RESEARCH ARTICLE Agricultural Science Digest, Volume 41 Issue 1: 42-48 (March 2021)

Yield and Profitability Analysis of Pulse and Oil Seed Based Cropping Patterns against Aman- Boro- Fallow Cropping Systems in Magura

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10.18805/ag.D-261

ABSTRACT

Background: Bangladesh is one of the densely populated countries in the world. To meet up the increasing food demand there's no alternative to increase the cropping intensity through high yielding and short duration crop varieties. Currently, cropping system of Bangladesh is mostly rice based which is also the staple food. Therefore, farmers which follow rice-rice based cropping patterns are gaining less profit day by day. Contrary, intensive rice culture is depleting soil properties gradually. Thus, to preserve soil health and increase profit pulse and oil seed based cropping patterns are crucial for sustaining a cropping pattern. This study was undertaken to find out a cropping pattern with higher yield and profit in the context of Magura district.

Methods: Five cropping patterns, CP_1 = Transplanted Aman rice (cv. Binadhan-7)-Mustard (cv. Binasarisha-9)-Boro rice (cv. Binadhan-14); CP_2 = T.Aman (cv. Binadhan-16)-Mustard (cv. Binasarisha-10)- Boro (cv. Binadhan-14); CP_3 = T.Aman (cv. Binadhan-17)-Mustard (cv. Binasarisha-10)- Boro (cv. Binadhan-14); CP_4 =T.Aman (cv. Binadhan-17)- Lentil (cv. Binamasur-8)- Sesame (cv. Binatil-3) and CP_5 (Control) = Aman (cv. Shorna) - Boro (cv. Heera) - fallow were assessed to identify the most suitable and profitable pattern as well as to enhance the cropping intensity by adding a pulse or oil seed crop between two rice crops. The investigation was conducted at farmer's field of Magura during 2018-19. Block farming method was followed for experiment set up.

Result: It was revealed that, maximum rice equivalent yield (REY) was obtained from CP_1 (14.46 t/ha) followed by CP_4 (13.52 t/ha), CP_3 (13.35 t/ha), CP_2 (13.09 t/ha) and CP_5 (11.33 t/ha) during one year crop cycle. Highest gross margin (Tk. 1,90,189) and MBCR (1.83) was obtained from the cropping pattern CP_4 and the lowest gross margin (Tk. 69,271) and MBCR (1.24) was found with the pattern CP_5. Based on the above results it can be suggested that, Aman rice-Lentil-Sesame pattern *i.e.* CP_4 may be a best choice for the farmers of Magura region for the maximum utilization of their land and gaining more profit compared to the other studied cropping patterns.

Key words: BCR, Binadhan-17, Binamasur-8, Binasarisha-10, Binasarisha-9, Binatil-3, Cropping pattern, Magura.

INTRODUCTION

Bangladesh is the 8th most populous country with a population nearing 163 million. It has a population density of 1,115.62 people per square kilometer (World Population Review, 2019). Total area of the country is 147,570 square kilometres (56,980 sq mi). Therefore, due to drought, salinity and unsuitable lands, crop production is limited to more or less 70% of the total area; which is decreasing at a rate of about 1% annually (Hossain *et al.,* 2015). The national average of cropping intensity is almost 2% (FAO, 2016). The opportunity for horizontal extension of cultivable land is quite impossible but cropping intensity can be enhanced to 400%. This may be achieved by adopting a series of modern technologies such as new modern high yielding short duration and stress tolerant varieties of mustard, potato, pulse, jute and aus rice. Recently with the development of early maturing varieties of the above crops; space have been created to accommodate four crops in same piece of land in a year (BARI, 2017). To feed the future upcoming generations, gain food security and increase productivity by 50%, there is no alternative for increasing

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How to cite this article: Chowhan, S., Ghosh, S.R., Hoque, M.I., Islam, M. and Nabi, K.M.E. (2021). Yield and Profitability Analysis of Pulse and Oil Seed Based Cropping Patterns against Aman-Boro- Fallow Cropping Systems in Magura. Agricultural Science Digest. 41(1): 42-48. DOI: 10.18805/ag.D-261.

