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CROP SEQUENCES FOR INCREASING CROPPING INTENSITY AND PRODUCTIVITY

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ABSTRACT

Field experiments were conducted at the Central Research Station of Bangladesh Agricultural Research Institute (BARI) for three consecutive years (2011-12, 2012-13 and 2013-14) to study the comparative agronomic performance and economic return of different cropping sequences for increasing cropping intensity and productivity. Three cropping patterns (CP_1 - Transplanted Aman rice (var:Binadhan-7)– Mustard (var:BARISarisha-14)– Boro rice (var:BRRIdhan-28)– Transplanted Aus rice (var:Parija), CP_2 - T. aman rice – Potato (var:Diamont) – Boro rice – T. aus rice and CP_3 - T. aman rice – Mustard (var:BARISarisha-15) – Mungbean (var:BARIMung-6) –T. aus rice) are based on four crops; and one cropping pattern (CP_4 = T. aman rice – Fallow – Boro rice – Fallow) with two rice crops as control were tested. Four crops can be grown successfully one after another in sequence in all the three cropping patterns tested. On an average organic matter 3.56, 4.70, 3.58 and 2 t ha^{-1} were added to soil in CP_1, CP_2, CP_3 and CP_4 by incorporation of biomass of respective crops. The highest rice equivalent yield (REY) 34.10, 34.02 and 33.36 t ha^{-1} was obtained from the cropping pattern CP_2 in 2011-12, 2012-13 and 2013-14, respectively and it was followed by CP_1 and CP_3. The highest average gross return (Tk.5,00,469 ha^{-1}) and net return (Tk. 2,63,773 ha^{-1}) were obtained from CP_2 and it was followed by CP_3 but the highest average B:C ratio (2.89) was obtained from the cropping pattern CP_3 followed by CP_2 (2.11) due to lower cost of production than in the former one. Four crops based patterns can be recommended for higher productivity, soil enrichment & economic benefit besides creating more employment opportunity.

Keywords: Four crop sequence, Rice, Mustard, Mungbean, Potato, Cropping pattern and Cropping intensity.

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INTRODUCTION

Bangladesh is a densely populated (1008 per sq. km.) country of the world with an area of 1,47,570 sq. km with population of about 149 million at an increasing rate of 1.19% per year (BBS 2012). At present total cultivable land is 8.5 million hectare and it is shrinking day by day. The overall land area increased in the recent past is due to reclamation of char lands .The annual loss of agricultural land is about 0.73% per annum due to construction of houses, roads and industrial infrastructure (BBS,

2011). There is very little scope of increasing cultivable land but there are some scope of increasing cropping intensity from existing level of 191% by improving the existing cropping patterns by incorporating short duration crops viz., mustard, potato, mungbean and aus rice in the rice based cropping system.

Sustainable crop production in Bangladesh through improvement of cropping intensity in rice based cropping system is regarded as increasingly important in national issues such as food security, poverty alleviation and creation of job opportunity . The main challenge of the new millennium is to increase 50% yield per unit land area through manipulating the limited land resource. In order to produce more food within a limited area, the most important options are i) to increase the cropping intensity producing three or more crops over the same piece of land in a year and ii) to increase the production efficiency of the individual crop by using optimum management practices. Oilseed and pulse are the important group of crops which are mostly grown in rabi season but area of those crops decreased due to increasing cultivation of irrigated boro rice. Recently with the development of short duration varities of rice, mustard, potato, pulse and jute, opportunities have been created to accommodate four crops in same piece of land in a year. Rapeseed-mustard production can be increased up to 20-25% only by replacing traditional variety with high yielding short duration varieties like BARI Sarisha-14 and BARI Sarisha-15 in the existing rice based cropping system. On farm Research Division (OFRD, 2014) of BARI also have developed four crops based cropping system. Pulses are important legume crops which are generally grown without fertilizer since they can meet their nitrogen requirement by symbiotic fixation of atmospheric nitrogen in the soil (Islam, 1991; Zapata et al., 1987; Fried and Middleboe, 1977). Nevertheless, pulses supply a substantial amount of nitrogen to the succeeding non-legume crops grown in rice based cropping system (Rachie and Roberts, 1974; Ahlawat et al., 1981; Kurtz et al., 1984; Sharma and Prasad, 1999). Potential adoption of mustard, mungbean and potato in T.aman-Fallow-Boro-Fallow cropping system would generate employment and additional income for the rural poor and producing more of these crops utilizing fallow and under utilize lands in the country. Considering the above facts, the present experiment was undertaken to study the feasibility of increasing cropping intensity and productivity by growing four crops in a year in a same piece of land by incorporating mustard, potato, mungbean and aus rice in the existing cropping system in order to sustain food security, poverty

reduction, resource management and livelihood improvement of the farmers through increasing farmer's income, creating employment opportunity and woman's participation in agriculture.

