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SYSTEM PRODUCTIVITY, NUTRIENT UPTAKE AND NUTRIENT BALANCE IN THE WHEAT-MUNGBEAN-T. AMAN RICE CROPPING SYSTEM

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Abstract

System productivity, nutrient uptake and apparent nutrient balance in the wheat-mungbean-T. aman rice cropping system was studied. The experiment comprised four treatments-absolute nutrient control (T_1); farmer's practice (T_2); AEZ basis fertilizer application (T_3) and soil test basis fertlizer application (T_4). The treatments were compared in a RCBD with three replications over two consecutive years, 2008-09 and 2009-10. The experiment was conducted in Chhiata clay loam soil. The average yields of wheat, mungbean and T. aman ranged from 1415 to 3096 kg ha^{-1}, 1020 to 1463 kg ha^{-1} and 2999 to 4282 kg ha^{-1}, respectively showing T_4 as the best treatment. The same treatment (T_4) demonstrated the highest nutrient uptake by the crops. The apparent balance of N and K (difference between nutrient uptake and nutrient addition) was negative; however it was less negative for T_4 treatment. The P balance was positive for all the treatment except T_1. Positive S balance was observed in T_3 and T_4 but negative in absolute control and farmer's practice. Zinc and B balance was also positive in case of T_3 and T_4, but negative for T_1 and T_2 except B. The study suggests soil test basis fertlizer recommendation for the wheat-mungbean-T. aman rice cropping system.

Keywords: System productivity, nutrient uptake, nutrient balance, wheat-mungbean-T. aman rice.

Introduction

Cropping system in an area depends largely on agro-climatic, technical and institutional factors. Several studies have shown that intensive rice-based cropping system including rice-wheat (RW) causes remarkable depletion of soil nutrients and threat to crop productivity (Timsina and Connor, 2001; Yadvinder-Singh *et al.,* 2005). Besides the farmers are following imbalanced use of fertilizers for crop production which leads to degrade soil fertility (Ali *et al*., 2010). Farmers generally use fertilizers on single crop basis, not the cropping system. High yielding varieties of crops uptake higher amount of nutrients from soils resulting in depletion of soil organic matter and deterioration of soil fertility, poses a great threat to sustainable crop production. Moreover, continuous

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cropping without adequate replacement of removed nutrients and nutrient loss through erosion, leaching, and gaseous emission have caused depletion soil fertility as well as soil organic matter (Tirol-Padre *et al.,* 2007). The bulk of literature indicates that, apart from residue management, cropping system productivity may become sustainable through integrated use of organic and inorganic sources of nutrients (Singh and Yadav, 1992). Hence, it is important to develop a cropping system based fertilizer dose for specific agro-ecological zone. Quantification of the loss or gain of nutrients under different cropping system has been less attended. Nutrient balance is an important tool for assessing the nutrient reserve in soils. Crop nutrient balance is a differences between nutrients applied to soil in relation to its removal by crops. Negative nutrient balance may limit crop yield and deplete soil fertility and positive nutrient balance shows nutrient accumulation and creates a risk of water and air pollution (Paul Fixen *et al.*, 2014). It is hypothised that the current fertilizer recommendation could be improved for a definite cropping system. Thus, the aim of this study was to compare system productivity, nutrient uptake and nutrient balance for the wheat-mungbean-T. aman rice cropping system with varying fertilizer management practices.

Materials and Method

Experiment with wheat-mungbean-T. *aman* rice cropping system was conducted for consecutive two years (2008-09 and 2009-10) at Pulses Research Sub-Station, BARI, Gazipur (24° 0′ 13″ N latitude and 90° 25′ 0″ E longitude) which lies at an elevation of 8.4 m above the sea level. The crop field was medium high land with clay loam soil and it belongs to Chhiata series (Soil taxonomy: Udic Rhodustalf) under the agroecological zone Madhupur Tract (AEZ-28).

The experiment consisted of four treatments-absolute nutrient controls (T_1); farmer's practice (T_2); AEZ basis fertilizer application (T_3) and soil test basis fertlizer application (T_4). Descriptions of the different treatments are given in Table 1.

