Bangladesh Agron. J. 2018, 21(2): 13-18

SYSTEM PRODUCTIVITY OF WHEAT- SESAME-T. AMAN RICE CROPPING PATTERN AS INFLUENCED BY VARIETAL REPLACEMENT

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(Received: 21 December 2017, **Accepted:** 25 January 2018**)**

Keywords: Sustainable yield index, production efficiency, land use efficiency, rice equivalent yield

Abstract

The study was carried out at Multi Location Testing site, Sujanagar, Pabna during two consecutive years of 2011-12 and 2012-13 growing season to assess the performance of the pattern with newly released crop varieties against the existing one usually practiced by the farmers with traditional varieties in order to increase yield and economic return. The experiment was laid out in a randomized complete block design with six dispersed replications at farmer's field. In improved pattern (IP) BARI Gom-26, BARI Til-4 and Binadhan-7 variety were used for wheat, sesame and T. aman rice, respectively. On the contrary in existing pattern (EP) farmers usually use BARI Gom-21, local (char shira) and Sharna cultivar for wheat, sesame and T. aman rice, respectively. The mean yield was recorded 4.66, 1.34 and 4.79 t ha^{-1} from wheat (BARI Gom-26), sesame (BARI Til-4) and T. aman (Binadhan-7) respectively from the improved cropping pattern whereas average yield 3.81, 0.98 and 4.58 t ha^{-1} was obtained from wheat (BARI Gom-21), sesame (local) and T. aman (Sharna), respectively from the existing pattern. Two years mean data also showed that improved pattern provided about 18% higher REY compared to existing pattern. Sustainable yield index and production efficiency were also found maximum with improved cropping pattern. Similarly, maximum gross margin and benefit cost ratio were obtained from improved cropping pattern.

Introduction

The major cropping pattern in Bangladesh agriculture mostly consist of rice based cereal crops. Cropping pattern is the yearly sequence, temporal and spatial arrangement of crops in a given crop field. A cropping pattern on an area largely depends on some factors like climate, type of soil, rainfall, agricultural technology, irrigation facilities, different inputs, marketing, transport facilities and growth of agro-industries (Neena, 1998; Gadge, 2003). An effective cropping pattern ensures the best efficiency of land, labor, fertilizer, irrigation water and other inputs (Harwood, 1974). Wheat-Sesame-T. aman rice is one of the most popular and important cropping pattern in Pabna region. But total productivity from this cropping patter is very much low.

The causes of lower yield of the crops under Wheat-Sesame-T. aman rice are mainly because the farmers' of that locality use old traditional varies of wheat, sesame and T. aman rice. Those old traditional crop varieties are low yield potential, insect and disease susceptible. The farmers harvest poor yield from

local and old varieties that can be increased manifold by introducing high yielding modern varieties (Alam and Rahman, 2006; Basak *et al.*, 2007). Therefore, the study was undertaken to assist the farmers in the drought prone areas to increase their income using proper cropping pattern with modern high yielding crop varieties.

Materials and Methods

The study was carried out at Multi Location Testing site, Sujanagar, Pabna during two consecutive years of 2011-12 and 2012-13 growing season to assess the performance of the pattern with newly released crop varieties against the existing one usually practiced by the farmers with traditional varieties in order to increase yield and economic return. High yielding modern varieties of wheat, sesame and T. aman were advised to be included in place of traditional local varieties usually cultivated by farmers. Wheat (BARI Gom-26), sesame (BARI Til-4) and T. aman (Binadhan-7) were selected for inclusion in the improved pattern against wheat (BARI Gom-21), local sesame (charshira) and Sharna as T. aman used to be cultivated by the farmers in their traditional existing cropping pattern. The experiment was laid out in a randomized complete block design with six dispersed replications at farmer's field.

The agronomic practices and cultural operation of crop production under improved and existing cropping patterns are presented in Table 1. All field operation and management practices were closely monitored. Yield and other relevant data were recorded carefully to make a comparison between the improved and existing pattern regarding yield and economic return. Agronomic performance viz. production efficiency, rice equivalent yield (REY) and sustainable yield index (SYI) of cropping patterns were calculated by the following formula:

Production efficiency

Production efficiency values in terms of kg ha^{-1} day^{-1} were calculated by total production in a cropping sequence divided by total duration of crops in that sequence (Tomer and Tiwari. 1990).

