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EFFECTS OF TILLAGE PRACTICES AND NUTRIENT MANAGEMENT ON CROP PRODUCTIVITY AND PROFITABILITY IN JUTE-T. AMAN RICE- ONION CROPPING SYSTEM

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Abstract

Conservation agriculture (CA) with appropriate nutrient management can help increase crop production, improve soil health and bring economic return. An experiment was conducted at farmer's field of Rajbari district under Low Ganges River Floodplain (AEZ-12) during 2017-2018 to evaluate the effects of tillage and nutrient management on the system productivity and profitability in the jute - T. Aman rice- onion cropping system. Strip tillage (ST) for jute, non-puddling for T. Aman rice and one pass minimum tillage (MT) for onion was contrasted with conventional crop establishment practice (CT). Four different nutrient management practices were NM_1: farmer's practice (FP), NM_2: soil test based (STB) fertilizer, NM_3:25% extra of STB and NM_4: organic amendments (20 % nutrients from cowdung). The experiment was laid out in a split-plot design with three replications by assigning tillage practices in main plots and nutrient management in sub-plots. The yield attributes of jute, T. Aman rice and onion responded similarly to tillage practices. On the other hand, the system productivity and yield of component crops varied due to different nutrient management practices ($p<0.05$). The highest fibre yield of jute (3.64 t ha^{-1}) was obtained in 25% extra of STB fertilizer dose; the highest T. Aman yield (6.02 t ha^{-1}) and the highest onion bulb yield (16.0 t ha^{-1}) in 20 % organic nutrient management, followed by25 % extra of STB fertilizer dose. The highest system productivity was also produced by 20 % organic amendments (33.6 t ha^{-1}), followed by 25 % extra of STB fertilizer dose (32.3 t ha^{-1}). The lowest yield of crops and system productivity was recorded in FP (28.6 t ha^{-1}).The increased yield of T. Aman rice and onion in 20 % organic amendment by cowdung and ST resulted in the highest net return (NR) and benefit-cost ratio (BCR), while 25% extra of STB and FP under CT gave the lowest NR and BCR. Residual nutrient from successive use of cowdung combined with chemical fertilizers outperformed other management practices in terms of crop yield and economic return.

Keywords: Benefit-cost ratio; cropping system productivity; minimal soil disturbance; nutrient management; strip planting

Introduction

In general, agriculture in Bangladesh depicts excessive tillage, crop residue removal, imbalance fertilization, etc. that degraded soil health with accelerated

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decomposition of soil organic matter (SOM).Cropping intensity has increasedover time by increasing puddled rice production (BBS, 2012). Consequently, most of the soils contain less than 1.5% SOM, and some soils have even less than 1% SOM (BARC, 2018). The sub-tropical humid climate causes rapid breakdown of SOM by heterotrophic microbes; consequently, nutrients loss occurs through different processes, viz. leaching, volatilization, runoff etc. The low SOM is a cause of low productivity and is considered as a serious threat to the sustainability of agriculture in Bangladesh (Jahiruddin and Satter, 2010). Organic matter (OM) depletion occurs in high land and medium high land soils (WRC, 2008-2009), while OM content has little increased in low land soils with rice-rice cropping pattern (BRRI, 2008). Intensification of agricultural land use with high expansion of modern crop varieties has increased remarkably which has exhausted nutrients from soil. Thus, with advancement of time, soil fertility has declined and chronologically the deficiency of nitrogen, phosphorus, potassium, sulphur, zinc and boron has arisen in the soils (Jahiruddin and Satter, 2010).