MATERIALS AND METHODS

The field experiment was conducted at the Central Research Station of BARI Joydebpur, Gazipur, Bangladesh (AEZ 28) from July to June of 2011-12, 2012-2013 and 2013-14. Soil samples were analysed in the month of July before land preparation for T.aman rice for estimating initial soil fertility status. Three cropping patterns (CP_1-Transplanted Aman rice (var:Binadhan-7)–Mustard (var:BARISarisha-14) – Boro rice (var:BRRIdhan-28) – Transplanted Aus rice (var:Parija) , CP_2 - T. aman rice – Potato (var:Diamont) – Boro rice – T. aus rice and CP_3 - T. aman rice – Mustard (var:BARISarisha-15) – Mungbean (var:BARIMung-6) –T. aus rice) are based on four crops; and one cropping pattern (CP_4 = T. aman rice – Fallow – Boro rice – Fallow) with two rice crops as control were tested for their comparative agronomic performance and economic return..

The experiment was laid out in a Randomized Complete Block (RCB) design with 5 replications. The unit plot size was 6m x 4m. Transplanted aman (T.aman) rice was grown during the Kharif season and it was the first crop of the sequence. Fertilizer management and intercultural operations like weeding, mulching, irrigation and pest management were done according to Rahman et al. (2008). Seedlings were grown in adjacent plot and transplanting was done with 20 to 25 days old seedling of rice var. Binadhan-7 at a spacing of 20cm x 15cm during 20 to 24 July in four cropping pattern. T. aman rice was harvested during 25 to 27 October in three consecutive years. Rice plant was harvested at 15cm height from soil surface and remaining parts of the plant was incorporated with soil. Potato was planted during 1 to 8 November. Fertilizer management and intercultural operations like weeding, mulching, irrigation and pest management were done according to Kabir and Haque (2012). Potato tubers (cv. Diamont) were planted with 60 cm x 25 cm spacing. Potato was harvested during 22 to 25 January. Tuber and foliage (over dry) weights were taken from whole plot and whole plant except tuber (1.48 t ha^{-1}) was incorporated with the soil. Mustard was grown during 30 October to 6 November. As per treatment fertilizers management and intercultural operations like weeding, mulching, irrigation and pest management were done according to Mondal and Wahhab (2001). Mustard variety BARI Sarisha-14 and BARI Sarisha-15 were seeded with 30 cm x 5 cm spacing. BARI Sarisha-14 was harvested during 18 to 25 January while BARI Sarisha-15 during 23 to 30 January. Seed yield and straw yields were taken from whole plot. Leaf biomass (from 0.13 to 0.14 t ha^{-1}) was incorporated in the soil.

Mungbean was sown during 20 to 24 February. Fertilizer management and intercultural operations were done according to Afzal et al. (2008). Mungbean (cv.

BARI Mung-6) was sown at a spacing of 20 cm in solid line. Mungbean were harvested during 20 to 27 April. Seed yield of mungbean and biomass weight of mungbean were taken from entire plot. After two or three picking of the pods, the green biomass (1.3 t ha^{-1}) was ploughed down into soil and left for decomposition until the T.aus was transplanted.

Boro rice was the third crop of the sequence. Fertilizer management and intercultural operations were done according to Haque et al. (2011). Thirty five to forty five days old seedling of variety BRRIdhan 28 were transplanted with 20 cm x 15cm spacing during 16 to 30 January in CP_4; during 24 to 29 January in CP_1 and ; during 27 to 29 January in CP_2. Boro rice were harvested during 2 to12 May in CP_1, CP_2 and CP_4. Rice was harvested at 25 cm height from soil surface and remaining part of the rice plant was incorporated into the soil. Grain yield and straw yields were taken from whole plot.