Table 1. Rates of fertilizers (kg ha^{-1}) for wheat, mungbean and T. *aman*

Treatments	Wheat	Mungbean	T. *aman*
T_1	Control	Control	Control
T_2	$N_{80}P_{20}K_{30}$	$N_6P_5K_4$	$N_{60}P_6K_{20}$
T_3	$N_{90}P_{20}K_{60}S_{10}Zn_0B_1$	$N_7P_7K_5$	$N_{65}P_7K_{28}S_8Zn_1$
T_4	$N_{110}P_{25}K_{70}S_{23}Zn_2B_1$	$N_{15}P_{20}K_{10}S_6Zn_1B_1$	$N_{70}P_{12}K_{40}S_{10}Zn_1B_1$

Subscripts represent kg ha^{-1}

The experiment was laid out in a randomized complete block design (RCBD) with three replications. The unit plot size was 4 m × 3 m for all crops having a spacing of 30 cm × 10 cm for wheat, 30 cm × 10 cm for mungbean and 20 cm × 15 cm for T. *aman* rice. Full amount of fertilizers except urea in wheat and rice was applied to crop during final land preparation. Urea was applied in two equal splits for wheat and three equal splits for T. *aman* rice. The sources of N, P, K, S, Zn and B were urea, triple superphosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. Wheat (var. BARI Gom-24) seeds were sown on 15 November 2008 and 11 November 2009. Mungbean (BARI Mung-6) seeds were sown on 26 March 2009 and 20 March 2010. T.*aman* rice (var. BRRI dhan33) seedlings (30 days old) were transplanted on 15 July 2009 and 18 July 2010. Intercultural operations were done as and when required. The crops were harvested at maturity. Data on yields (kg ha^{-1}) for all test crops were recorded from whole plot. Analysis of variance (ANOVA) for the yields and different nutrient content was done following the principle of F-statistics and the mean values were separated by DMRT (Gomez and Gomez, 1984) at 5% level of probability using MSTAT-C software.

Soil samples at 0-15 cm were collected before establishing the experiment and after completion of two cycles of the cropping system from each treatment plot. Plant samples (straw and grain) against each treatment plot were oven-dried at 70° C for 48 h and finely ground. The initial and final soil samples were analyzed for soil pH and organic matter by Nelson and Sommers (1982) method; total N by Microkjeldahl method (Bremner and Mulvaney, 1982); exchangeable K by 1N NH_4OAc method (Jackson, 1973); available P by Olsen and Sommers (1982) method; available S by turbidity method using $BaCl_2$ (Fox *et al*., 1964); available Zn by DTPA method (Lindsay and Norvell, 1978); available B by azomethine-H method (Page *et al*., 1982). Ground plant samples were digested with di-acid mixture (HNO_3-$HClO_4$) (5: 1) as described by Piper (1966) for the determination-concentration of N (Micro-Kjeldahl method), P (spectrophotometer method), K (atomic absorption spectrophotometer method), S (turbidity method using $BaCl_2$ by spectrophotometer), Zn (atomic absorption spectrophotometer method) and B (spectrophotometer following azomethine-H method). Rain and irrigation water samples were analysed for concentration of P, K, S, Zn and B same as plant samples method.

Crop nutrient uptake was calculated from the nutrient (N, P, K, S, Zn and B) concentration and the straw and grain yields (Quayyum *et al*., 2002). Apparent nutrient balance for the wheat-mungbean-T. aman rice cropping system (average of two years) was computed as the difference between nutrient input and output (Paul Fixen *et al.*, 2014). The inputs were supplied from (i) fertilizer (ii) rainfall and (iii) irrigation water and the outputs were estimated from crop uptake in a cycle.