Submitted: 11-04-2020 **Accepted:** 10-08-2020 **Online:** 17-12-2020

cropping intensity. On the other hand, yield gap has to be reduced by eradication of monocropping to get the desired productivity of a crop variety (Islam *et al.,* 2018a). As a result, agronomists are in challenge to develop improved crop production technologies, address production problems, processes and management of problems to maximize the production efficiency of an individual crop with optimum management practices (Hossain *et al*., 2015).

Cropping pattern is the yearly sequence, temporal and partial arrangement of growing crops in a given land area. A cropping system is the crop production activity of a farm which includes all cropping patterns grown on the farm resources, other household enterprises and the physical, biological, technological and socioeconomic factors or environments (Islam *et al.,* 2018b). Total cultivable land of Magura district is 76,701 ha. Among this, dominant cropping pattern is Boro-fallow-T.aman; which occupying about 21,880 ha of land (28%). Pulse-Jute-fallow and Wheat-Jute-T. aman based pattern occupies 11,033 ha (14%) and 10,618 ha (14%) of land respectively. Rest are minor cropping patterns which contributes less than 10% of the total arable land (DAE, 2019). Among the total arable land; 51,340 ha (BARC, 2020a) and 9,463 ha (BARC, 2020b) is very suitable for production of lentil and mustard respectively.

Rice is the staple food of Bangladesh and it is extensively produced over 70% of its total agricultural lands (Chowhan *et al*., 2019). Intensive rice-rice cropping systems results in lessening of soil pH and thereby creating soil acidity problem which ultimately results in unavailability of nutrients, depletion of soil and lowering crop yields. Crop rotation with pulse or oil seeds can be easily included in between two rice crops to sustain productivity and profitability of rice based production system (Singh *et al*., 2019). Sequential cultivation of different crop ensures utilization of all set of nutrients within the soil. It also contributes to reduce soil erosion, enhance soil fertility and crop yield (Adarsh *et al*., 2019). Cost of rice production is being rising every year; whereas, market price is not up to the mark. Thus, making it a less profitable crop. Production cost of pulse and oil seed crops is much less compared to rice. Conversely, profit is more than rice. Keeping the above factors in mind the present research program was aimed to select suitable crop(s) and pattern to raise yield and cropping intensity and to find out the most profitable cropping pattern in the context of Magura.

MATERIALS AND METHODS

The study was conducted at the farmer's field of Maghi under the sadar upazila of Magura district during July 2018 to June 2019. Geographical position of the experiment site was 23°25′51.7″N latitude and 89°23′54.1″E longitude. It was under the AEZ (Agro Ecological Zone) 11; which is high ganges river flood plain and mostly high to medium high land type characterized by lower content of organic matter and fertility level (Table 1). Total area of AEZ 11 is 1320549 ha under this Magura holds 85700 ha of land (Das *et al.,* 2018; Ahmed *et al.,* 2018). It belonged to tropical monsoon climate with unimodal rainfall. Average weather data (2018-19) of Magura district is presented in Fig 1 (BINA, 2019a). Block farming approach was followed for experiment set up. The following five cropping patterns (CP) were laid for the experimentation-

CP_1 = Transplanted Aman rice (cv. Binadhan-7)-Mustard (cv. Binasarisha-9)- Boro rice (cv. Binadhan-14).

CP_2 = T. Aman (cv. Binadhan-16) -Mustard (cv. Binasarisha-10) - Boro (cv. Binadhan-14).

CP_3 = T.Aman (cv. Binadhan-17) -Mustard (cv. Binasarisha-10) - Boro (cv. Binadhan-14).

CP_4 = T.Aman (cv. Binadhan-17) -Lentil (cv. Binamasur-8) - Sesame (cv. Binatil-3).

CP_5 = (Control) -Aman (cv. Shorna) - Boro (cv. Heera) - fallow.

