



ISSN(e): 2789-4231 & ISSN (p): 2789-4223

International Journal for Asian Contemporary Research

www.ijacr.net



Research Article



Open Access

Development of Four Crop Based Cropping Pattern for Increasing Profitability in Bogura Region of Bangladesh

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Article info	Abstract
<p>Received: 16 April 2023 Accepted: 12 May 2023 Published: 19 May 2023 Available in online: 19 May 2023</p> <p>*Corresponding author:  tanbirhasanshuvo88@gmail.com</p> 	<p>A field trial was conducted at Multi Location Testing (MLT) site shibganj under On Farm Research Division, BARI, Bogura during 2018-19 and 2019-20 at farmers' field condition to develop Mustard-Boro-T. aus-T. aman rice cropping pattern against Mustard-Boro-T. aman rice cropping pattern. There were two treatments i.e, T₁: Existing Cropping pattern: Mustard (Tori-7)-Boro (BRR1 dhan 28)-T. aman (BR-11) and T₂: Alternate Cropping pattern: Mustard (BARI Sarisha-14)-Boro (BRR1 dhan 28)-T. aus (BRR1 dhan-48)-T. aman (BRR1 dhan-62). Research result obtained that rice equivalent yield (REY) in alternate cropping pattern was 20.32 t ha⁻¹, which is 41.99% higher over existing pattern (14.31 t ha⁻¹). Higher gross return (332370), gross margin (149360) and marginal benefit cost ratio (2.08) were obtained from alternate cropping pattern over existing cropping pattern in both years due to introduction of new crop and varieties. Message of this research, the new pattern may be recommended for large scale production to other extrapolation areas in Bogura district of Bangladesh.</p> <p>Keywords: Crop sequence, Mustard, Boro rice, T. aus, T. aman and Cropping intensity.</p>

Introduction

Bangladesh with an area of 1, 47, 570 sq km is the most densely populated (about 843 persons per sq. km) country of the world. Its present population is about 169 million, which is increasing annually at the rate of about 1.37 percent. By the year 2025 AD, the population will increase to about 178 million ((BBS, 2018). Total cultivable land of the country is about 8.44 million hectares. Demographic pressures and increased urbanization have caused cultivated area to decline at a rate of 1 percent per year. Food requirement of the country is estimated to be doubled in the next 25 years (Islam and Haq 1999). The demand has to be met up from our limited and shrinking land resources. Rice occupies more than 75.01% of total cropped area of Bangladesh (BBS, 2018). It provides 75% of the calories and 55% of the proteins in the average daily diet of the people (Bhuiyan et al., 2002). Bangladesh is predominantly a rice growing country and rice is the staple food. Rice occupies about 80% of the total cropped area and is cultivated in three seasons a year. In rice based cropping system T. aman-Fallow-Boro-Fallow is a dominant cropping pattern of the country. Thus, intensification of crop production in rice-based cropping systems is critical for food security and poverty alleviation. In the near future, the primary challenge will be to increase yield

per unit land by 50% through resource management. To produce more food on a small plot of land, the most important options are to increase cropping intensity and to maximize the production efficiency of each crop through the use of optimal management practices (Mondol et al., 2015). Recently, with the development of short-season rice, mustard, potato, pulse, and jute varieties, opportunities have been created to develop four crops on the same plot of land in a single year (BARI, 2017). Bogura is widest rice-growing district of Bangladesh. Mustard-Boro-Fallow-T. aman is a major cropping patterns (DAE, 2015). Because the land remains fallow following Boro rice harvesting, T. aus rice fits easily into the Mustard-Boro-Fallow-T. aman cropping pattern. Thus, the inclusion of T. Aus in the Mustard-Boro-Fallow-T. Aman cropping pattern is expected to increase cropping intensity and productivity in the Bogura region of Bangladesh. Additionally, the adoption of this alternate cropping pattern Mustard-Boro-T. Aus-T. Aman can generate employment and additional revenue for the region of rural people. Therefore, the current study was conducted to determine the feasibility of growing four crop sequence in order to increase cropping intensity, productivity and income of farm families in Bogura district of Bangladesh.

