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Full Length Research Paper

Adaptation of pea (*Pisum sativum* L) as relay crop with monsoon rice is a resource conservation technology in medium high to medium low lands of Bangladesh

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The study was conducted at *Pulses Research Centre (PRC), Ishurdi, Pabna, Regional Agricultural Research Station (RARS), Jamalpur and Pulses Research Sub-station (PRSS), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, Bangladesh during rabi 2011-2012* to select an improved variety of pea as relay crop with monsoon rice for well adaptation and higher yield as green pod for vegetable as well as high biomass for fodder. A total of seven pea varieties for Ishurdi location Viz. BARI Motorshuti-1, BARI Motorshuti-3, IPSA Motorshuti-1, IPSA Motorshuti-2, IPSA Motorshuti-3, Jhikorgacha local and Natore local and five pea varieties for Jamalpur location Viz. BARI Motorshuti-1, BARI Motorshuti-3, IPSA Motorshuti-1, Natore Local, Jikorgachha Local and for Joydebpur location only Natore Local and Jikorgachha Local were included as a treatment in this experiment. The result revealed that the variety Natore local gave the highest pod yield 5,318 kg ha⁻¹, 4,825 kg ha⁻¹ and 2,200kg ha⁻¹ at Ishurdi, Jamalpur and Joydebpur locations respectively followed by Jickorggacha local variety. Maximum gross margin Tk. 1,52,836 ha⁻¹, Tk. 1,45,809ha⁻¹ & Tk. 44,840 ha⁻¹, and BCR 4.04, 4.65 and 2.21 were obtained by the cultivar Natore local at Ishurdi, Jamalpur and Joydebpur locations, respectively. Similarly, cultivar Natore local along with improved production technologies also showed satisfactory level of yield and economic performances at Farmers' field. It was also identified that, by the inclusion of pea in the monsoon rice field, lands could be brought under pea cultivation to enhance pea production, provide human nutrition and also to ensure soil health improvement for sustainable production system.

Keywords: Adaptation, pea, relay, rice, resource conservation and land

INTRODUCTION

Bangladesh is one of the most populous and poverty affected country in the world. To meet high demand of food against blooming population, highest emphasis is given to cereal production. As a result, Bangladeshi population suffers from protein malnutrition. Eighty eight percent of the population suffers from protein deficiency and children, women and lactating mothers in particular (94.4%) are the worst suffers (Kabir *et al.*, 2005). The soil is also poor considering nutrients and water content. Whereas, growing of legumes helps to improve these situations. Pulses as a member of legumes is a wonderful gift of nature which is a store house of nutrition. Among the pulses pea (*Pisum sativum*) is a cool-season legume crop that is grown on over 6.33 M ha area worldwide (FAO, 2012) where as it contributed only a 18,749 acres of land and 7385 metric tons production to the total area of cultivation and production of pulses, respectively in Bangladesh (BBS, 2015). Han & Baik (2008) stated that as food component peas are rich in starch, protein and dietary fiber, they have significant amounts of vitamins and minerals and are characterized by a relatively high antioxidant activity which are proved for a cholesterol-lowering effect (Martins *et al.*, 2004). Pea seeds are of great nutritional value in terms of high-quality protein and energy content. It contains 21-32% of protein rich in lysine (Nikolopoulou *et al.*, 2007, Wang *et al.*, 1998) which is the limiting amino acid in most of the plant products (Palander *et al.* 2006, Biel *et al.*, 2009). In Bangladesh, many crops viz. lentil, grasspea, chickpea, field pea, mustard etc. are relayed with monsoon rice where monsoon rice harvesting is delayed and/or land remains moist which takes few to more days to become optimum condition for land preparation for next crop cultivation (Islam *et al.*, 2015). Among the pulses, pea is mainly grown after the harvest of monsoon-rice in the winter season (October-March) in Bangladesh. But in most cases, pea cultivation, after the monsoon-rice harvesting is delayed in medium high-medium low lands and further aggravated by higher infestation of diseases and insect pests and forced maturity, resulting in lower yields. It was also identified that global climatic changes led to more frequent high temperature during the end of crop cycle. In this context, pea relay cropping in conservation agriculture in the rice field has great promise which generally ensures the best use of residual soil moisture of rice field and timely sowing. Besides these, in cereal-based cropping pattern, pulses make an important contribution to increase food and feed production without damaging the environment to crop diversification and sustainable agricultural production by adding nitrogen to the soil and breaking cereal based monoculture.