Land area for each pattern (block) was 0.25 acre (25 decimal) and total area was 1.25 acres for all the five patterns. For rice, land preparation, planting method, time, seedling age, weeding, pest control, rouging *etc*. were done according to the methodology followed by Chowhan *et al.* (2017) and Chowhan *et al.* (2019). In case of mustard, seeds were broadcasted at the rate of 3.0 Kg/ha. They were thinned and weeded after 15-20 days to maintain plant population of 50-60/m^2. To prevent from Alternaria blight and other fungal diseases Rovral-50 WP and Autostin-50 WDG were sprayed @ 3g and 2g/L respectively. Insects were controlled by applying Reeva 2.5 EC @ 2.5ml/L when necessary. Seeds were harvested by cutting the crop plants from ground level when siliquae attained a maturity of 80%. For lentil, seeds were treated with Provax 200 WP @ 3g/kg seed and broadcasted @ 15 kg/acre. Weeding, thinning and mulching were done at 30 DAS (days after sowing). For effective controlling of foot and root rot, Provax 200 WP was sprayed @ 2.5g/L thoroughly with care into the root zone at 12 days interval for 3 times. Ripcord 10 EC was applied @ 2ml/L for controlling insects. During early maturity period Amistar Top 325 EC was sprayed 2 times at 10 days interval @ 3ml/L. Tilt 250 EC @ 2.5ml/L was used to prevent rust of lentil. When the pods matured and the color turned dark yellow to brown whole plants were harvested and the seeds were separated from the pods by a mechanical thresher. Sesame seeds were sown @ 3.25kg/acre by broadcasting. Land preparation of sesame was done according to Paul *et al.* (2019). Plots were kept weed free up to 25 days. Insect infestation was checked through Karate 2.5 EC @ 3ml/L. Fungal diseases were stifled by Forastin 50 WP @ 2.5g/L. Plants were harvested by cutting when plant and capsules turned yellowish color from the bottom. Then the collected plants were sun dried evenly up to complete drying. Later seeds were extracted manually by labor. A well drainage facility was ensured in all the patterns to prevent excess moisture stress. Fertilizer dose (N-P-K-S-Zn-Mg-B kg/ha) for Aman rice was 60-10-50-8-0.8-0-0, Mustard was 80-24-60-18-1.5-3.0-1.0, Boro rice was 120-16-76-12-1.3-0-0, lentil was 80-24-60-18-1.5-3.0-1.0 and sesame were 120-16-76-12-1.3-0-0. Fertilizers were applied as per crop and time stated in FRG (2012). After the end of each crop's harvest, data were

collected on yield and yield attributes, gross return, total variable cost, gross margin and BCR (Benefit cost Ratio). Then, summation of different parameters of the individual crop's result was done separately and average performance was calculated.

Rice Equivalent Yield (REY) was used to compare between crop sequences, the yield of all crops was converted into rice equivalent on the basis of prevailing market prices of individual crop (Verma and Modgal, 1983). Following formula (Kamrozzaman *et al.,* 2016) was employed to determine REY-

$$\text{REY (t/ha)} = \frac{\text{Yield individual crop (kg) x market price of that crop (TK/KG)}}{\text{Market price of rice (TK/KG) X 1000}}$$

Economic analysis included data collection on prices and quantities of inputs used and output produced (seed, straw, byproducts *etc*.). The inputs used included seed, fertilizer, labour and pesticides. The output and inputs were valued at market prices. Results were used to count net income, benefit cost ratio and rice equivalent yield of crops. Net income was computed as the difference between management (family labour and operator's) cost and gross margin. BCR was computed Kamrozzaman *et al.* (2016) as per the following formula:

$$\text{BCR} = \frac{\text{Gross return}}{\text{Total (variable) cost of cultivator}}$$