Added cost and added benefit were calculated. Besides, the gross return was calculated on the basis of different treatments which were directly related to the price of product. Cost of cultivation was involved with wage rate (land preparation, weeding, seed sowing and fertilizers application), pesticides, irrigation and fertilizers cost. Land used cost or rental value of land was not considered here. Marginal benefit cost ratio (MBCR) is the ratio of marginal or added benefit and cost. To compare different treatments combination with one control treatment the following equation was applied (Rahman *et al.,* 2011).

$$\text{MBCR (over control)} = \frac{\text{Gross return(Ti)} - \text{Gross return(To)}}{\text{VC (Ti)} - \text{VC (To)}}$$

$$= \frac{\text{Added benefit (overcontrol)}}{\text{Added cost (overcontrol)}}$$

Where, $T_i = T_2$, ... T_4 treatments; T_0 = Control treatment; VC= Variable cost; and Gross return = Yield × price

Results and Discussion

Crops yield

Nutrient management practices significantly influenced the grain and straw/stover yields of wheat, mungbean and T. aman rice in every year (Table 2). The control (T_1) treatment gave the lowest grain yield of 1415, 1020 and 2999 kg ha^{-1} (mean of two years) in wheat, mungbean and T. aman rice, respectively. The farmers practice of fertilizer application (T_2) increased grain yield to 2201 kg ha^{-1} in wheat, 1222 kg ha^{-1} in mungbean and 3556 kg ha^{-1} in T. aman rice. Fertilizer dose on AEZ basis (T_3) resulted in further yield increased of 2787 kg ha^{-1} in wheat, 1346 kg ha^{-1} in mungbean and 3914 kg ha^{-1} in T. aman rice. The T_4 treatment (soil test basis fertilizer application) gave the highest crop yields for all the test crops (Table 2). In case of straw/stover yield, the treatments generally statistically differed with one another. The highest value being noted in T_4 treatment. The reasons of yield increase due to fertilizer management might be attributed to deficency of soil nutrients, particularly N and K. The percent grain yields of wheat, mungbean and T. aman rice increased over control due to different nutrient management practices were 55 to 119%, 20 to 43% and 19-43%, respectively. Islam *et al* (1996) also reported 42% yield increase of rice over control due to balanced fertilization. Most of the yield contributing characters of wheat, mungbean and T. aman rice highly responded to soil test basis fertilization (T_4) followed by AEZ basis fertilization (T_3).

Nutrient uptake

Nutrient management practices had significant effect on the uptake of N, P, K, S, Zn and B by the crops in wheat-mungbean-T.*aman* rice cropping system in both the years (Table 3). Fertlizer application on soil test basis (T_4) showed significantly higher nutrient uptake by wheat, mungbean and T. aman rice in both the years. The nutrient uptake followed the order: N>K>P>S>Zn>B. The lower nutrient uptake was found in control (T_1) treatment by all test crops. The total uptake of nutrients by crops (wheat+mungbean+T. *aman* rice) ranged from 160-

260 kg N ha^{-1}, 17.4-32.0 kg P ha^{-1}, 132-194 kg K ha^{-1}, 9.05-17.6 kg S ha^{-1}, 0.47-0.79 kg Zn ha^{-1} and 0.23-0.40 kg B ha^{-1}(Table 4).

Table 2. Effects of nutrient management practices on grain and straw/stover yields of crops in the wheat-mungbean-T. *aman* rice cropping system

Treatment	Grain yield (kg ha^{-1})				Straw/stover yield (kg ha^{-1})		
	2009	2010	mean	% increase over control	2009	2010	mean
Wheat							
Control (T_1)	1251d	1580d	1415	-	1984d	2345d	2164
F. practice (T_2)	2088c	2314c	2201	55	2510c	2800c	2655
AEZ (T_3)	2565b	3010b	2787	97	3136b	3612b	3374
STB (T_4)	2898a	3294a	3096	119	3454a	3910a	3682
CV (%)	2.99	2.35	-	-	3.32	2.37	-
Mungbean							
Control (T_1)	1038d	1003d	1020	-	2156d	2124b	2140
F. practice (T_2)	1229c	1216c	1222	20	2274c	2235ab	2255
AEZ (T_3)	1359b	1332b	1346	32	2410b	2389ab	2400
STB (T_4)	1485a	1440a	1463	43	2531a	2500a	2516
CV (%)	3.65	2.87	-	-	4.23	4.69	-
T. *aman*							
Control (T_1)	3022c	2976d	2999	-	3137d	3134c	3135
F. practice (T_2)	3521b	3591c	3556	19	3736c	3753c	3744
AEZ (T_3)	3908b	3920b	3914	31	4070b	4094b	4082
STB (T_4)	4224a	4341a	4282	43	4352a	4443a	4397
CV (%)	3.83	3.94	-	-	3.72	4.74	-

Values within a column with a common letter do not differ significantly (p=0.05) by DMRT.