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Materials and Methods

The trial was conducted at the farmers' field of Multi location testing site, Shibganj, Bogura during 2018-19 and 2019-20 to develop Mustard-Boro-T.aus-T.aman cropping pattern. There were two treatments i.e, T₁: Existing Cropping pattern: Mustard (Tori-7)-Boro (BRRI dhan 28)-T.aman(BR-11) and T₂: Alternate Cropping pattern: Mustard (BARI Sarisha-14)-Boro(BRRI dhan 28) -T.aus(BRRI dhan 48)-T.aman (BRRI dhan 62). Boro rice was the first crop of the crop sequence. Fertilizer management and other intercultural operations were done

activities including sowing/transplanting, harvesting, spacing, fertilizer management etc. are presented in Table 2. Before conducting the experiment and after completion of two years cycle soil samples were collected from farmer's field and then sent to the SRDI laboratory, Bogura for chemical analysis. The chemical properties of the initial and post soil are presented in Table 1. After getting the results of initial soil analysis value, fertilizer doses were estimated with the help BARC fertilizer recommendation guide, 2018 in trial plot along with the application methods were done to support the normal growth of the crops. For economic comparison

Table 1. Initial and final soil properties of four crop based cropping pattern field at MLT site Shibganj, Bogura during 2018-19 to 2019-20

Soil properties	Land type	pH	Organic matter (%)	Total N (%)	(µg/g)				
					K	P	S	Zn	B
Initial	MHL	6.5	1.61	0.07	0.14	17.75	17.24	0.74	0.31
Final	MHL	6.6	1.64	0.09	0.15	15.61	16.93	1.02	0.29
Critical Limit	-	-	-	0.12	0.12	7.0	10.0	0.6	0.2

MHL= Medium High Land

according to Haque et al. (2011). Thirty to thirty-five days old seedling of variety BRRI dhan 28 were transplanted with 20 cm x 15 cm spacing during 4 to 9th February in both existing and improved cropping pattern.

between two crop sequences, the yield of all crops was converted into price equivalent yield on the basis of prevailing market price of individual crops. The economic indices i.e. gross return, gross margin, and benefit cost ratio were also calculated on the basis of

Table 2. Agronomic performance of different crops at existing and alternate cropping pattern at MLT site, Shibganj, Bogura (Averaged over two years' data).

Parameters	Existing Cropping Pattern			Alternate Cropping Pattern			
	Boro	T.aman	Mustard	Boro	T.aus	T.aman	Mustard
Crop							
Variety	BRRI dhan 28	BR-11	Tori-7	BRRI dhan 28	BRRI dhan 48	BRRI dhan 62	BARI sorisha-14
Unit plot size	1ha			1ha			
Fertilizer dose (CD tha ⁻¹ , NPKSZnB kgha ⁻¹)	0,104-18-37-14-0-0	0,108-22-37-13-0-0	0,85-15-37-13-0-0	0,142-25-74-14-4-0	0, 83-35-53-9-2.70-0	0,83-10.5-42-9.6-2.70-0	5,121-36-60-24-2.70-1.27
Date of transplanting/ sowing	04-06 February	24-26 July	12-15 November	05-9 February	17-21 May	14-16 August	12-13 November
Date of harvesting	7-9 May	08-10 November	26-28 January	13-15 May	8-10 August	2-4 November	28-30 January
Field duration	93	105	74	99	82	81	78
Turnaround time	06	77	04	05	04	04	10
Grain yield (t ha ⁻¹)	5.66	5.16	0.84	5.72	4.68	4.27	1.43
Straw yield (t ha ⁻¹)	6.32	6.07	1.44	6.16	5.11	4.97	2.16

T. aus rice was the second crop of the crop sequence. Fertilizer management and other intercultural operations like weeding, irrigation and pest management were done according to Haque et al. (2011). Twenty to twenty-two days old seedling of var. BRRI dhan 48 were transplanted with 20 cm x 15 cm spacing during 17-21 May in the alternate cropping pattern. Grain yield and straw yields were taken from whole plot.

T. aman rice was grown during the Kharif II season and it was the third crop of the sequence. Fertilizer management and other intercultural operations like weeding, irrigation and pest management were done according to Rahman et al. (2008). Seedlings were grown in adjacent plot and transplanting was done with 22-23 days old seedling of rice BRRI dhan 62 at a spacing of 20 cm x 15 cm during 14-16 August in four crop based cropping pattern. T. aman rice was harvested during first week of November and yields were taken.

Mustard was planted as a fourth crop during second week of November in the four crop based cropping pattern. Fertilizer management and intercultural operations like weeding, irrigation, mulching and pest management were done according to Mondal et al. (2014). Most popular mustard variety (BARI sorisha-14) was planted with broadcasting in the field. Mustard was harvested 28-30 January. Grain yields were taken from whole plot.