RESULTS AND DISCUSSION

Crop duration and turnaround time of patterns

In the first cropping pattern (CP_1) Binadhan-7 was transplanted within 25 DAS; which was harvested at field duration of 93 DAT (days after transplanting) (Table 2). Rahman and Islam (2019) reported that field duration of Binadhan-7 was between 95 to 99 days. This resulted in sowing of next crop in cropping sequence within 2 days. So, after harvesting immediately the plot was made ready for Binasarisha-9 sowing. Binasarisha-9 matured at 94 DAS. BINA (2019b) concluded that mean duration of Binasarisha-9 in Magura was 90 days. Mustard left an additional time (turnaround time) of 29-30 days for sowing of Binadhan-14 in *boro* season. Binadhan-14 is a *braus* and short duration variety thus required less seedling age during transplantation. But here, the seedling age was 30 days thus it shortened its life cycle in the main field. Harvesting of Binadhan-14 was completed at 89 DAT. Chowhan *et al.* (2018) observed, *aus* rice varieties shortened their duration due to drought.

Seedlings of Binadhan-16 was transplanted to field at 20 DAS in CP_2. It ripened within 89 DAT and was cut (Table 2).

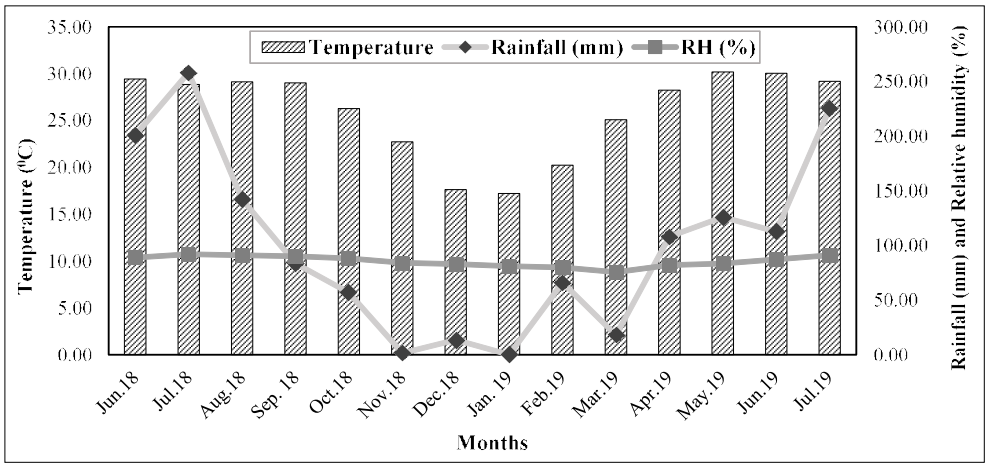


Fig 1: Mean temperature (^{0}C), rainfall (mm) and relative humidity (%) during experiment period at Magura. (Source: BINA, 2019a).

Table 1: Soil physical and nutrient status of the experimental area in AEZ-11.

Major land type	Soil pH	Soil OM	N	P	K	S	Ca	Mg	Zn	B	Mo	Physiological characteristics of soil
H- 43%	4.5-9.1	L-M	VL-L	VL-L	L-M	L-M	Opt-H	VL-L	VL-L	L-M	M	· calcareous dark grey soil type
MH-32%	5.0-8.4	L-M	VL-L	VL-L	L-M	L-M	Opt-H	VL-L	VL-L	L-M	M	medium high land · well drained
ML- 12%	6.0-8.3	L-M	VL-L	VL-L	L-M	L-M	Opt-H	Opt-H	L-M	L-M	M	· above flood level · dark grey in color

H= High, MH= Medium High, ML= Medium Low, L-M= Low to Medium, VL-L= Very Low to Low, L-M= Low to Medium, Opt-H= Optimum to High, M= Medium.

Table 2: Crop management of different cropping patterns (CP_1-CP_4) at Magura during 2018-19.