The maximum N uptake was found in STB (260 kg ha^{-1}yr^{-1}) followed by AEZ (T_3). This finding is in agreement with the findings of Timsina *et al*. (2006) where N uptake was consistently and significantly greater under STB than in FP fertilizer management. The minimum N uptake was estimated in control. Shrestha and Ladha (2001) reported that N uptake by sweet pepper–fallow–rice, sweet pepper–indigo–rice, sweet pepper–indigo + mungbean–rice and sweet pepper–corn–rice were 241, 390, 358 and 411 kg N ha^{-1} yr^{-1}, respectively. The uptake of other nutrients (P, K, S, Zn and B) due to different nutrient management practices followed almost the same trend of N uptake (Saleque *et al.*, 2006; Debnath *et al.*, 2011).

Table 3. Effects of nutrient management practices on nutrient uptake (kg ha^{-1}) by wheat-mungbean-T. aman rice (grain+straw/stover) cropping system

Treatment	N		P		K		S		Zn		B	
	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr	1st yr	2nd yr
Wheat												
Control (T_1)	33.6d	40.9d	4.75d	5.20d	26.5d	31.2d	2.51c	2.67c	0.15d	0.18d	0.09d	0.08d
F. practice (T_2)	54.2c	59.5c	8.00c	8.3c	36.1c	39.7c	3.85b	3.76b	0.22c	0.24c	0.11c	0.12c
AEZ (T_3)	68.0b	78.8b	10.4b	11.2b	45.5b	52.0b	5.33a	5.54a	0.28b	0.33b	0.14b	0.16b
STB (T_4)	78.5a	88.0a	12.6a	13.3a	51.4a	57.5a	6.59a	6.75a	0.33a	0.37a	0.16a	0.18a
CV (%)	2.14	2.36	8.73	7.65	5.06	4.52	8.16	7.14	5.41	6.11	8.71	7.56
Mungbean												
Control (T_1)	60.2d	58.0d	5.92c	5.47d	61.7d	59.9d	2.01b	1.65c	0.08	0.07	0.06	0.05
F.practice (T_2)	68.5c	67.1c	6.90bc	6.40c	67.6c	66.1c	2.47b	2.09b	0.09	0.08	0.06	0.06
AEZ (T_3)	75.5b	73.6b	7.80b	7.10b	72.9b	71.5b	3.05a	2.39a	0.09	0.09	0.07	0.07
STB (T_4)	82.7a	80.0a	8.50a	7.90a	78.3a	76.1a	3.51a	2.80a	0.11	0.10	0.08	0.07
CV (%)	2.43	3.11	6.69	4.35	1.23	2.35	9.23	8.54	7.04	6.95	8.19	7.20
T. aman												
Control (T_1)	63.9d	62.1d	7.04c	6.36c	42.7d	41.3d	5.24c	3.98c	0.23d	0.24d	0.11d	0.10c
F.practice (T_2)	76.2c	76.5c	9.00b	8.40b	51.7c	51.0c	6.53b	5.88b	0.27c	0.28c	0.12c	0.11b
AEZ (T_3)	84.8b	84.3b	9.50b	8.70b	57.4b	56.9b	7.20ab	6.02b	0.31b	0.30b	0.15b	0.16a
STB (T_4)	94.7a	95.0a	11.1a	10.5a	62.3a	62.8a	8.15a	7.47a	0.33a	0.34a	0.16a	0.17a
CV (%)	1.95	1.26	6.27	5.89	1.21	1.09	6.50	5.89	4.04	3.33	3.85	4.97

Values within a column with a common letter do not differ significantly ($p=0.05$) by DMRT.