Relay cropping is a method of multiple cropping where one crop is seeded into standing second crop well before harvesting of second crop (Queen *et al.*, 2009). Relay cropping possesses the capability to improve soil quality, to increase net return and land equivalent ratio, and to control the weeds and pest infestation, thereby decreasing chemical pest control measures (Jabbar *et al.*, 2011; Bandyopadhyay *et al.*, 2016). So, under this context introduction of suitable pea cultivars through the relay cropping practices especially sowing of pulses prior to the harvest of monsoon rice and adoption of minimum tillage would be a phenomenon option to increase the cropping intensity. Inter/relay cropping would be appropriate and more efficient cropping system which may ensure proper utilization of resources towards increased production per unit area and time on a sustainable basis (Ahmad *et al.*, 2007). Gupta *et al.* (2005) opined that relay cropping is an ancient and traditional agronomic practice has been recognized as a potentially benefitted technology to provide more remuneration to the farmers instead of sole crops. Relay cropping is beneficial in terms of utilize residual moisture from previous crop and reduced planting cost (Saleem *et al.*, 2000; Malik *et al.*, 2002; Jabbar *et al.*, 2005). Joy *et al.* (1986) reported that legumes grown after rice at zero/minimum tillage are less affected by the compact puddled soil than the cereal crop probably due to their deep rooting system. In terms of above convenient of relay cropping farmers are to be able to produced pea as green pod and sell green pods as vegetable, and after harvest of pod the plants are to be used as fodder. However, if suitable pea cultivars can be inserted as relay cropped with monsoon rice as vegetable (cash crop) a large area may come under pea cultivation without disturbing the environment. Although, now a day, farmers sporadically cultivate pea with low yielding cultivars as relay crop in monsoon rice, resulting lower yield. But still now, there is no specific variety of pea for relay cropping. Improved varieties of pea for this system are to be developed for better adaptation and achieving higher yield of pea through relay cropping. In addition to yield, higher biomass production should be taken into consideration in selecting pea variety. So, it is therefore, necessary to evaluate the existing cultivars/varieties of peas under relay cropping with monsoon rice to select appropriate variety.

Considering the above demand, a study was conducted to develop an improved variety/varieties of pea as relay crop with monsoon rice for well adaptation and higher yield as green pod as well as high biomass for fodder. As a result, medium high – medium low lands can be brought under pea cultivation as relay cropping which will enhances pea production in country.