Parameters		**CP_1**			**CP_2**	
Crop	Rice (*Aman*)	Mustard	Rice (*Boro*)	Rice (*Aman*)	Mustard	Rice (*Boro*)
Variety	Bd-7	Bs-9	Bd-14	Bd-16	Bs-10	Bd-14
Spacing (cm^2)	20 × 20	Broadcast	20 × 20	20 × 20	Broadcast	20 × 20
Date of sowing/ transplanting	24-25 Jul. 18	27-28 Oct. 18	27-28 Feb. 19	24-25 Jul. 18	22-23 Oct. 18	24-25 Feb.19
Irrigation (no.)	1	1	2	1	1	2
Weeding (no.)	2	1	2	2	1	2
Field duration	93	94	89	83	82	95
Turn around time	57-58	2	29-30	52-54	8-9	43-44
Date of harvesting	24-25 Oct. 18	29 Jan.19	26-27 May, 19	14-15 Oct.18	11-12 Jan.19	30-31 May,19
Parameters		**CP_3**			**CP_4**	
Crop	Rice (*Aman*)	Mustard	Rice (*Boro*)	Rice (*Aman*)	Lentil	Sesame
Variety	Bd-17	Bs-10	Bd-14	Bd-17	Bm-8	Bt-3
Spacing (cm^2)	20 × 20	Broadcast	20 × 20	20 × 20	Broadcast	20 × 20
Date of sowing/ transplanting	30 Jul.18	10 Nov.18	02-03 Mar. 19	01-02 Aug. 18	15 Nov. 18	13 Mar. 19
Irrigation (no.)	1	1	2	1	1	1
Weeding (no.)	2	1	2	2	1	1
Field duration	97	83	90	92	106	91
Turn around time	61	06	28	52	13	11
Date of harvesting	04 Nov.18	02 Feb.19	31 May, 19	02 Nov.18	01-02 Mar. 19	12-13 June, 19

Bd - Binadhan, Bs - Binasarisha, Bm - Binamasur, Bt - Binatil.

Binadhan-16 is extremely a short duration variety of *aman* which matures within 100 (Chowhan *et al.* 2017). Hossain *et al.* (2018) found that, field duration of Binadhan-16 was 75-78 days. Turnaround time was 8-9 days for sowing of mustard (Binasarisha-10) in the next sequence whose field duration had 82 days. BINA (2019b) conducted 40 demonstrations at Magura and reported 84 days mean life cycle of Binasarisha-10. Next crop (*boro* rice) got a turnaround time of 43-44 days. Seedlings were raised during this time. This time 25 days old seedlings were used for transplanting of Binadhan-14. It matured at 95 DAT. Chowhan *et al.* (2019) found duration of Binadhan-14; 126.11 days with varietal effect.

First crop (Binadhan-17) of CP_3 was transplanted at 20 DAS. Field maturity of Binadhan-17 was 97 days (Table 2). Average duration of 30 demonstrations of Binadhan-17 at Magura was found to be 116 days by BINA (2019b). The next crop in this pattern, mustard (Binasarisha-10) had a duration of 83 days. After harvesting mustard, there were 28 days turnaround time for transplanting Binadhan-14. 28 days old seedlings were transplanted in the main field. Binadhan-14 matured within 90 DAT. Less duration may have occurred due to soil and weather conditions.

Fourth cropping pattern's (CP_4) first crop *aman* rice, Binadhan-17 was transferred to main plot at 27 DAS. It gained maturity within 92 days (Table 2); later 13 days turn around time was obtained for sowing lentil (Binamasur-8). Harvesting of Binamasur-8 was done 106 DAS. Earlier studies (BINA, 2019b) mentioned that, mean duration of Binamasur-8 in Magura was 104 days. Which was close to the present findings. Sesame was sown after 11 days of harvesting lentil. Binatil-3 attained maturity 91 DAS. Investigations from Ali, (2018) and BINA, (2019b) indicated that, mean duration of Binatil-3 in Magura ranged from 81 to 88 days. Which was in conformity with the present outcome.