$$\text{Production efficiency} = \frac{Y_1 + Y_2 + Y_3}{d_1 + d_2 + d_3}$$

Where, Y_1= Yield of 1st crop and d_1= Duration of 1st crop of the pattern
Y_2= Yield of 2nd crop and d_2= Duration of 2nd crop of the pattern
Y_3= Yield of 3rd crop and d_3= Duration of 3rd crop of the pattern

Sustainable yield index (SYI)

Sustainable yield index was worked out by the following formula suggested by Krishna and Reddy (1997).

$$\text{Sustainable yield index (SYI)} = \frac{Y_{mean} - SD}{Y_{\max}} \times 100$$

Where, Y mean: Estimated mean yield of a practice over years; SD: Estimated standard deviation; Y max: Observed maximum yield in the experiment over the years.

Rice Equivalent Yield (REY)

For comparison between crop sequences, the yield of all crops was converted into rice equivalent on the basis of prevailing market price of individual crop (Verma and Mongal, 1983). The economic indices like Gross return and net

return and benefit cost ratio were also calculated on the basis of prevailing market price of the produces.

Rice equivalent yield =

For economic evaluation of two different cropping sequences averaged data of two crop cycles were used. The gross cost of cultivation of different crops was calculated on the basis of different operations performed and materials used for raising the crops. Gross margin, gross return and total cost of cultivation of the crops were calculated as well as benefit cost ratio (BCR) as per following formula:

Benefit cost ratio (BCR) = Gross return (Tk. ha^{-1})/ Total variable cost (Tk. ha^{-1})

Table 1. Management practices of improved and existing cropping pattern

Parameters	Crops	Improved pattern (IP)	Existing pattern (EP)
Variety	Wheat	BARI Gom-26	BARI Gom-21
	Sesame	BARI Til-4	Local charshira
	T. aman	Binadhan-7	Sharna
Sowing/Transplanting time	Wheat	30 November to 5 December	
	Sesame	16 to 24 April	
	T. aman	7 to 13 August	
Planting method	Wheat	Line sowing	Broadcasting
	Sesame	Line sowing	Broadcasting
	T. aman	Line sowing	Line sowing
Fertilizer dose (N-P-K-S-Zn-B kg ha^{-1})	Wheat	83-28-20-20-3-2.5	
	Sesame	48-27-23-18-0-0	
	T. aman	69-22-35-11-3.6-1.4	
Weeding (no)	Wheat	1	1
	Sesame	1	1
	T. aman	2	2
Irrigation/Rainfed	Wheat	2	2
	Sesame	Rainfed	Rainfed
	T. aman	2	2
Harvesting time	Wheat	17 to 25 March	20 to 28 March
	Sesame	18 to 28 July	14 to 23 July
	T. aman	2 to 10 November	20 to 26 November
Field duration (days)	Wheat	108-112	111-115
	Sesame	94-96	90-92
	T. aman	88-92	106-110

Results and Discussion

Grain and straw yield of the pattern

Grain and straw yield of wheat, sesame and T. aman rice of both the cropping patterns are presented in Table 2. It was observed that wheat, sesame and T. aman rice under improved cropping pattern perform significantly higher than that of existing cropping pattern in both the year. In case of wheat the mean grain yield of BARI Gom-26 (4.66 t ha^{-1}) was found higher than BARI Gom-21 (3.81 t ha^{-1}). The seed yield of BARI Til-4 (1.34 t ha^{-1}) was also found higher than local sesame cultivar (0.98 t ha^{-1}). In case of T. aman rice yield of Binadhan-7 (4.79 t ha^{-1}) was found higher compare to local cultivar Sharna (4.58 t ha^{-1}). Similar trend was found in case of straw yield except T. aman rice where local cultiver Sharna provided higher straw yield compared to Binadhan-7. In both the

year improved pattern performed better than the existing cropping pattern. This might be due to use of high yielding modern crop varieties in improved cropping pattern. On the contrary the verities used in existing cropping pattern are low yielder, insect and disease susceptible. This result was supported by the results of Nazrul (2016), Nazrul *et al.* (2013), Khan *et al.* (2005) and Hossain and Wahhab (1992)

Table 2. Grain and straw yield of different crops obtained from improved pattern (IP) and existing pattern (EP) during 2011 to 2013