Data for Existing cropping pattern were collected from the adjacent farmer's field. The unit plot size was 1 hectare. All agronomic

prevailing market price of the commodities. Relevant data were taken and analyzed statistically.

Results and discussion

Yield and profitability of cropping pattern

Yield and economic performance of alternate and existing cropping pattern are presented in Table 2 and Table 3 during 2018-19 and 2019-20. The two years average grain yield of rice and mustard in alternate cropping pattern of Boro, T.aus, T.aman and mustard were recorded as 5.72, 4.68, 4.27 and 1.43 t ha⁻¹, respectively, while in existing cropping pattern yield of Boro, T.aman and mustard produced 5.66, 5.16 and 0.84 t ha⁻¹, respectively. The results clearly indicated that higher yield of Mustard, Boro, T.aus and T.aman in alternate cropping pattern as compared to the existing cropping pattern. Total productivity of different cropping sequences was determined by Rice Equivalent Yield (REY) which was calculated from yield of component crops. Rice Equivalent Yield was different under different cropping sequences. From the results of two years' research on four crop based cropping pattern, it was observed that the average higher REY (20.32 t ha⁻¹) was recorded from the alternate cropping sequence than the existing cropping sequence (14.31 t ha⁻¹). Rice equivalent yield in the improved cropping pattern was 41.99% higher than the existing cropping pattern due to inclusion of one cereal crops (T.aus) and use of

Table 3. Economic performance of existing and alternate cropping pattern at MLT site Shibganj, Bogura (Averaged over two years' data)

Parameters	Existing Cropping Pattern			Alternate Cropping Pattern			
	Boro	T.aman	Mustard	Boro	T. aus	T.aman	Mustard
Rice Equivalent yield (t ha ⁻¹)	14.31			20.32			
Gross return (Tk.ha ⁻¹)	235365			332370			
Total variable cost (Tk. ha ⁻¹)	136485			183010			
Gross margin (Tk. ha ⁻¹)	98880			149360			
MBCR (Whole pattern)	2.08						

MBCR= Marginal Benefit Cost Ratio, Market price of Mustard @ 50 Tkkg⁻¹, Straw @ 1.0 Tkkg⁻¹, Boro @ 15Tk kg⁻¹, T.aman @ 17Tk kg⁻¹, T. aus @ 16 Tkkg⁻¹, Straw @ 1.50 Tk kg⁻¹

modern varieties and other technologies in the alternate cropping pattern. The result of the study similar with the Naher et al. (2016); Hossain et al. (2017) and Hossain et al. (2018) who stated that short duration varieties and improved four crop based cropping pattern increases total productivity and profitability over farmers existing pattern.

Economic analysis

Economic analysis was done on the basis of prevailing market price of the commodities. Productivity of different cropping systems was compared in terms of rice equivalent yield. Economics of system productivity of alternate and existing cropping sequences showed in Table 3 and it was observed that gross return for different cropping patterns. Higher gross return (Tk. 332370 ha⁻¹) and gross margin (Tk. 149360 ha⁻¹) were obtained in alternate Boro-T. aus-T. aman-Mustard cropping pattern as compared to existing cropping pattern. Higher economic return recorded from alternate cropping sequence Boro-T. aus-T. aman-Mustard, was the result of increase of total productivity than the existing one. Higher rice equivalent yield and gross margin were obtained in alternate cropping pattern due to introduction of new crop and varieties. MBCR was also found in 2.08. Mondal et al., 2014 agreed that four crop based cropping pattern would play a vital role to ensure food security of the country in upcoming days.

Conclusion

Based on two years' average results of the cropping pattern research, it may be concluded that four crop based alternate cropping pattern is more profitable to existing three crop based cropping pattern. So, alternate cropping pattern may be recommended for other extrapolation areas to large scale production in Bogura district of Bangladesh.

Conflict of interest

The authors state that they did not have any commercial or financial associations that could be interpreted as a possible conflict of interest during the research.

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To cite this article: Hasan, M.T., Alam, M.S., Islam, M.A., Mollah, M.R.A. and Akter, M.M. (2023). Development of Four Crop Based Cropping Pattern for Increasing Profitability in Bogura Region of Bangladesh. *International Journal for Asian Contemporary Research*, 3 (1): 19-21.