Transplanted aus (T.aus) rice was forth crop of the sequence. Fertilizer management and intercultural operations like weeding, mulching, irrigation and pest management were done according to Haque et al. (2011). 20 to 25 five days old seedling of var. Parija were transplanted with 15cm x 15cm spacing during 11 to 15 May in CP_1, during 11 to 15 May in CP_2 and; during 11 to 25 May in CP_3 in three years. T. aus were harvested during 20 to 22 July and 14 to 23 July in first and second year, respectively. Grain yield and straw yields were taken from whole plot. Rice equivalent yield and economics of different cropping systems were estimated to judge their performance. T.aman rice and total rice equivalent data were analyzed statistically and treatment means were compared by Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

Soil chemical analysis of different cropping patter revealed that on an average pH of the soil increased slightly in all patterns and more in CP_1 & CP_2 whereas OM increased in CP_3 where mungbean incorporated as a component crop in the cropping system (Table 1). There was no definite trend followed with respect to other elements but all the elements maintained above critical level. Organic matter added to soil through incorporation of non-economic plant parts l varied among the four cropping patterns and it was helped to improve the quality of soil (Table 2) by increasing total organic matter in every succeeding year. Three rice crops along with potato maintained higher organic matter followed by T.aman- Mustard- Mungbean-T.aus pattern and T.aman- Mustard –Boro rice - T.aus but little change was observed in case of two rice (T.aman and Boro).

Grain yields of T. aman rice in case of CP_1, were 4.7, 4.6 and 4.5 t ha^{-1} in three years respectively and mean straw yields were 4.0 t ha^{-1}. Seed yield of mustard (var: BARI Sarisha-14) were 1.42, 1.39 and 1.37 t $ha^{-1}$and straw yields were 3.2, 3.0 and 3.1 t ha^{-1} in three years respectively. Grain yield of Boro rice were 5.9 t ha^{-1} in first

year and 5.8 t ha^{-1} in following years and mean straw yields were 5.0 t ha^{-1}whereas for T. aus grain yields were 2.50, 2.90 and 2.97 t ha^{-1} and straw yields were 3.6, 4.05 and 3.90 t ha^{-1} in three years respectively.

In case of CP_2, grain yields of T. aman were 4.8, 4.7 and 4.5 t ha^{-1} and mean straw yield was 4.2 t ha^{-1}. Tuber yields of potato were 24.89, 23.99 and 22.79 t ha^{-1} and mean biomass yield was 2.0 t ha^{-1}. Grain yields of Boro rice were 6.0, 5.9 and 5.7 t ha^{-1} and straw yields were 5.5, 5.1 and 5.3 t ha^{-1} and; T. aus were 2.51, 2.60 and 2.94 t ha^{-1} and mean straw yield was 3.1 t ha^{-1}. In case of CP_3, grain yields of T. aman were 4.5, 4.6 and 4.7 t ha^{-1} and on an average straw yields were 4.2 t ha^{-1}, seed yield of mustard (var:BARISarisha-15) were 1.46, 1.43 and 1.39 t ha^{-1} and straw yields were 3.10, 3.05 and 3.10 t ha^{-1} respectively for three years. Seed yields of mungbean were 1.19, 1.14 and 1.15 t ha^{-1} and straw yields were 1.55, 1.29 and1.30 t ha^{-1} and; T. aus were 2.54, 2.63 and 2.95 t ha^{-1} and straw yields were 3.30, 3.42 and 3.35 t ha^{-1}. Grain yields of T. aman were 4.9, 4.8 and 4.6 t ha^{-1} and straw yields on an average were 4.2 t ha^{-1} in all the years and grain yields of Boro rice were 6.2, 6.1 and 6.0 t ha^{-1} and straw yields were 5.6, 5.5 and 5.6 t ha^{-1}, respectively, in CP_4 Boro rice grain yields did not vary in years.

Rice Equivalent Yield

Total rice equivalent yield (REY) had significantly varied among the different cropping pattern.But T.aman rice yield was not significantly difference among the different crooping pattern.