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MATERIALS AND METHODS

A research study was conducted at Pulses Research Centre (PRC), Ishurdi, Pabna, Pulses Research Sub-Station (PRSS), Joydebpur, Gazipur, and Regional Agricultural Research Station (RARS), Jamalpur, Bangladesh belongs to Agro-ecological zone (AEZ-11), (AEZ-15) and (AEZ-9), respectively under Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur-1701, Bangladesh during *rabi* 2011-2012 to select an improved variety of pea as relay crop with monsoon rice for well adaptation and higher yield as green pod for vegetable as well as high biomass for fodder. The geographic coordinates of the research studied areas were located between 24.15° north latitude and 89.0° east longitude and between 23°53' and 24°21' north latitudes and 90°09' and 92°39' east longitudes, 24°34' and 25°26' north latitude and between 89°40' and 90°12' east longitude, respectively. A total of seven pea varieties for Ishurdi location Viz. BARI Motorshuti-1, BARI Motorshuti-3, IPSA Motorshuti -1, IPSA Motorshuti -2, IPSA Motorshuti -3, Jhikorgacha local and Natore local and five pea varieties for Jamalpur Viz. BARI Motorshuti-1, BARI Motorshuti-3, IPSA Motorshuti-1, Natore Local, Jikorgachha Local but for Joydebpur location only Natore Local and Jikorgachha local due to lack of seeds for all the materials. Among the tested materials, five were released varieties and two were local cultivars which were found promising in the earlier screening program under relay cropping. Due to lack of promising genotypes these materials were used for varietal selection. Considering the over location the unit plot size was maintained by 5 m × 4 m. Randomized complete block design was followed with three replications. Fertilizers were applied @ 14-20-20-10 kg/ha of NPKS, respectively as basal before seed sowing except N. N was top dressed at 20 DAE. Seed rate was used @225 kg/ha for five released varieties due bold seeded while @ 90 kg/ha seed rate was used for two local cultivars due to small seeded. Seeds were soaked into water over a night to ensure the optimum germination prior to sowing. Seeds were sown on 29 October, 2011; 2 November, 2011 and 15 November, 2011 at Jamalpur, Ishurdi and Joydebpur locations of Bangladesh, respectively. Seeds were sown in the existing monsoon rice (Binadhan-7) field through broadcast method, 10-15 days before of rice harvest as relay crop just drained out of water when soil moisture was 42-45%. Monsoon rice was harvested leaving 30 cm straw height from ground level. One hand weeding was done at 35 day after emergence (DAE). Pods were harvested at different dated on the basis of pod maturity as a green pod for vegetable at different locations are as follows:

BARI Motorshuti-1 was harvested four times at 84, 90, 97, 102 DAS days after sowing (DAS) and, 93, 105, 110 and 115 (DAS) at Jamalpur and Ishurdi, respectively. At Jamalpur location Variety of BARI Motorshuti-3 was harvested two times at 60 and 68 DAS while at Ishurdi

location it was done at 68 and 72 DAS. The variety IPSA Motorshuti-1 was harvested three times at 80, 85 and 90 DAS at Jamalpur location while at Ishurdi location it was done 78, 83 and 90 DAS. At Ishurdi location IPSA Motorshuti-2 and IPSA Motorshuti-3 was done at 80, 85 & 90 (DAS) and, 85, 91 & 100 DAS, respectively. A local cultivar of pea, Jikorgaccha local was harvested three times at 82, 90 & 96 DAS and, 86, 89 & 97 DAS and, 87, 90 & 98 DAS at Jamalpur, Ishurdi and Joydebpur, respectively. Another local local cultivar- Natore local was harvested four times for all the locations at 85, 94, 102 & 105 DAS and, 90, 99, 105 & 107 DAS and, 94, 102, 108 & 112 DAS at Jamalpur, Joydebpur and Ishurdi, respectively.

Ten plants were selected randomly from each plot before harvest of crop to record data on yield attributes while pod yield was collected on the whole plot basis at different day's interval when bearing pod was matured as green pod. Weight of fresh green pod obtained from the different harvests were recorded and summed up at the end of the crops life and converted into kg ha⁻¹. Collected data of Jamalpur and Ishurdi location were analyzed statistically following the ANOVA technique with the help of MSTAT-C software and mean separation was done as per LSD test at 5% level of significance according to Gomez and Gomez (1984) where as at Joydebpur location means value was calculated. Variable cost of cultivation, gross margin and benefit cost ratio (BCR) were calculated considering the wages of local labour and input prices and selling prices of seed at the harvesting time.

After the selection of pea cultivar, Natore local along with improved production technology a testing-cum demonstration programme, i.e. a validation program was conducted on about 0.4 ha of lands comprising four farmers at Multi Location Testing (MLT) site of Sadar Upazilla of Faridpur, MLT site of Atghoria, Pabna and MLT site of Jamalpur Sadar, Bangladesh during 2012-13 under farmers' field condition. Fertilizers were applied @ 14-20-20-10 kg/ha of NPKS, respectively as basal before seed sowing except N. N was top dressed at 20 DAE. Seeds of cultivar, Natore local, @ 90 Kg/ha was broadcasted as relay, 10-15 days before harvesting of monsoon rice within 2 November, 2012 to 9 November, 2012 at different locations. One weeding was done at 35 DAE. Green pods were harvested four times (90, 98, 105 and 112 DAS) in all the locations and sold at the local market. Data on green pod was recorded. All variable production costs at farmer's field were recorded to find out the net return and benefit cost ratio (BCR). Benefit cost ratio was calculated by using following formula:

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return (Tk.ha}^{-1}\text{)}}{\text{Cost of Cultivation (Tk.ha}^{-1}\text{)}}$$

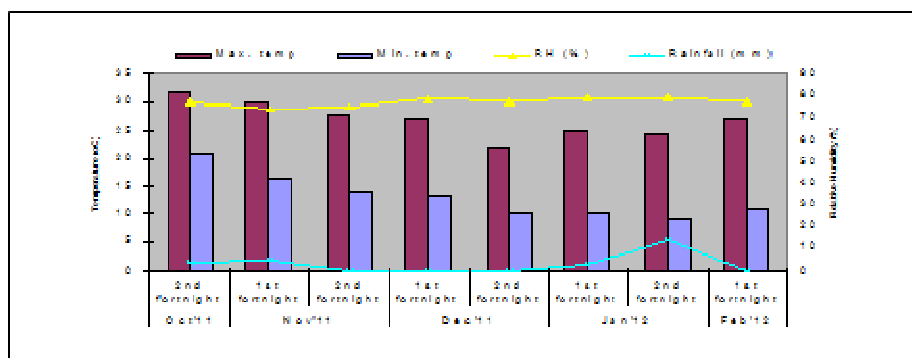


Figure 1. Fortnightly average maximum and minimum temperature (°C) and Rainfall (mm) during the crop growing period at Regional station Jamalpur

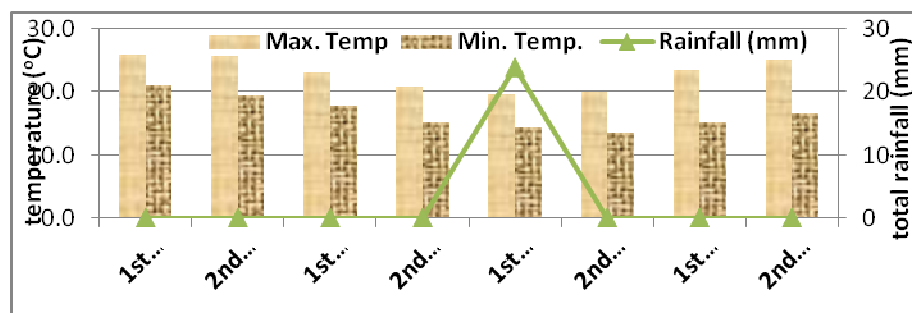


Figure 2. Fortnightly average maximum and minimum temperature (°C) and Rainfall (mm) during the crop growing period at Pulses research centre (PRC), Ishurdi, Pabna

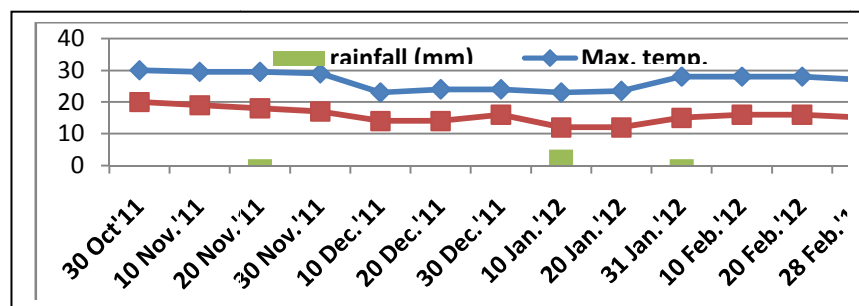


Figure 3. Ten days average maximum and minimum temperature (°C) and Rainfall (mm) during the crop growing period at Pulses research Sub-station (PRSS), Joydebpur

RESULT AND DISCUSSION

Meteorological information of research areas during crop growing period

Meteorological data of experimental areas during cropping period are shown in Figures 1, 2 and 3. Considering the over locations the maximum temperature was prevailed in the last part of October while the minimum temperature was in the last part of January during the crop growing period. During the first fortnight of January a considerable

rainfall occurred in Joydebpur and Ishurdi location while during the second fortnight in Jamalpur location.