Most agricultural soils have become vulnerable to tillage-stimulated rapid loss of SOM in the coarse texture soils (Stewart *et al.*, 2007). As the delta country has most of the cropping systems based on rice (Alam *et al.*, 2016b), the puddling of soil for rice crop establishment causes heavy havoc on soil properties by destroying structure of soil. In addition, puddling of soil accelerates decomposition of SOM, increases greenhouse gas emissions (GHGs)and nitrogen loss (Alam *et al.*, 2019b) and inflicts increased costs for upland crop establishment (Bell *et al.*, 2019).In contrary, minimum or zero tillage practice increases SOM levels (Busari and Salako, 2013),enriches nutrients in soils (Alam, 2018) and water retention capacity (Aziz *et al.*, 2013), and decreases production costs (Salahin, 2017) and GHGs (Alam *et al.*, 2019b) by reducing fuel use for intensive tillage and irrigation requirements (Johansen *et al.*, 2012). There are many researches on zero and minimum tillage that has been proved as a greater technique to increase SOM, microbial activity, total N, and extractable P, S, Zn and B at the soil surface compared to conventional tillage (Alam *et al.*, 2016a; Vu *et al.*, 2009). Besides, non-puddled rice crop establishment has been recently developed and performed well in yield, soil health, economics and climate change mitigation (Bell *et al.*, 2019; Salahin, 2017; Alam, 2018; Alam *et al.*, 2019a). In these situations, the idea of conservation agriculture (CA) in rice-based intensive cropping systems through employing minimal soil disturbance, crop residue retention with suitable crop rotations (Kassam *et. al.*, 2009) has emergedas a holistic alternative agricultural system for its production sustainability, economic viability, environment friendly approach. However, conservation agriculture (CA) is inadequately developed for intensive upland-rice cropping system widely practiced in Bangladesh (Alam *et al.*, 2016b; Salahin, 2017) and the experimentation of CA with different nutrient management practices on soil properties and crop yields under jute-T. Aman rice- onion cropping systems has not been examined in the poorly fertile soils of Bangladesh. With a view to address such issues, the present study was undertaken with the following objectives:

i). to find out the suitable combination of tillage practices and nutrient management for maximizing the crop yield in the jute- T. Aman- onion cropping system, and

iii). to evaluate the system productivity and economic profitability in this system.

Materials and Methods

Description of experimental site

The experiment was done at farmer's field of Rajbari district during 2017-2018.It belongs to the agro-ecological zone "Low Ganges River Floodplain" (AEZ-12; located at 23°48"35" N and 89°25'55" E, at 11.0 m above the sea level. Initial soil characteristics of the experimental field were determined and information of soil texture, bulk density, soil pH, organic matter, total N, available P, K, S, Zn, and B contents at 0-15 cm soil depth are presented in Table 1.

Table 1. Initial soil characteristics of the experimental field, Rajbari district (0-15 cm)

pH	SOM	TN	Available nutrients					Textural class	Bulk density
	%		K	P	S	Zn	B		
			meq 100 g soil^{-1}	mg kg^{-1}					(g cm^{-3})
8.1	1.09	0.060	0.15	7.2	13	0.25	0.15		
Slightly alkaline	Low	Very Low	Medium	Low	Mediu m	Very Low	Low	Sandy loam	1.53

Treatments and design

The unit experimental plot area was 7.2 m × 4.5 m and the design of the experiment was split-plot with three replications. Tillage practices such as, T_1: conventional tillage (CT) and T_2: minimum tillage (MT)/strip tillage (ST)/non-puddling was assigned in main plots and four nutrient management practices such as NM_1: farmer's practice (FP), NM_2: soil test based recommended fertilizer (100% STB as per Fertilizer Recommendation Guide-FRG, all from chemical fertilizers), NM_3: 25% extra of STB as per FRG, all from chemical fertilizers and NM_4: 80% from chemical fertilizer and the 20% nutrients supplemented with cowdung manure were allotted in sub-plots. Details of the treatments are given in Table 2.

Sowing/transplanting

Jute seed (cv. Nabin) was sown on 11 May, 2017 maintaining 25 cm × 7-10 cm spacing, T. Aman rice seedlings (cv. BRRIdhan 72) were transplanted on 10 August 2017 maintaining 20 cm × 20 cm spacing and onion seedlings (cv. King) were transplanted on 23 January 2018 at 15 cm apart from row to row and 10 cm apart from plant to plant.

Table 2. Different tillage and nutrient management practices along with fertilizer application method for component crops of jute-T. Aman- onion cropping system

Treatments		Crops		
		Jute	T. Aman	Onion
Tillage practices	Conventional tillage/puddling	4-5 pass of power tiller machine followed by 2-3 laddering	Puddling was done by 4-5 wet tillage operations using power tiller machine followed by 2-3 laddering	4-5 pass of power tiller machine followed by 2-3 laddering
	Minimum tillage (MT)/ Strip tillage (ST)	ST was done by one pass with PTOS using rotating blades maintaining 25 cm spacing from row to row	Non-puddling; Strip was done by one pass with PTOS using rotating blades maintaining 20 cm spacing from row to row around 18-24 hours before transplanting rice; Full puddling was not done	MT was done by one pass with power tiller operated seeder (PTOS
Nutrient Management practices	NM_1:Farmers' practice (FP)	Fertilizer dose: N_{180}, P_{10}, K_{45} and S_8 kg ha^{-1} *Application method:* ½ urea was applied with all other fertilizers during final land preparation and ½ urea was at 30 DAS	Fertilizer dose: N_{120}, P_{10}, K_{40}, S_6 and Zn_1 kg ha^{-1} *Application method:* ½ urea was applied with all other fertilizers during final land preparation and ½ urea was at 36 DAT	Fertilizer dose: N_{140}, P_{30}, K_{60} and S_{16} kg ha^{-1} *Application method:* ½ urea was applied with all other fertilizers during final land preparation and ½ urea was at 35 DAT