CP_5 was the control pattern in the study. A wide locally cultivated *aman* rice (*Shorna*) was the first crop in this pattern. 30 days old seedlings were used for transplanting of *shorna*. This variety gained maturity at 99 DAT and harvested (Table 3). Rahman and Islam, (2019) observed field duration of *shorna* between 103 to 108 days. After *aman* rice the land under this pattern (CP_5) was kept fallow as farmers local practice. But there's a huge scope to cultivate short duration mustard varieties through zero tillage in this type of land to meet up national oil demand (TBS, 2019). In the third sequence, locally produced hybrid variety of *boro* rice was transplanted at 45 DAS. *Heera* was harvested at 100 DAT. Chowhan *et al.* (2019) stated that *Heera-1* had a mean duration of 147.78 days with varietal effect. Which closely supported the present findings.

Productivity and yield of five patterns

Binadhan-7 in CP_1 (Fig 2) produced a grain and straw yield of 5.3 t/ha and 5.88 t/ha respectively. This field results were in supporting with the findings of Rahman and Islam (2019); who found grain yield, 4.18 t/ha to 5.26 t/ha and straw yield, 4.85 t/ha to 5.15 t/ha on several cropping pattern experiments. Next crop, Binasarisha-9 gave 1.6 t/ha seed

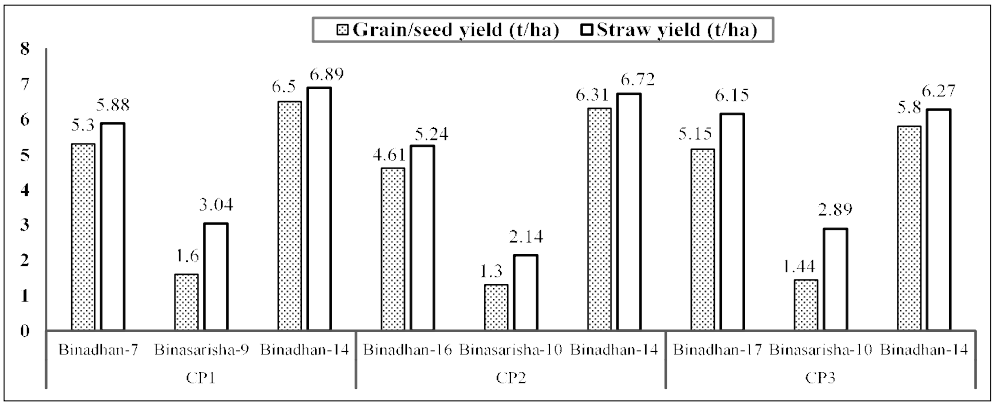


Fig 2: Yield of three cropping patterns (CP_1, CP_2, CP_3).

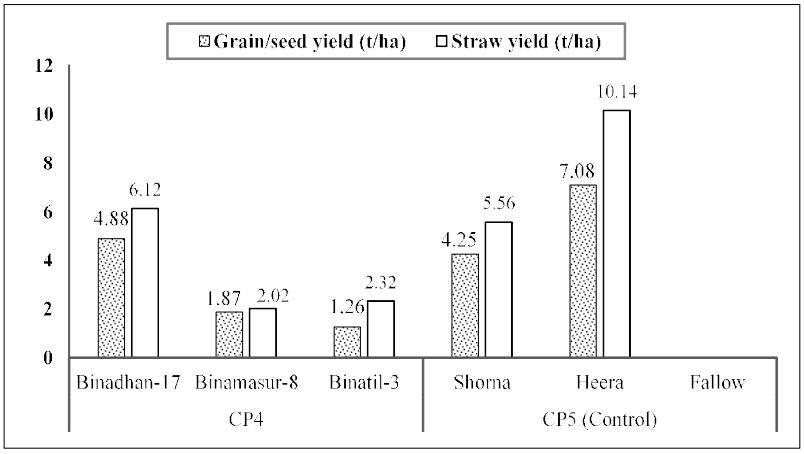


Fig 3: Yield of pulse-oil based cropping pattern (CP_4) over control (CP_5).