Total productivity of different cropping systems were evaluated in terms of rice equivalent yield (REY) and it was calculated from yield of component crops. Rice equivalent yields were varied due to different cropping systems (Table 4). The highest REY (34.10 t ha^{-1}) was recorded from the cropping system; T. aman – Potato – Boro – T.aus comprise of three rice crops with potato. T. aman – Mustard – Boro – T. aus also showed reasonable REY (24.01 t ha^{-1}). The lowest REY (14.23 t ha^{-1}) was obtained from the cropping pattern; T. aman – Fallow – Boro – Fallow. Inclusion of mustard during rabi season in CP_1 and CP_3 increased REY 49 to 67% compared to farmer's practiced cropping system, CP_4 while Mungbean & T.aus in kharif-1season showed highest REY which was 37% higher than CP_4. It is noted that inclusion of two crops in CP_1, CP_2 & CP_3 showed much higher REY than only two crops in CP_4.

Crop Duration

On an average, cropping pattern comprises CP1 CP2, CP3 and CP4 took 345, 352, 315 and 197 days excluding seedling age of T.aman and T.aus rice to complete the cycle. . It is observed that CP3 comprising of mustard and mungbean could be easily fitted in the cropping pattern with turn around time of 50 days in a year.

Economic Analysis

Gross return, net return and BCR were significantly difference among the different cropping pattern. Economics of system productivity of four cropping

sequences showed that the gross return was quite different for cropping patterns. The highest gross return (Tk. 5,00,469 ha^{-1}) was recorded from T. aman – potato – Boro – T. aus . T. aman – Mustard – Boro – T. aus also showed gross return of Tk 3, 36,900 ha^{-1} followed by T. aman – Mustard – Mungbean – T. aus (Tk. 3,12,444 ha^{-1}) with reasonable gross return but much less than CP_2. Two rice crops pattern (T. aman – Fallow – Boro – Fallow) gave the lowest gross return (Tk. 1,96,875 ha^{-1}). Total variable cost was lower in CP_3 (Tk. 1,07,992 ha^{-1}) followed by CP_4 (Tk. 1,10,655 ha^{-1}). The highest total variable cost was recorded from CP_2 and might be due to higher seed cost of potato. The highest gross margin was obtained from CP_2 (Tk. 2,63,773 ha^{-1}) followed by CP_3 (Tk. 2,05,527 ha^{-1}) and CP_1 (Tk.1,73,563 ha^{-1}) While CP_4 gave the lowest gross margin (Tk.86,220 ha^{-1}). The highest BCR was found in CP_3 (2.89) followed by CP_2 (2.11) and CP_1 (2.05). CP_4 gave the lowest BCR (1.78). The cost benefit analysis showed that inclusion of potato, mustard and aus rice in the existing pattern showed higher benefit.

CONCLUSION

From the above result showed that T. aman rice (var: Binadhan7) – Mustard (var: BARISarisha-15) – Mungbean (var:BARIMung-6)–T. aus rice (var: Parija) cropping pattern gave higher benefit with less cost of production and could be easily fitted in the existing pattern. T. aman rice (var: Binadhan7)–Potato (var:Diamont)–Boro rice (var:BRRIdhan-28) –T. aus rice (var: Parija) also showed reasonable benefit and added higher organic matter than the former one. Short duration of mustard, mungbean, potato and aus rice variety could be easily fitted in the existing pattern without deteriorating soil nutrient system. Due to growing four crops in year in the same piece of land more employment opportunity for male and female laboures could be created and at the same time due to increased production of rice, potato, mustard and mungbean, the food security and nutritional security could be ascertained for the farmers at same time cropping intensity and productivity could be increased.

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Table1. Initial soil properties of the experimental field of BARI, Gazipur during 2011 – 14

Cropping pattern	Year	P^H	OM (%)	K meq $100ml^{-1}$	Total N (%)	P ($\mu g\ ml^{-1}$)	S ($\mu g\ ml^{-1}$)	B ($\mu g\ ml^{-1}$)	Zn ($\mu g\ ml^{-1}$)
	1st	6.0	2.1	0.12	0.11	40	15	0.31	3.90
CP_1	2nd	6.1	2.2	0.19	0.11	42	13	0.30	3.83
	3rd	7.1	2.01	0.16	0.11	49	17	0.44	3.89
	1st	5.9	1.68	0.13	0.09	43	14	0.26	2.09
CP_2	2nd	5.9	1.68	0.12	0.80	45	12	0.22	2.00
	3rd	6.9	2.12	0.14	0.11	44	14	0.51	3.97
	1st	7.0	1.23	0.12	0.06	51	17	0.20	4.18
CP3	2nd	6.9	1.25	0.13	0.07	50	13	0.23	4.19
	3rd	7.1	2.08	0.13	0.10	47	12	0.38	3.75
	1st	6.6	2.04	0.14	0.11	55	16	0.38	2.71
CP_4	2nd	6.7	2.1	0.18	0.09	57	14	0.39	2.73
	3rd	7.0	2.03	0.12	0.11	60	16	0.32	3.72
Critical Level		-	-	0.12	-	7.0	10	0.2	0.6