Treatments		Crops		
		Jute	T. Aman	Onion
	NM_2: Soil test based recommended fertilizer (100% STB as per FRG-2012, all nutrients from chemical fertilizers)	STB dose: N_{153}, P_{13}, K_{72}, S_{12}, $Zn_{1.0}$ and $B_{0.5}$ kg ha^{-1} *Application method:* Urea was applied in two equal splits at 25 and 50 days after sowing (DAS)	STB dose: N_{100}, P_{13}, K_{47}, S_9, Zn_2 and $B_{0.5}$ kg ha^{-1} *Application method:* all other fertilizers except urea were applied during final land preparation. Urea in 3 equal splits- the 1/3rd at 4 DAT, the second split at 35 DAT and the third split at 48 DAT	STB dose: N_{100}, P_{46}, K_{94}, S_{23}, Zn_4 and $B_{1.5}$ kg ha^{-1} *Application method:* all required fertilizers in full dose and ½ urea and MoP was applied as basal dose whereas the rest urea and MoP applied in 2 equal splits at 25 and 50 days after transplanting
	NM_3: 25 % extra of STB as per FRG-2012, all nutrients from chemical fertilizers	Fertilizer dose: N_{191}, P_{16}, K_{90}, S_{15}, $Zn_{1.3}$ and $B_{0.63}$ kg ha^{-1} *Application method:* Same as NM_2	Fertilizer dose: N_{125}, P_{16}, K_{59}, S_{11}, $Zn_{2.5}$ and $B_{0.63}$ kg ha^{-1} *Application method:* Same as NM_2	Fertilizer dose: N_{125}, P_{58}, K_{118}, S_{29}, Zn_5 and $B_{1.9}$ kg ha^{-1} *Application method:* Same as NM_2
	NM_4: 80% from chemical fertilizer and the 20 % nutrients supplemented with cowdung manure @ 5 t ha^{-1}	Fertilizer dose: N_{122}, P_{10}, K_{58}, S_{10}, $Zn_{0.8}$ and $B_{0.4}$ kg ha^{-1} from CF & N_{31}, P_3, K_{14}, S_2, $Zn_{0.2}$ and $B_{0.2}$ kg ha^{-1} from cowdung *Application method:* chemical fertilizers were applied as same as NM_2 whereas organic manure (cowdung) was applied before land preparation	Fertilizer dose: N_{80}, P_{10}, K_{38}, S_7, $Zn_{1.6}$ and $B_{0.4}$ kg ha^{-1}kg ha^{-1} from CF & N_{20}, P_3, K_9, S_2, $Zn_{0.5}$ and $B_{0.2}$ kg ha^{-1} from cowdung *Application method:* chemical fertilizers were applied as same as NM_2 whereas organic manure (cowdung) was applied before land preparation	Fertilizer dose: N_{80}, P_{37}, K_{75}, S_{18}, Zn_3 and $B_{1.2}$ kg ha^{-1} from CF &N_{20}, P_{10}, K_{20}, S_5, Zn_1 and $B_{0.3}$ kg ha^{-1} from cowdung *Application method:* chemical fertilizers (CF) were applied as same as NM_2 whereas organic manure (cowdung) was applied before land preparation

Crop harvesting and data collection

Jute was harvested on 31 July 2017, T. Aman rice on 03 December 2017 and onion was harvested on 08 April 2018. Two (2) m^2 area from each plot was selected immediately after sowing/transplanting for data collection. Ten plants of each plot were selected for yield attributes. Thousand grain weight of T. Aman was measured plot-wise. The plants were cut, then threshed, cleaned, sun-dried and weighed of grain and straw separately from 2 m^2 area of each plot. Finally, the grain and straw were converted into t ha^{-1}.

Statistical analysis

The effects of tillage practices and nutrient management approaches on yield and economics were assessed using a two-factor analysis of variance. All data were statistically analysed with SPSS (Statistical Package for the Social Sciences) software package version 21 (SPSS Inc., Chicago, IL, USA). Means were compared by using least significant difference (LSD) at$p < 0.05$.