Yield and yield contribution characters

The result presented in Table 1a,1b and 1c exerted that phenological, yield and yield contributing characters differed significantly among the different pea varieties/cultivars as a relay cropped with monsoon rice at Jamalpur, Ishurdi and Joydebpur locations. Considering the both locations, the variety BARI Motorshuti-1 took the maximum time- 53 & 63 days for flowering at Jamalpur and

Table 1a. Phenological, yield and yield contributing attributes of peas as relay cropping with monsoon rice at RARS, Jamalpur, Bangladesh

Varieties	DF (Days to Flowering)	Plant height (cm)	Number of plants m ⁻²	Number of pods plant ⁻¹	Number of seeds pod ⁻¹	Green pod yield (kg ha ⁻¹)	Fodder yield (kg ha ⁻¹)
BARI Motorshuti-1	53	56.5	13.32	3.0	5.90	1517	2017
BARI Motorshuti-3	25	30.6	9.20	2.0	2.93	962	630
IPSA Motorshuti-1	38	80.4	31.10	3.9	4.00	1900	3133
Jhikorgachha Local	40	115.9	42.70	5.1	4.10	4067	5233
Natore Local	44	115.3	44.13	6.9	5.20	4825	8467
F-test	**	**	**	**	**	**	**
LSD _{0.05}	1.89	11.95	5.55	0.90	0.73	404.3	509.1
CV (%)	2.53	7.96	10.49	11.67	8.81	8.41	7.02

Table1b. Phenological, yield and yield contributing attributes of peas as relay cropping with monsoon rice PRC, Ishurdi, Bangladesh

Varieties	DF (days)	Plant height (cm)	Number of plants m ⁻²	Number of pods plant ⁻¹	Number of seeds pod ⁻¹	Green pod yield (kg ha ⁻¹)	Fodder yield (kg ha ⁻¹)
BARI Motorshuti-1	63.00	59.27	16.00	4.67	4.33	1920.00	2453.00
BARI Motorshuti-3	32.00	35.37	10.30	3.67	4.00	980.00	1230.00
IPSA Motorshuti -1	33.00	53.10	9.50	2.33	4.33	733.00	896.00
IPSA Motorshuti -2	35.00	44.23	9.03	2.00	4.00	773.00	950.00
IPSA Motorshuti -3	42.00	85.73	25.67	3.00	4.33	2543.00	2954.00
Jhikorgacha local	44.00	107.27	45.00	7.00	5.00	4360.00	5819.00
Natore local	51.67	120.13	47.00	9.33	5.67	5318.00	8503.00
F-test	**	**	**	**	**	**	**
LSD _{0.05}	1.66	44.55	5.25	1.85	1.45	179.5	92.9
CV (%)	2.17	17.16	12.78	10.20	8.10	4.25	1.60

Table1c. Phenological, yield and yield contributing attributes of peas as relay cropping with monsoon rice at BARI, Joydebpur, Bangladesh

Varieties	DF (days)	Plant height (cm)	Number of plants m ⁻²	Number of pods plant ⁻¹	Number of seeds pod ⁻¹	Green pod yield (kg ha ⁻¹)	Fodder yield (kg ha ⁻¹)
Jhikorgachha Local	44	75.50	42.00	5.9	4.00	1920	2300
Natore Local	48	80.60	45.00	6.0	5.00	2200	2420