yield and 3.04 t/ha straw yield. BINA (2019b) reported that mean seed yield of Binasarisha-9 demonstrations at Magura was 1.33 t/ha. Higher yield in pattern was may be due to improved management practices. Khatun *et al.* (2015) concluded that, straw yield of Bina mustard varieties were 3.74 t/ha to 4.05 t/ha. The low yield of straw may have obtained due to soil moisture, fertility and weather related factors. Last crop of CP_1; Binadhan-14 yielded 6.5 t/ha of grain and 6.89 t/ha straw; this was the maximum yield obtained among the three cropping patterns (CP_1 - CP_3). Similar results on yield were mentioned by BINA (2019b).

First crop of CP_2 (Fig 2), Binadhan-16 attained a grain and straw yield of 4.61 t/ha and 5.24 t/ha. These results are alike with the findings of Chowhan *et al.* (2019). Binasarisha-10, the second crop of this pattern gave less production than CP_3. It obtained 1.3 t/ha seed yield and 2.14 t/ha straw yield. Ahmed and Kashem (2017) achieved similar outcomes with BARI Sarisha-14. Finally, third crop Binadhan-14 gave 6.31 t/ha grain yield and 6.72 t/ha straw yield; which was the second highest yield compared to the first three patterns. This finding was in affirmatively supported by Chowhan *et al.* (2019).

In CP_3 (Fig 2), Binadhan-17 yielded more than CP_4. It gave 5.15 t/ha grain yield and 6.15 t/ha straw yield. Chowhan *et al.* (2017) reported 5.05 t/ha and 7.58 t/ha grain and straw yield of Binadhan-17 in *aman* season. Differences in straw yield might have occurred for fertilizer management and crop duration. A seed and straw yield of 1.44 t/ha and 2.89 t/ha was given by Binasarisha-10 which was slightly more than CP_2's mustard yield. Conversely, Binadhan-14 produced 5.8 t/ha and 6.27 t/ha grain and straw yield, which was lowest among the first three patterns (CP_1 - CP_3).

Fourth pattern's (CP_4) first crop (Fig 3), Binadhan-17 gave lesser production compared to CP_3 (Fig 3). 4.88 t/ha grain and 6.12 t/ha straw yield were gathered from Binadhan-17 in CP_4. The next crop, lentil (Binamasur-8) gave a seed and straw yield of 1.87 t/ha and 2.02 t/ha serially. Haque *et al.* (2015) found varietal impact of different BARI Masur gave seed yield between 0.94 t/ha to 1.28 t/ha and straw yield of 2.2 t/ha to 2.48 t/ha. BINA (2019b) reported that, mean yield of Binamasur-8 from field demonstrations of Magura were 1.812 t/ha. These consequences were consistent with the present outcomes. Binatil-3 was the final crop in CP_4. It provided a seed and straw yield of 1.26 t/ha and 2.32 t/ha. BINA (2019b) stated mean seed yield of Binatil-3 in farmers' field demonstrations were 1.16 t/ha. Which validates the current finding.

Control pattern (CP_5) had only two crops in the cropping sequence *i.e. aman* and *boro* rice (Fig 3). First crop, *Shorna* gave 4.25 t/ha of grain and 5.56 t/ha of straw yield. Rahman and Islam (2019) concluded, grain yield extent of *Shorna*

Table 3: Crop management of the controlled pattern (CP_5) at Magura during 2018-19.

Parameters	Rice (*Aman*)	Fallow	Rice (*Boro*)
Variety	*Shorna*	-	*Heera*
Spacing (cm^2)	20 × 20	-	20 × 20
Date of transplanting	24 July, 2018	-	25 February, 2019
Irrigation (no.)	1	-	2
Weeding (no.)	2	-	2
Field duration	99	-	100
Turn around time (days)	28	98	40
Date of harvesting	31 October, 2018	-	05 June, 2019

Table 4: Rice equivalent yield, cost and return of the five cropping pattern during 2018-19.