Results and Discussion

1st Crop: Jute

Effects of tillage and nutrient management on plant population, plant height and fibre yield of jute

Regardless of tillage methods, different nutrient management showed significant variations on the plant height as well as fibre yield of jute (Table 3). The highest plant height (229 cm) was recorded in 25 % extra of STB which was statistically identical to 20 % organic amended with 80% CF but different from FP and STB. The highest fibre yield was obtained from 25 % extra of STB treatment ($NM_{3,}$ 3.64 t ha^{-1}) which was different from FP (NM_1,2.96 t ha^{-1}), 100% STB (NM_2,3.16 t ha^{-1}) and 20 % organic amended with 80% CF (NM_4, 3.23 t ha^{-1}), shown in Table 2. Bell *et al.* (2019) and Salahin (2017) recorded increased yield of jute fibre in rice-based cropping system in strip tillage and residue retention practice. Higher yields with ST were associated with better crop establishment that was possibly due to better placement of seed and fertilizers.

2nd Crop: T. Aman rice

Effects of tillage and nutrient management on grain and straw yield of T. Aman rice

Different nutrient management showed significant variations in the grain and straw yields of T. Aman rice. No variations in the rice yields were recorded under tillage methods. The highest grain yield was produced in 20 % organic amended with 80% CF (6.02 t ha^{-1}) which was statistically similar with 25 % extra of STB (5.93 t ha^{-1}) and STB recommended fertilizer (5.72 t ha^{-1}). The lowest grain yield (5.43 t ha^{-1})was obtained in farmers' practice, FP. Similar pattern was noticed in case of straw yield of T. Aman rice, showing the sequence as, 20 % organic amended with 80% CF>25 % extra of STB >STB recommended fertilizer>farmers' practice (Table 4). The increase in rice yield in the study may not only be due to tillage, but also due to the combined effect of conservation tillage and nutrient management practices. Many studies have reported increased productivity of intensive rice-based systems under conservation tillage (reduced/no- tillage) with integrated nutrient management (Munda *et al.*, 2009), but effects vary with regions due to differences in climatic and edaphic factors (Sun *et al.*, 2010).

Table 3. Effects of tillage and nutrient management on plant height and fibre yield of jute

Treatments	Plant height (cm)	Fibre yield (t ha^{-1})
Tillage methods		
Conventional tillage (CT)	216	3.21
Strip tillage (ST)	218	3.29
$LSD_{0.05}$ value	5^{ns}	1.10^{ns}
Nutrient management practices		
NM_1 (FP)	203 b	2.96 b
NM_2 (STB)	210 b	3.16 b
NM_3 (25% extra of STB)	229 a	3.64 a
NM_4 (80% CF + 20% CD)	225 a	3.23 b
$LSD_{0.05}$ value	12**	0.39*
CV (%)	4.34	9.58

NM= nutrient management, CF = chemical fertilizers, STB = soil test basis, CD = cow dung, LSD = least significant difference at P>0.05, ns= non-significant, * = P<0.05, ** = P<0.01

Table 4. Effects of tillage and nutrient management on the grain and straw yields of T. Amanrice

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Tillage methods		
Conventional tillage (CT)	5.59	6.21
Strip tillage (ST)	5.96	6.94
$LSD_{0.05}$ value	1.34^{ns}	0.28^{ns}
Nutrient management practices		
NM_1 (FP)	5.43 b	5.79 c
NM_2 (STB)	5.72 ab	6.12 bc
NM_3 (25% extra of STB)	5.93 a	6.46 ab
NM_4 (80% CF + 20% CD)	6.02 a	6.71 a
$LSD_{0.05}$ value	0.42*	0.39**
CV (%)	5.80	4.91

NM= nutrient management, CF = chemical fertilizers, STB = soil test basis, CD = cow dung, LSD = least significant difference at P>0.05, ns= non-significant, * = P<0.05, ** = P<0.01.

3rd Crop: Onion

Effects of tillage methods and nutrient management on yield and yield attributes of onion

Tillage methods did not show any significant difference in the bulb diameter and bulb yield of onion (Table 5). However, numerically higher bulb diameter and fresh as well as sundry bulb yield of onion was recorded in minimum tillage (MT) than in conventional tillage (CT).