Table 4. Effects of fertilizer management practices on total nutrients uptake by crops in the wheat-mungbean-T. aman rice cropping system (mean of two years)

Treatment	N	P	K	S	Zn	B
			kg ha^{-1}			
Control(T_1)	160	17.4	132	9.05	0.47	0.23
F. practice(T_2)	201	23.5	156	12.3	0.59	0.28
AEZ (T_3)	233	27.4	178	14.8	0.70	0.37
STB (T_4)	260	32.0	194	17.6	0.79	0.40

Total input of nutrients

The nutrient input was mainly from fertilizer but in this estimate, the nutrients supply from fertilizer, rainfall and irrigation under wheat-mungbean-T. aman rice cropping system. BNF was not considerd. Total input of nitrogen was 146-195 kg N ha^{-1} of which the major part was added through fertilizer application, except in control treatment. Phosphorus input ranged from 0.48 to 57.5 kg ha^{-1} yr^{-1} and K from 9.05 to 129 kg ha^{-1} yr^{-1} (Table 5). The S input varied from 5.50 to 44.6 kg ha^{-1} yr^{-1}. Input of Zn ranged from 0.14 to 4.14 kg ha^{-1} yr^{-1}. Boron input was estimated 0.36 to 3.36 kg ha^{-1} yr^{-1} (Table 5).

Table 5. Total input of N, P, K, S, Zn and B from fertilizer, rainfall and irrigation under wheat-mungbean-T. aman rice cropping system

Treatment	N	P	K	S	Zn	B
	2009-10	2009-10	2009-10	2009-10	2009-10	2009-10
			kg ha^{-1}			
Control (T_1)	0.00	0.48	9.05	5.50	0.14	0.36
F. practice (T_2)	146	31.5	63.1	5.60	0.14	0.36
AEZ (T_3)	162	34.5	102	23.6	1.14	1.36
STB (T_4)	195	57.5	129	44.6	4.14	3.36

Apparent nutrients balance

An apparent nutrient balance was calculated considering the amount of added nutrient through fertilizer, rain, irrigation water minus the amount of nutrient removed by crops. However, the nutrient balance did not account for the addition of N from rainfall, irrigation water, or gaseous losses or BNF. Apparent balance of N, P, K, S, Zn and B are shown in Fig. 01 & 02. The balance was mainly affected by different nutrient management practices. The apparent balance of N was negative in all the treatments and the nutrient depletion ranged from −55.0 to −160 kg N ha^{-1} yr^{-1}. Some researchers supported the results: in rice-maize system in Bangladesh, the apparent nutrient balances have been highly negative for N (–120 to –134 kg ha^{-1} yr^{-1}) (Timsina *et al.*, 2010). In case of P balance which was negative in control treatment T_1 and the P balance was positive (8.0 to 25.5 kg ha^{-1}) in all the other treatment where P containing fertilizer was utilized. This evident indicated that P depletion was fewer amounts as compared added fertilizer (Ishaque *et al.*, 1998). The balance of K was negative in all the treatments where the K mining ranged from −65.0 to −123 kg K ha^{-1} yr^{-1}. The results confirmed the declining trends in available soil K in many treatments and they are comparable with many other long-term studies in rice–rice and rice–wheat systems of Asia (Ladha *et al*., 2003).

The negative S and Zn balance was observed in control (T_1) and farmers practice (I_2) ranged from –3.55 to –6.7 and -0.33 to -0.45 kg ha^{-1} yr^{-1}, respectively. Remaining treatments showed positive balance ranging from 8.80 to 27.0 and

0.44 to 3.35 kg ha^{-1} yr^{-1}, respectively. Some workers are in agreement with these findings. Jahan *et al*. (2015a) corroborated that the negative balance was observed in control and farmers practice treatments which was –1 to –8 kg S ha^{-1}yr^{-1} and remaining treatments showed positive balance ranged from 1 to 4 kg ha^{-1} yr^{-1}. Similar result of Zn was found by Jahan *et al.* (2015a) in a monocrop cultivation of T.amn rice where –0.08 to –0.31 kg Zn ha^{-1} yr^{-1} was found in control and farmers practice and positive balance (1.12 to 1.61 kg Zn ha^{-1} yr^{-1}) was found in AEZ and STB treatment. The B balance was found positive (0.08 to 2.96 kg ha^{-1}) in all the treatments. Jahan *et al.* (2015b) observed that positive B balance ranged from 0.86 to 1.17 kg ha^{-1} and negative B balance was –0.01 to –0.07 kg ha^{-1} yr^{-1} in mungbean cultivation.