Years	Cropping patterns	Grain yield (t ha^{-1})			Straw yield (t ha^{-1})		
		Wheat	Sesame	T. aman	Wheat	Sesame	T. aman
2011-12	IP	4.56	1.36	4.81	5.54	4.8	6.5
	EP	3.87	1.0	4.65	4.5	3.0	6.86
	t value	28.327	12.198	2.701	26.501	12.198	-4.309
	Level of significance	**	**	*	**	**	**
2012-13	IP	4.75	1.32	4.76	5.69	4.6	6.25
	EP	3.75	0.95	4.5	4.3	2.75	6.66
	t value	387.29	24.222	71.204	380.67	270.81	-44.041
	Level of significance	**	**	**	**	**	**
Mean	IP	4.66	1.34	4.79	5.62	4.7	6.38
	EP	3.81	0.98	4.58	4.43	2.88	6.76

IP = Improved pattern, EP = Existing pattern.
* = Significance at 5 % level and ** = Significance at 1 % level

Rice equivalent yield

Rice equivalent yield of improved cropping pattern was found higher compared to existing cropping pattern in both the years (Table 3). The mean rice equivalent yield 14.24 t ha^{-1} was obtained from improved pattern which was about 18% higher than existing pattern. This higher rice equivalent yield was might be due to inclusion of high yielding modern varieties in improved cropping pattern.

Production efficiency

Higher production efficiency was found from improved cropping pattern in both the year as compared to existing cropping pattern (Table 3). The mean production efficiency of 38.56 kg ha^{-1} day^{-1} was obtained from improved pattern which was about 26% higher than existing pattern. This higher production efficiency was might be due to higher yield of modern varieties in improved cropping pattern. Similar results were also observed by Nazrul (2016), Nazrul *et al.* (2013) and Khan *et al.* (2005).

Sustainable yield index

Maximum sustainable index was also found from improved cropping pattern in both the years as compared to existing cropping pattern (Table 3). The mean sustainable yield index (68.25%) was obtained from improved pattern which was about 41% higher than existing pattern.

Table 3. Rice equivalent yield, Production efficiency and Sustainable yield index obtained from improved pattern (IP) and existing pattern (EP) during 2011 to 2013

Years	Cropping patterns	Rice equivalent yield (t ha^{-1})	Production efficiency (kg ha^{-1} day^{-1})	Sustainable yield index (%)
2011-12	IP	14.22	48.53	70.95

2012-13	EP	12.25	39.26	48.71
	IP	14.26	48.67	66.01
	EP	11.81	37.85	47.84
Mean	IP	14.24	48.60	68.25
	EP	12.03	38.56	48.28
% increase over EP		18.37	26.04	41.36

IP = Improved pattern, EP = Existing pattern, Price: of Rice = 18 Tk. kg^{-1}; Wheat = 20 Tk. kg^{-1}; Mustard = 45 Tk. kg^{-1}

Cost and Return Analysis

Between two cropping patterns, the improved pattern provided more profit over existing pattern during two consecutive cropping years (Table 4). The mean gross return obtained from improved pattern (Tk. 2,56,320 ha^{-1}) was higher than that of existing cropping pattern (Tk. 2,16,540 ha^{-1}). Higher gross margin was obtained from improved cropping pattern which was Tk. 13,94,465 ha^{-1} against total variable cost of Tk. 1,21,855 ha^{-1} whereas existing pattern provided lower gross margin which was Tk. 97,090 ha^{-1} against total variable cost of Tk. 1,19,450 ha^{-1}. Maximum BCR was also recorder from improved pattern (2.10) and minimum from existing pattern (1.81).

Table 4. Cost and return of improved and existing cropping pattern during 2011 to 2013

Years	Cropping patterns	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
2011-12	IP	255960	121230	134730	2.11
	EP	220500	118850	101650	1.85
2012-13	IP	256680	122480	134200	2.10
	EP	212580	120050	92530	1.77
Mean	IP	256320	121855	134465	2.10
	EP	216540	119450	97090	1.81

IP = Improved pattern, EP = Existing pattern. Price of rice seed = 18 Tk. kg^{-1}; Wheat seed= 20 Tk. kg^{-1}; Mustard seed= 45 Tk. kg^{-1} and all straw = 1 Tk. kg^{-1}

Conclusion

Wheat-Sesame-T. aman rice is one of the major cropping patterns in Pabna region. This pattern could be more productive, sustainable and profitable if farmer cultivated modern high yielding varieties of wheat, sesame and T. aman rice. Therefore, the farmers of this locality should cultivate BARI Gom-26, BARI Til-4 and Binadhan-7 instead of BARI Gom-21, local charshira sesame and local cultiver Sharna in their Wheat-Sesame-T. aman rice cropping pattern for higher system productivity and profitability.

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