Ishurdi locations, respectively while the variety BARI Motorshuti-3 took the minimum time- 25 & 32 days at the same locations. Other hand, at Ishurdi location IPSA Motorshuti- 1 and Motorshuti- 2 took closely similar days to BARI Motorshuti-3. Days to flower initiation of the different pea varieties varied, it may be due to the variation of different sowing dates at different geographical locations. The tallest plant was produced by Natore local 120 cm and 80 cm at Ishurdi and Joydebpur location, respectively (Figure. 4.) which was similar to Jhikorgachha local but at Jamalpur Jhikorgachha local was produced the tallest plant (115.9 cm) which was statistically similar to Natore local but the variety BARI Motorshuti-3 produced the shortest plant stature (30.6

cm) and (35.4cm) at Jamalpur and Ishurdi locations, respectively. Plant height differences might be due to individual genetic character of the lentil genotypes. Haddad *et al.*(1982) reported that plant height has been found quantitatively inherited. Saxena (2009) mentioned that plant height may ranges from 15 cm to 75 cm depending on genotype and the growth environment. Ferguson and Robertson (1999) also reported that a ratio of plant height to canopy width is good measure of plant structure and it has been used to characterize growth habit in lentil germplasm evaluation.

The cultivar Natore local produced the maximum number of plants m⁻² (44.1) and (45.0) at Ishurdi and Jamalpur location,



Figure 4: Vigorous and tallest growth of field pea cultivar Natore local as relay crop



Figure 5: Use of different pea varieties as fodder purpose

respectively which was statistically similar to Jhikorgachha local. At Joydebpur location, Natore local produced numerically the highest number of plants m^{-2} than Jikorgachha local. Among the bold seeded variety IPISA Motorshuti-3 moderately survived as relay cropped in normal moisture, untilld and unwedded condition where as others IPISA and BARI varieties produced the lowest number of plants m^{-2} . BARI Motorshuti-3 and IPISA Motorshuti-1 and IPISA Motorshuti-2 produced the lowest number of plants m^{-2} at Jamalpur and Ishurdi location. It was also identified that bold seeded pea varieties germination percentage as well as adaptation is lower than small seeded. It may be due to bold seeded it needs more time with optimum moisture level better for germination where relay cropping failed to provide optimum environment for germination as well as subsequent root and crop growth.

Maximum number of pods plant⁻¹ 9.33, 6.9 and 6.0 were obtained from the Natore local at Ishurdi, Jamalpur and Joydebpur, location, respectively while BARI Motorshuti-3 produced the lowest number of pods plant⁻¹ at Ishurdi but IPISA Motorshuti-2 produced the lowest number of pods plant⁻¹ at Jamalpur. Highest number of seeds pod⁻¹ (5.67) and (5.0) was obtained by the Natore local at Ishurdi and Joydebpur location but at Jamalpur BARI Motorshuti-1 hold foremost position which was statistically similar with Natore local while the variety BARI Motorshuti-3 produced the lowest number of seeds pod⁻¹ at trialed locations. The number of pods per plant which is very important yield determinant in pea varies considerably depending on the genotypes as well as the environment. These findings are

in agreement with the observation of Malhotra *et al.* (1974) and Muehlbauer (1974). Significantly the highest green pod yield (5318 kg ha⁻¹, 4825 kg ha⁻¹ and 2200 kg ha⁻¹) was obtained from Natore local at Ishurdi, Jamalpur & Joydebpur location, respectively while the Jikorgachha local gave the succeeding highest pod yield. IPISA Motorshuti-1 produced the lowest green pod yield at Ishurdi but BARI Motorshuti-3 gave the lowest pod yield at Jamalpur. This yield variation might be due to genetic power of the genotypes and the growth environment. Ali *et al.* (2009) reported that the genotype plays an important role in realizing high productivity. In case of fodder yield the variety Natore local produced the highest amount of 8503 kg ha⁻¹, 8467 kg ha⁻¹ and 2420 kg ha⁻¹ at Ishurdi, Jamalpur and Joydebpur which was significantly different from others. IPISA Motorshuti-1 produced the lowest yield of fodder at Ishurdi but BARI Motorshuti-3 showed the lowest performance at Jamalpur location. Due to vigor morphological characters of the cultivar Natore local followed by Jikorgachha local, had a great potential as a fodder crop. After harvest of green pods, plants can be used as a green fodder due to higher amount of moisture in pea forage. So, after picking of green pod for human consumption, the plants can be used as a fodder purpose (Figure 5.) in those growing areas where fodder scarcity is acute. The cultivar Natore local produced the highest green pod yield as well as fodder yield, it may be due to highest number of plants m^{-2} and cumulative influences of yield contributing characters.

