-1 under relay cropping. IPSA motorshuti-1 produced the minimum number of seed pod^{-1} with conventional sowing method. Hundred seed weight did not vary significantly due to interaction of sowing method and variety. Hundred seed size ranged from 15.93 g in BARI motorshuti-1 with relay cropping to 9.00 g in IPSA motroshuti-1 with conventional sowing method (Table-6). In general, larger sized seeds in all varieties were found in relay cropping compared to conventional method. Green pod yield variation was found significant among the combinations of sowing methods and varieties of motorshuti. In general, all varieties gave higher green pod yield in relay cropping corresponding to their yields in conventional sowing method (Table-6). The highest green pod yield was obtained from Natore local and this was statistically at par with Jhikorgacha local in the relay cropping system. The lowest green pod yield was obtained from BARI motorshuti-1 under conventional method of sowing. The highest green pod yield in Natore local and Jhikorgacha local might be attributed by the higher number of pod/plant as well as plant population/m^2. Due to lower number of pod/plant all varieties produced lower green pod yield in spite of higher plant population/m^2 in the conventional sowing method. Seeds were sown about 20-day later in conventional method than relay cropping. Thus due to late sowing the crop of conventional method experienced high temperature which might hastened flowering and adversely affected pod development and filling stages resulting less number of pod and smaller sized seed. Like green pod yield, fodder yield also differed significantly due to interaction of methods of sowing and varieties of motorshuti. Significantly highest fodder yield was obtained from the variety Natore local with relay cropping system while the lowest was obtained from BARI motroshuti-1 with conventional method of sowing (Table 6). Generally varieties with short statured plant produced comparatively lower fodder yield with both conventional and relay cropping systems. The second highest fodder yield was obtained from Jhikorgacha local with relay cropping which was statistically similar to that of Natore local with conventional sowing method.

Partial budget analysis

Cost and return analysis was done considering Bangladesh currency (BDT). Maximum cost of cultivation was BDT 54,600 /ha for varieties IPSA motorshuti-1, Jhikorgachha local and Natore local in the conventional method of sowing while minimum cost of cultivation was BDT 43500 /ha for variety BARI Motorshuti-1 in relay cropping system (Table-7) . More cost of cultivation was calculated in conventional

method of sowing because of necessity of extra cost for land preparation and weeding. Besides, labour cost was considered for more pod yield in the respective varieties for both sowing methods. The maximum gross return (BDT 1, 74, 760 /ha) was obtained from the variety Natore local followed by Jikorgacha local (BDT 1, 69, 218 /ha) in relay cropping system (Table-7). Similar trends were found in case of gross margin. Maximum BCR (3.53) was recorded in Natore local followed by Jhikorgachha local (3.42) under relay cropping system while minimum BCR (1.85) was found in BARI motorshuti-1variety in conventional method of sowing [22, 23].

Table-6: Interaction effect of conventional and relay methods of sowing on pea with T. Aman rice during rabi (winter) 2012-2013

Treatment combination	Plant population/ m^2	Plant height (cm)	Number of pod/ plant	Number of seed/ pod	100 seed weight (g)	Green pod yield (kg/ha)	Fodder yield (kg/ha)
TV_1	68.00 c	53.40 f	3.650 d	4.750	13.58	1745 e	2220 f
TV_2	89.50 b	74.80 c	4.125 d	4.875	11.15	2685 c	2990 d
TV_3	118.0 a	65.00 de	3.850 d	3.900	9.00	2825 bc	3538 c
TV_4	116.0 a	73.70 c	4.250 d	4.600	10.88	2683 c	3658 b
RV_1	57.00 c	59.10 ef	5.450 c	5.625	15.93	2003 d	2853 e
RV_2	66.00 c	68.71 cd	7.625 a	5.000	11.66	2918 b	3543 c
RV_3	84.00 b	101.7 a	6.700 b	4.425	10.48	3234 a	3759 b
RV_4	68.00 c	85.70 b	7.650 a	4.600	11.80	3333 a	4055 a
CV(%)	12.28	6.55	11.26	7.69	7.63	5.60	2.33
$LSD_{0.05}$	15.20	7.084	0.9049	-	-	222.8	115.1
Level of significance	*	**	*	NS	NS	*	**

Note: T= Conventional method of sowing (after land preparation)**, R=** Relay cropping with T. Aman rice, **V_1=** BARI motorshuti-1, **V_2=** IPSA motorshuti-1, **V_3=** Jhikorgacha Local motoshuti, **V_4=** Natore Local motorshuti; ** indicates mean values are significantly different at 1% level of probability; * indicates mean values are significantly different at 5% level of probability; NS – Non-significant.

Table-7: Partial budget analysis of different pea varieties in conventional and relay methods of sowing with T. Aman rice during rabi 2012-2013

Varieties	Pod yield (kg/ha)	Fodder yield (kg/ha)	Cost of cultivation (BDT/ha)	Gross return (Pod + fodder) (BDT/ha)	Gross margin (BDT/ha)	BCR
TV_1	1745	2220	49600	91690	42090	1.85
TV_2	2685	2990	54400	140230	85830	2.58
TV_3	**2825**	3538	54400	148326	93926	2.73
TV_4	**2683**	3658	54400	141466	87066	2.60
RV_1	**2003**	2853	43500	105856	62356	2.43
RV_2	**2918**	3543	48000	152986	104986	3.19
RV_3	**3234**	3759	49500	169218	119718	3.42
RV_4	**3333**	4055	49500	174760	125260	3.53

Note: Selling Price: Green pod of Motorshuti -BDT 50 /kg; Fodder - BDT 2 /kg; **T=** Conventional**, R=** Relay**, V_1** = BARI Motorshuti-1**, V_2** = IPSA Motorshuti-1**, V_3** = Jhikorgacha Local motorshuti**, V_4** = Natore Local motorshuti

CONCLUSION

Most of the medium high and high lands remain fallow after harvest of T. Aman rice in greater Sylhet region. With the utilization of residual soil moisture short duration pea crop may be grown as relay crop with T. Aman rice. This attempt will be helpful to increase cropping intensity, land productivity, farm income and food security of the local people in Sylhet region. Fodder supply for cattle may also be enhanced and could be a good option for mitigation of cattle feed setback in this region.

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