Table 2. Addition of organic matter from non-economic plant parts of different crops in soil for four different cropping patterns at BARI , Joydebpur

Cropping patterns	Years	T.aman (15 cm height from soil level) (t ha^{-1})	Boro (20 cm height from soil level) (t ha^{-1})	T.aus (25 cm height from soil level) (t ha^{-1})	Mustard (organic matter from leaf) (t ha^{-1})	Potato (organic matter from whole plant) (t ha^{-1})	Mungbean (organic matter from whole plant) (t ha^{-1})	Total organic matter (t ha^{-1})
Copping pattern 1 (CP_1)	1st	1.15	1.30	1.06	0.15			3.62
	2nd	1.13	1.27	1.03	0.13	-	-	3.56
	3rd	1.11	1.23	1.00	0.11	-	-	3.50
	Average	-	-	-	-	-	-	**3.56**
Copping pattern 2 (CP_2)	1st	1.17	1.30	1.05	-	1.32	-	4.79
	2nd	1.15	1.25	1.02	-	1.28	-	4.70
	3rd	1.13	1.20	1.00	-	1.24	-	4.70
	Average	-	-	-	-	-	-	**4.70**
Copping pattern 3 (CP_3)	1st	1.16	-	1.04	0.16	-	1.6	3.65
	2nd	1.13	-	1.02	0.14	-	1.3	3.59
	3rd	1.10	-	1.00	0.12	-	1.0	3.50
	Average	-	-	-	-	-	-	**3.58**
Copping pattern 4 (CP_4) (Control)	1st	1.22	1.26	-	-	-	-	2.60
	2nd	1.17	1.23	-	-	-	-	2.40
	3rd	1.12	1.20	-			-	2.20
	Average	-	-	-	-	-	-	**2.40**

Table 3. Performance of different crops under four cropping patterns during 2011-12 to 2013-14 at BARI, Joydebpur, Gazipur

Parameters	Years	Copping pattern 1 (Variety)				Copping pattern 2 (Variety)			
		T.aman (Binadhan 7)	Mustard (BARI Sarisha-14)	Boro (BRRI dhan-28)	T.aus (Parija)	T.aman (Binadhan 7)	Potato (Diamont)	Boro (BRRI dhan-28)	T.aus (Parija)
Sowing/Transplanting date	1st	20-07-11	30-10-11	24-01-12	15-05-12	22-07-11	01-11-11	27-01-12	15-05-12
	2nd	21-7-12	01-11-12	27-01-13	10-05-13	23-07-12	02-11-12	27-01-13	14-05-13
	3rd	24-7-13	6-11-13	29-01-13	11-05-14	24-7-13	8-11-14	29-1-14	11-5-14
Crop duration	1st	95	80	104	64	95	80	103	67
	2nd	94	82	100	70	92	81	100	70
	3rd	95	80	100	70	95	79	100	69
Harvesting date	1st	25-10-11	18-01-12	10-05-12	18-07-12	27-10-11	22-01-12	12-05-12	22-07-12
	2nd	25-10-12	21-01-13	05-05-13	17-07-13	25-10-12	22-01-13	10-05-13	23-07-13
	3rd	27-10-13	25-1-14	7-5-14	20-7-14	27-10-13	25-1-14	7-5-14	19-7-14
Grain Yield ($t\ ha^{-1}$)	1st	4.7	1.42	5.9	2.50	4.8	24.89	6.0	2.51
	2nd	4.6	1.39	5.8	2.90	4.7	23.99	5.9	2.60
	3rd	4.5	1.37	5.8	2.97	4.5	22.79	5.7	2.94
Straw yield ($t\ ha^{-1}$)	1st	4.0	3.2	5.0	3.6	4.1	2.0	5.5	3.0
	2nd	4.0	3.0	5.0	4.05	4.1	2.0	5.1	3.1
	3rd	4.2	3.1	5.1	3.90	4.3	1.99	5.3	3.2
Sowing/Transplanting date	1st	20-07-11	30-10-11	02-02-12	25-04-12	20-07-11	-	16-01-12	-
	2nd	21-07-12	01-11-12	13-02-13	05-05-13	23-07-13	-	20-01-13	-
	3rd	24-7-13	6-11-13	24-2-14	11-5-14	24-7-13	-	30-1-14	-
Crop duration	1st	95	85	68	67	96	-	108	-