Different nutrient managements had significant effect on the bulb diameter and fresh as well as sundry bulb yield of onion. The highest bulb diameter of onion (3.88 cm) was found in 20 % organic amended with 80% CF which was statistically identical to 25 % extra of STB (3.87 cm) and the lowest bulb diameter was found in farmers' practice (3.67 cm). Similarly, the highest bulb yield (16.0 t ha^{-1} fresh and 13.9 t ha^{-1} sundry) was recorded in 20 % organic with 80% CF followed by 25 % extra of STB(14.6 t ha^{-1} fresh and 12.5 t ha^{-1} sundry), STB recommended fertilizer(14.2 t ha^{-1} fresh and 12.0 t ha^{-1} sundry) and the lowest bulb yield (12.7 t ha^{-1} fresh and 10.6 t ha^{-1} sundry) was found in farmers' practice (Table 5). No research has been done before on combined effect of tillage methods and nutrient management practices. However, Tayel *et al.* (2017) recorded increased bulb volume and yield under minimum tillage practices, while under conventional tillage; increased moisture stress resulted in decreased onion volume and yield.

Table 5. Effects of tillage and nutrient management on the bulb diameter, fresh and sundry bulb yield of onion at farmer's field of Rajbari

Treatments	Bulb diameter (cm)	Fresh bulb yield (t ha^{-1})	Sundry bulb yield (t ha^{-1})
Tillage methods			
Conventional tillage (CT)	3.74	13.6	11.4
Minimum tillage (MT)	3.84	15.1	13.1
$LSD_{0.05}$ value	0.11^{ns}	2.8^{ns}	2.0^{ns}
Nutrient management			
NM_1 (FP)	3.67 b	12.7 c	10.6 c
NM_2 (STB)	3.75 b	14.2 b	12.0 b
NM_3 (25% extra of STB)	3.87 a	14.6 b	12.5 b
NM_4 (80% of CF + 20% CD)	3.88 a	16.0 a	13.9 a
$LSD_{0.05}$ value	0.09**	1.1**	1.1**
CV (%)	1.97	5.88	7.36

NM= Nutrient management, CF = Chemical fertilizers, STB = soil test basis, LSD = least significant difference at P>0.05, ns = non-significant, ** = P<0.0.

Integrated nutrient management is one of the most important factors that greatly influence the quality and yield of onion (Mahanthesh *et al.*, 2009 and Bagali *et al.*, 2012). Singh *et al.* (1997) reported that combined doses of organic and inorganic fertilizer (FYM 25 t ha^{-1} + NPK 100:25:25 kg ha^{-1}) increased marketable yield. Bagali *et al.* (2012) noted that the combination of higher levels of inorganic with higher levels of organic fertilizers recorded higher bulb yield and the market value.

Effects of tillage methods and nutrient management on cropping system productivity

Cropping system productivity refers to the total yields of the crops (main produce) grown in sequence in the same piece of land in a year, expressed as, rice equivalent yield (REY). Between the tillage methods, strip/minimum tillage(ST/MT) numerically gave higher REY over conventional tillage (CT).

Among the different nutrient managements, the maximum REY (33.6 t ha^{-1}) was recorded in NM_4treatment, where 80% of chemical fertilizers and 20% cowdung was applied which was statistically identical to NM_3 treatment (32.3 t ha^{-1}), where 25% extra CF of STB applied but different from NM_2 (STB, 30.6 t ha^{-1}) and NM_1 (FP), whereas the minimum REY (28.6 t ha^{-1}) was recorded in NM_1 (FP), as presented in Table 6.

Table 6. Effects of tillage and nutrient management on rice equivalent yield (t ha^{-1})

Treatments	Rice equivalent yield (t/ha)
Tillage methods	
Conventional tillage (CT)	30.2
Strip/minimum tillage (ST/MT)	32.3
$LSD_{0.05}$ value	2.8^{ns}
Nutrient management	
NM_1 (FP)	28.6 c
NM_2 (STB)	30.6 b
NM_3 (25% extra of STB)	32.3 a
NM_4 (80% CF + 20% CD)	33.6 a
$LSD_{0.05}$ value	1.4**
CV (%)	3.66

NM= nutrient management, CF = chemical fertilizers, STB = soil test basis, LSD = least significant difference at P>0.05, ns= non-significant, ** = P<0.01.

Note: Market prices of the crops were: Tk. 20.0 kg^{-1} for rice, Tk. 25.0 kg^{-1} for onion (fresh) and Tk. 45.0 kg^{-1} for jute fibre.

Yadav *et al.* (2017) put forward that adoption of conservation tillage and nutrient management practice involving no-tillage and integrated nutrient management along with residue retention can enhance the system productivity of the rice-based cropping system in Indo-Gangetic plains. Yadav *et al.* (2017) concluded that modifications of farmers' practice with inclusions of minimal disturbance of soil improved soil health and increased the system productivity by an average of 30.6%.