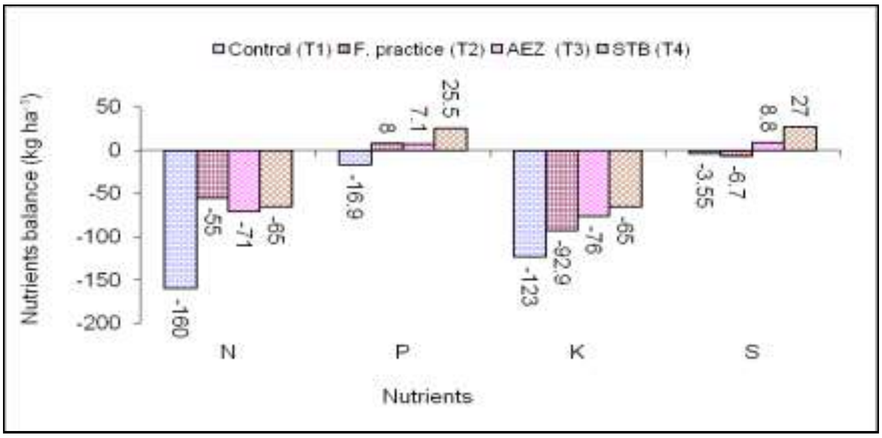

Fig. 01. Apparent nutrient balance of N, P, K and S under wheat-mungbean -T.aman cropping rice pattern.

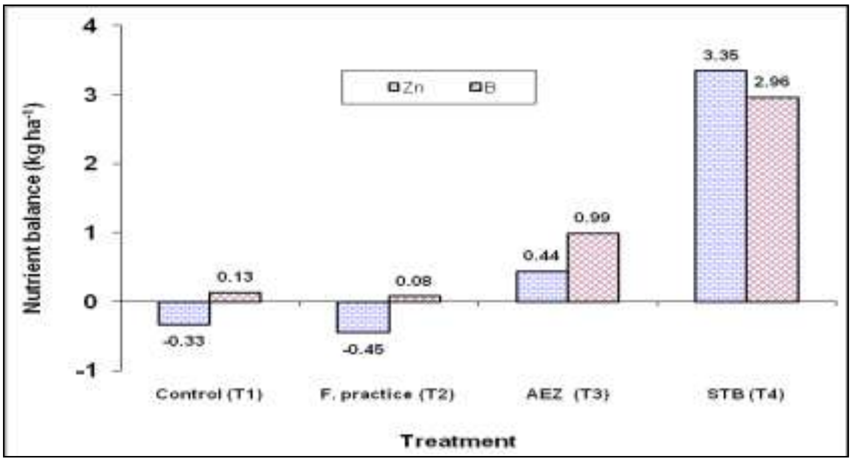

Fig. 02. Apparent nutrient balance of Zn and B under Wheat-Mungbean-T.aman cropping pattern.

Soil Fertility

Initial soil samples were collected from the experimental field and post harvest soil samples were also collected from each treated plot after two cycles of wheat-mungbean-T. *aman* rice cropping system for analyzing different soil properties viz. soil pH, organic matter, total N and available P, K, S, Zn and B. The initial and post harvest soil results are presented in Table 6. Initially the soil pH was 6.1, but after completion of two crop cycles and incorporation of mungbean stover and other crop residues in soil, the pH remained unchanged although minor variation existed. A minor change in soil fertility occurred from initial status due to different fertilizer management practices over two years. Soil test basis fertilizer application (T_4) tended to maintain the initial fertility or increased slightly (Table 6). The treatment T_4 showed an encouraging effect on organic matter, N, P, S, Zn and B only. Such observations are in agreement with the findings of Zaman *et al.* (1994). Potasium (K) slightly decreased in all plots over the initial status. The results are in agreement with the findings of Timsina and Connor (2001). The available Zn and B content of the soil slightly decreased when they were not applied, but remained almost static or increase when applied (Table 6).