Table 2a. Economic performances of different pea varieties as a relay cropped with monsoon rice at RARS, Jamalpur, Bangladesh

Varieties	Pod yield (kg ha ⁻¹)	Fodder yield (kg ha ⁻¹)	Cost of cultivation (Tk. ha ⁻¹)	Gross return (Pod + fodder) (Tk. ha ⁻¹)	Gross margin (Tk. ha ⁻¹)	BCR
BARI Motorshuti-1	1517	2017	40,000	57,129	17,129	1.43
BARI Motorshuti-3	962	630	30,000	34,930	4,930	1.20
IPSA Motorshuti-1	1900	3133	35,000	72,766	37,766	2.08
Jhikorgachha Local	4067	5233	40,000	1,52,811	1,12,811	3.82
Natore Local	4825	8467	40,000	1,85,809	1,45,809	4.65

Price: Motorshuti pod -Tk. 35 kg⁻¹; fodder - Tk. 2 kg⁻¹

Table 2b. Economic performances of different pea varieties as a relay cropped with monsoon rice at PRC, Ishurdi, Bangladesh

Varieties	Pod yield (kg ha ⁻¹)	Fodder yield (kg ha ⁻¹)	Cost of cultivation (Tk. ha ⁻¹)	Gross return (Pod + fodder) (Tk. ha ⁻¹)	Gross margin (Tk. ha ⁻¹)	BCR
BARI Motorshuti-1	1920	2453	42,200	72106	29906	1.71
BARI Motorshuti-3	980	1230	32,100	36760	4,660	1.15
IPSA Motorshuti -1	733	896	25,100	27447	2347	1.09
IPSA Motorshuti -2	773	950	25,800	28955	3155	1.12
IPSA Motorshuti -3	2543	2954	43,000	94913	51913	2.21
Jhikorgacha local	4360	5819	48,100	164238	116138	3.41
Natore local	5318	8503	50,300	203136	152836	4.04

Price: Motorshuti pod -Tk. 35 kg⁻¹; fodder - Tk. 2 kg⁻¹

Table 2c. Economic performances of different pea varieties as a relay cropped with monsoon rice at PRSS, BARI, Joydebpur, Gazipur

Varieties	Pod yield (kg ha ⁻¹)	Fodder yield (kg ha ⁻¹)	Cost of cultivation (Tk. ha ⁻¹)	Gross return (Pod + fodder) (Tk. ha ⁻¹)	Gross margin (Tk. ha ⁻¹)	BCR
Jikorgachha Local	1920	2300	35,100	71800	36700	2.05
Natore Local	2200	2420	37,000	81840	44840	2.21

Price: Motorshuti pod -Tk. 35 kg⁻¹; fodder - Tk. 2 kg⁻¹

Economic performances

Economic performance result showed in the Table of 2a, 2b and 2c revealed that maximum cost of cultivation Tk. 40,000 ha⁻¹, Tk. 50,300 ha⁻¹ and Tk. 37,000 ha⁻¹ was recorded in Natore local at Jamalpur, Ishurdi and Joydebpur, respectively followed by Jhikorgachha local. The minimum cost of cultivation Tk. 30,000 ha⁻¹ was found for the variety BARI Motorshuti-3 at Jamalpur location and Tk. 25,100 ha⁻¹ was found for IPSA Motorshuti-1 at Ishurdi location. The maximum gross margin Tk. 1,52,836 ha⁻¹, Tk. 1,45,809 ha⁻¹ & Tk. 44,840 ha⁻¹ and Benefit Cost Ratio (BCR) 4.04, 4.65 and 2.21 was obtained by the Natore

local at Ishurdi, Jamalpur and Joydebpur, respectively. The variety BARI Motorshuti-1 and IPSA Motorshuti-3 contributed the lowest BCR (1.20 & 1.09) at Jamalpur and Ishurdi, respectively.