Profitability of growing crops under different tillage methods and nutrient management in the jute-T. Aman- onion cropping system

From the first cop, jute cultivation, the highest net return (64,306 taka ha^{-1}) and BCR (1.83) was obtained from strip tillage and 25% extra of STB and the lowest net return (54,129 taka ha^{-1}) and BCR (1.72) was in CT and FP combination (Table 7).

Table 7. Profitability of component crop production under different tillage methods and nutrient management at Rajbari

Particulars	Strip tillage (ST)/Minimum tillage (MT)				Conventional tillage (CT)			
	NM_1 (FP)	NM_2 (STB)	NM_3 (25% extra of STB)	NM_4 (80% CF + 20% CD)	NM_1 (FP)	NM_2 (STB)	NM_3 (25% extra of STB)	NM_4 (80% CF + 20% CD)
Jute								
Gross return (Tk. ha^{-1})	127120	131620	141450	132750	128910	133010	142820	134420
Total input cost (Tk. ha^{-1})	72989	75218	77144	75190	74781	77010	78936	76982
Net return (Tk. ha^{-1})	54131	56402	64306	57560	54129	56000	63884	57438
BCR	1.74	1.75	1.83	1.77	1.72	1.73	1.81	1.75
T. Aman rice								
Gross return (Tk. ha^{-1})	120370	123330	125700	126630	116200	119370	121540	122660
Total input cost (Tk. ha^{-1})	75227	76869	79686	77416	78699	80341	83158	80888
Net return (Tk. ha^{-1})	45143	46461	46014	49214	37501	39029	38382	41772
BCR	1.60	1.60	1.58	1.64	1.48	1.49	1.46	1.52

Particulars	Strip tillage (ST)/Minimum tillage (MT)				Conventional tillage (CT)			
	NM_1 (FP)	NM_2 (STB)	NM_3 (25% extra of STB)	NM_4 (80% CF + 20% CD)	NM_1 (FP)	NM_2 (STB)	NM_3 (25% extra of STB)	NM_4 (80% CF + 20% CD)
Onion								
Gross return (Tk. ha^{-1})	266000	298000	308000	340000	242000	270000	276000	300000
Total input cost (Tk. ha^{-1})	114802	122492	128455	122762	109874	117004	123527	116714
Net return (Tk. ha^{-1})	151198	175508	179545	217238	132126	152996	152473	183286
BCR	2.32	2.43	2.40	2.77	2.20	2.31	2.23	2.57

In case of T. Aman rice cultivation, the highest net return (49,214 taka ha^{-1}) and BCR (1.64) was found in 20 % organic amended with 80% CF + 20% CD) with non-puddling treatment (ST), while CT and 25% extra of STB combination gave the lowest BCR (1.46), as presented in Table 7. It was due to the use of higher rate of costly chemical fertilizers requirements.

In case of onion cultivation, the highest net return (2,17,238 taka ha^{-1}) and BCR (2.77) was found in minimum tillage and 20 % organic amended with 80% CF, whereas farmers' tillage and nutrient practice gave the lowest net return (1,32,126 taka ha^{-1}) and BCR (2.20), as shown in Table 7.It was due to lower yield obtained with the farmers' practice.

Conclusions

Different nutrient management showed significant variations on fibre yield of jute; grain yield of T. Aman rice as well as the bulb yield of onion at the farmer's field of Rajbari district. The yield and yield attributes of jute, T. Aman rice and onion responded similarly to tillage methods ($p>0.05$). The highest fibre yield (3.64 t ha^{-1}) of jute was obtained from 25 % extra of STB and20 % organic amended with 80% CF (3.23 t ha^{-1}) compared to STB dose(3.16 t ha^{-1}) and farmers' practice (2.96 t ha^{-1}). The highest grain yield of rice was produced in 20% organic amended with 80% CF (6.02 t ha^{-1}), which was statistically similar to 25 % extra of STB(5.93 t ha^{-1}) and STB dose(5.72 t ha^{-1}). In case of onion, 20% organic amended with 80% CF outperformed yields of 16.0 t ha^{-1} fresh and 13.9 t ha^{-1} sundry than other nutrient management practices. Supplementing 20% of RFD by CD along with 80% chemical fertilizer exhibited the best performance over other treatments (25% extra of STB dose, STB dose and farmers' practice) in terms of crop yield and economic return.

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