Parameters	Years	Copping pattern 1 (Variety)				Copping pattern 2 (Variety)			
		T.aman (Binadhan 7)	Mustard (BARI Sarisha-14)	Boro (BRRI dhan-28)	T.aus (Parija)	T.aman (Binadhan 7)	Potato (Diamont)	Boro (BRRI dhan-28)	T.aus (Parija)
	2nd	96	84	67	70	94	-	107	-
	3rd	95	84	67	70	95	-	101	-
Harvesting date	1st	25-10-11	23-01-12	12-04-12	02-07-12	25-10-11	-	02-05-12	-
	2nd	25-10-12	24-01-13	21-04-13	14-07-13	25-10-13	-	06-05-13	-
	3rd	27-10-13	30-1-14	27-4-14	20-7-14	27-10-13	-	10-5-14	
Grain Yield ($t\ ha^{-1}$)	1st	4.5	1.46	1.19	2.54	4.9	-	6.2	-
	2nd	4.6	1.43	1.14	2.63	4.8	-	6.1	-
	3rd	4.7	1.39	1.15	2.95	4.6	-	6.0	-
Straw yield ($t\ ha^{-1}$)	1st	4.0	3.10	1.55	3.30	4.2	-	5.6	-
	2nd	4.0	3.05	1.29	3.42	4.1	-	5.5	-
	3rd	4.5	3.10	1.30	3.35	4.2	-	5.6	-

Table 4. Rice equivalent yield (REY) from different cropping pattern during 2011-12, 2012-13 and 2013-14 at BARI, Joydebpur, Gazipur (pooled)

Patterns	**REY(t/ha) of different crops**							
	T.aman (Binadhan 7)	**Mustard (BARI Sarisha-14)**	**Potato (Diamont)**	**Mustard (BARI Sarisha-15)**	**Mungbean (BARI Mung -6)**	**Boro (BRRI dhan28)**	**T.aus (Parija)**	**Total (t ha^{-1})**
CP_1	5.95	6.15	-	-	-	7.73	4.07	23.90
CP_2	6.08	-	15.94	-	-	7.96	3.85	33.83
CP_3	5.99	-	-	6.28	5.11	-	3.87	21.25
CP_4	5.95	-	-	-	-	8.33	-	14.28
Level of significance	NS	-	-	-	-	-	-	**
CV(%)	1.24	-	-	-	-	-	-	5.24
LSD(.05)	0.33	-	-	-	-	-	-	8.21

Price: T.aman:Tk.15/kg-, Mustard: Tk.55/kg, Mungbean: Tk.60/kg, Boro: Tk.12.5/kg,

Potato: Tk.10/kg, Aus: Tk.13.75/kg and Straw: Tk. 5.00/kg

Table 5. Gross return, total cost and gross margin and BCR of four cropping patterns at BARI, Joydebpur (pooled)

Cropping pattern	Gross Return (Tk/ha)	Total variable cost (Tk/ha)	Gross Margin (Tk/ha)	BCR
CP1	**336900**	**164004**	**172896**	**2.05**
CP2	**500469**	**236696**	**263773**	**2.11**
CP3	**312444**	**108149**	**204653**	**2.89**
CP4	196875	**110855**	**86020**	**1.78**
CV(%)	5.54	**7.45**	**8.88**	**1.10**
LSD(.05)	150110	**50112**	**34110**	**0.70**

Price: T.aman:Tk.15 kg^{-1}, Mustard: Tk.55 kg^{-1}, Mungbean: Tk.60 kg^{-1}, Boro: Tk.12.5 kg^{-1}, Potato: Tk.10 kg^{-1} and Aus: Tk.13.75 kg^{-1}