Patetrn	REY (t/ha)	Gross return (Tk/ha)	Variable cost (Tk/ha)	Gross margin (Tk/ha)	MBCR
CP_1	14.46	452000	326316	125684	1.39
CP_2	13.09	408600	324462	84138	1.26
CP_3	13.35	418500	320400	98100	1.31
CP_4	13.52	420700	230511	190189	1.83
CP_5 (control)	11.33	357900	288629	69271	1.24

Average Price (Tk/Kg): Rice 30, Mustard 50, Lentil 90 and Sesame 65.

was 4.22 t/ha to 4.80 t/ha and straw yield was 4.40 t/ha to 5.10 t/ha. Which was consistent with the present result. Heera gained a yield of 7.08 t/ha in grain and 10.14 t/ha in straw. Tiongco and Hossain, (2015) reported that, Heera is a very popular grown dry season (*boro*) rice and its mean grain yield was 7.632 t/ha. Variation of yield in Heera rice in the pattern (CP_5) may have happened due to cultural, environmental and fertilizer management practices.

Within the studied cropping patterns (CP_1 - CP_5) highest rice equivalent yield (REY) was observed (Table 4) with CP_1 (14.46 t/ha) followed by CP_4 (13.52 t/ha) and CP_3 (13.52 t/ha). Pattern (CP_4) under control (farmers practice) produced the lowest REY (11.33 t/ha). Greater REY is not always an indication of improved or profitable cropping pattern; rather it depends on the type, market value and crop sequence.

Economic analysis

Highest gross return (Tk. 4,52,000) was obtained from CP_1 (Table 4) followed by CP_4 (Tk. 4,20,700), CP_3 (Tk. 4,18,500) and CP_2 (Tk. 4,08,600). The control pattern had a gross return of Tk. 3,57,900. On the other hand, maximum gross margin (Tk. 1,90,189) and MBCR (1.83) was obtained from the cropping pattern CP_4 followed by CP_1 (Tk. 1,25,684 and MBCR 1.39), CP_3 (Tk. 98,100 and MBCR 1.31) and CP_2 (Tk. 84,138 and MBCR 1.26). Whereas, the control pattern produced the minimum gross margin (Tk. 69,271) and MBCR (1.24). In CP_4 higher MBCR was gained as it expensed the minimum amount of variable cost (Tk. 1,90,189) resulting in increased BCR.

Farmers' opinion

Farmers opined that a pulse or oil crop could be grown successfully after cutting *aman* rice. Some of them were interested to cultivate mustard through zero tillage. Finally, they realized the importance growing pulse and oil crops for higher economic benefits. The also said, Mustard, lentil and sesame being a field crop and requirement of less input cost it will be profitable. They widely cultivate Shorna for its taste, flavor and market price and Heera for higher yield.

CONCLUSION AND RECOMMENDATIONS

From the results it can be concluded that, for magura region CP_4 =T.Aman (cv. Binadhan-17)- Lentil (cv. Binamasur-8)-Sesame (cv. Binatil-3) may be a suitable cropping sequence over the existing *Aman* rice – *Boro* rice – fallow cropping pattern. Contrary, the lag phase between sesame and *aman* rice in CP_4 can be exploited for cultivation of short duration vegetables. As CP_4 incorporates all the modern high yielding and short duration varieties. By adopting this pattern farmers of this region will gain higher yield, profit and ensure the maximum utilization of land and time. Though this research explored only a limited area of Magura sadar upazila; further verification and investigation is required for more authentication of the above outcomes.

ACKNOWLEDGEMENT

The authors would like to express heartfelt thanks and gratitude to Md. Abu Saeed, ASO; Mrinal Kumar Shil, JEO; ASM Mushfiqur Rahim, SA-1, Akash Ahmed, Field Man; Md. Jahangir, PO and labors of BINA Sub-station, Magura for their utmost cooperation during the entire research work. Authors also acknowledge the contribution of central revenue budget of Bangladesh Institute of Nuclear Agriculture (BINA) for funding this experiment.

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