The benefit cost ratio of farmers field also revealed that Natore local variety contributed gross return (Tk. 1,47,440 ha⁻¹), gross margin (Tk. 98,273 ha⁻¹) and benefit cost ratio (BCR) (2.30) that was also higher than other BARI and IPSA released pea varieties. Jabbar *et al.*, (2005) who reported that rice/legumes relay cropping system such as rice/chickpea and rice/lentil proved to be more productive and economically viable.

Table 3. Yield and yield contributing characters of field pea as relay cropping at farmers field of three locations (Average of four farmers' field for each site)

Location	Plant height (cm)	No. of Plant m ⁻²	No. of pod plant ⁻¹	No. Seed pod ⁻¹	Green pod yield (t ha ⁻¹)	Fodder yield (t ha ⁻¹)
MLT site, Pabna	105	49	6.5	4.9	6.60	8.5
MLT site, Faridpur	96	50	6.7	5.0	7.20	8.9
MLT site Jamalpur	94.1	40	5.9	4.8	4.66	6.8

Table 4. Economic performance of relay pea with monsoon rice at three locations of Bangladesh

Location	Green pod yield (t ha ⁻¹)	Fodder yield (t ha ⁻¹)	Gross return (Tk. ha ⁻¹)	Total variable cost (TVC) (Tk. ha ⁻¹)	Gross margin (Tk/ha)	BCR (on the basis of TVC)
MLT site, Pabna	6.60	8.5	2,48,000	25,738.00	2,22,262	9.64
MLT site, Faridpur	7.20	8.9	2,69,800	26,738.00	2,43,062	10.09
MLT site Jamalpur	4.66	6.8	1,76,700	23,655.00	1,53,045	7.47

Price: Motorshuti pod -Tk. 35 kg⁻¹; fodder - Tk. 2 kg⁻¹

Results of farmer's field

The results of block demonstrations in the farmer's field of three locations are presented in the Table 3 and 4. A pea cultivar, Natore local was grown as relay crop under farmer's field conditions at 3 locations, differences were observed for the plant population per square meter, ranging from 45 to 50 (Table 3). The highest green pod yield (7.20 t ha⁻¹) and fodder yield (8.90 t/ha) was harvested at Faridpur followed by Pabna pod yield (6.60 t ha⁻¹) and fodder yield (8.5 t/ha), and the lowest pod (4.66 t ha⁻¹) and fodder (6.8 t ha⁻¹) at Jamalpur, it may be due to relatively less population as well as lower yield contributing characters (Table 3).

From the cost of benefit analysis it appeared that the highest net return Tk. 2,69,800 ha⁻¹, gross margin Tk. 2,43,062 ha⁻¹ and highest BCR (10.09) was obtained at Faridpur and the lowest at Jamalpur location (Table 4). These are quite high benefit indeed. This suggests that, relay cropping with modern variety will be more profitable. Gahoonia *et al.* (2005) also reported the similar results. Farmers can harvest the pods as cash crop and also can retain some crop for seed/grain purpose. Farmers wished to cultivate Natore local cultivar in relay condition as an extra crop.

Farmers' reaction:

Farmers are very pleased to cultivate field pea's variety (Natore local) in their monsoon rice field as relay crop. They demanded field pea's seed after that next season.

CONCLUSION

Considering the over locations performance as well as farmer's field result's, the cultivar Natore local can be released as a variety for extensive cultivation as relay crop in the monsoon rice field for green pod as vegetable and fodder. It also be created an opportunity for pea production in the cropping pattern of monsoon rice- pea (as green pod +fodder)- summer rice/mungbean/sesame. In the some areas fallow lands will be used for pea production within the window of monsoon and spring rice. Relay cropping of pea with monsoon rice may give an opportunity for earlier sowing of pea for substantial yield which may contribute to further improvement of the system. Besides this, inclusion of pea in the rice-based cropping system, medium- high to medium -low lands could be brought under pea cultivation to enhance pea production, provide human and animal nutrition and also to ensure soil health improvement for sustainable production system. Finally, sustainable agriculture will be helpful for safety food production in the farm level as well as food will be secured.

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