Table 6. Initial and post soil fertility status after two cycles of wheat-mungbean-T. aman rice cropping system due to different fertilizer management practices

Treatment	pH	OM (%)	Total N (%)	K	P	S	Zn	B
				Meq. 100 g^{-1}	µg g^{-1}			
Initial status	6.1	1.28	0.061	0.13	15.0	17.1	1.33	**0.16**
Control (T_1)	6.2	1.29	0.060	0.11	15.5	16.5	1.31	**0.14**
F. practice (T_2)	6.1	1.31	0.062	0.12	16.1	16.9	1.32	0.14
AEZ (T_3)	6.1	1.32	0.061	0.11	16.4	17.6	1.35	0.16
STB (T_4)	6.0	1.34	0.063	0.12	16.8	18.1	1.37	0.17

Economic analysis

The gross margin due to treatment T_4 increased over farmers practice (T_2) for higher crop yield. The highest marginal benefit cost ratio (4.06) was in T_3 followed by T_4 but T_3 was economically viable due to the cost of production of T_3 (Tk. 74248 ha^{-1} yr^{-1}) was lower than T_4 (Tk. 83967 ha^{-1} yr^{-1}) (Table 7). Similar observation was made by Malika *et al.* (2015) that the highest marginal benefit-cost ratio of 3.66 was obtained from T_1 (100% RFD) which was followed by T_3 (75%RFD + PM 3 t ha^{-1}). Considering the marginal benefit-cost ratio (MBCR) T_3 ranked the first.

Table 7. Economic analysis of wheat-mungbean-T. *aman* rice cropping pattern affected by different nutrient managements (after completion of two years cycle)

Treatment	Variable cost	Gross return	Added cost over control	Added benefit over control	Gross margin over control	MBCR
	Tk ha^{-1} yr^{-1}					
Control(T_1)	59875	151148	-	-	-	
F. practice(T_2)	69249	185704	9374	34556	25182	3.68
AEZ (T_3)	74248	209564	14373	58416	44043	4.06
STB (T_4)	83967	233971	24092	82823	58731	3.44

Note: Input prices: Urea= Tk.12 kg^{-1}, T.S.P= Tk.22 kg^{-1}, MoP= Tk.20 kg^{-1}, Gypsum= Tk.6 kg^{-1}, Zinc sulphate= Tk.120 kg^{-1}, Boric acid= Tk.300 kg^{-1}, Rovral fungicide= Tk.250 100 $^{-g}$, Bavistin fungicide= Tk.200 100^{-g}, Provex fungicide = Tk.3200 kg^{-1}, Ripcord insecticide = Tk.105 100^{-g}, Karate insecticide= Tk.450 500^{-ml} , Plowing= Tk.1400 ha^{-1}(one pass), Labour wage= Tk.125 day^{-1}, Wheat seed= Tk.25 kg^{-1}, Mungbean seed= Tk.60 kg^{-1}, T.aman rice seed= Tk.35 kg^{-1}.

Output prices: Wheat= Tk.18.75 kg^{-1}, Mungbean= Tk.55 kg^{-1}, T.aman rice= Tk.19 kg^{-1}, Wheat straw rate = Tk.1 kg^{-1}, Rice straw= Tk.1.25 kg^{-1}.

Conclusion

Productivity of tested system showed higher through soil test based fertilization. Results clearly indicated that the nutrient uptake by wheat, mungbean and T. *aman* rice were found to be higher in soil test basis treatment. Nitrogen and K mining occured remarkably from the soil due to different fertilizer management practices. Results of economic and soil fertility suggest that soil test basis fertilization is good for achieving sustainable crop yield.

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