Peertechz

LIFE SCIENCES GROUP

ANNALS OF Environmental Science and Toxicology OPEN ACCESS JOURNAL

ISSN: 2641-2969 DOI: https://dx.doi.org/10.17352/aest

Research Article

Improving crop productivity in low land through crop intensification in Bangladesh

MAK Mian[1]* and AA Begum[2]

[1]Chief Scientific Officer (Research Wing), BARI, Gazipur, Bangladesh

[2]Principal Scientific Officer (Agronomy Division), BARI, Gazipur, Bangladesh

Received: 07 December, 2023
Accepted: 08 January, 2024
Published: 09 January, 2024

***Corresponding author:** MAK Mian, Chief Scientific Officer (Research Wing), BARI, Gazipur, Bangladesh, E-mail: khayer66@gmail.com ; mianmd.abulkhayer@yahoo.com

Keywords: Productivity; Low land; Rice; Non-rice crops; Cropping pattern

https://www.peertechzpublications.org

Check for updates

Abstract

Two experiments were conducted at Chalan Beel (Experiment-1: Sirajgonj) and at Monglar Beel (Experiment-2: Faridpur) to improve the rice-based cropping system in the lowlands during 2021 - 2022. Treatments of Experiment 1 were four cropping patterns, T_1 = Mustard-*Boro* rice, T_2 = Mustard-Jute, T_3 = Potato-*Boro* rice, and T_4 = Fallow-*Boro* rice. Treatments of Experiment 2 were four cropping patterns viz. T_1 = Onion-Jute, T_2 = Onion-Broadcast *aman* (B. *aman*) rice, T_3 = Lathyrus- B. *aman* rice and T_4 = Fallow-*Boro* rice. Experiments were conducted in an RCB design with five dispersed replications. Crops in the patterns were sown/planted/transplanted timely in the growing season. Cultural management was done as and when necessary as per the recommendation of each crop. All relevant data was collected and analyzed systematically. The results of Experiment 1 revealed that Mustard-Jute and Potato-*Boro* rice cropping patterns were found to be superior in respect of productivity and economic returns as compared to existing cropping patterns (*ie.* Fallow-*Boro* rice cropping pattern). The findings of Experiment 2 indicated that Onion-Jute and Onion-B. *aman* rice were found as the most productive cropping pattern with better economic benefits over existing cropping patterns (*i.e.* Fallow-*Boro* rice cropping pattern). Farmers are interested to adopt in these improved cropping patterns in the beel area. They will get more economic returns. The total food production of the country will be enhanced through the adoption of these improved cropping patterns.

Introduction

The Beel area (Lowland goes underwater and remains underwater for about 4 months - 5 months generally from July to November) is under an unfavourable ecosystem covering an area of 2.43 million hectares in Bangladesh [1]. Water depth varies from 1 m to 3 m during the flooding period in the beel area [2]. It is a climatic hot spot area and more vulnerable to climate change effects [3]. Bangladesh has experienced a climate change effect on crop production [4]. Agricultural scientists and researchers are trying to increase food production in the country to cope with the climate change effect. Storms, cyclones, drought, unpredicted and heavy rainfall, high temperatures, salinity intrusion, river erosion, waterlogging, and flooding are the effects of climate change [3]. Every now and then, heavy rainfall and early flooding cause crop (*boro rice*) damage in the beel area [5]. Beel is less productive as compared to upland cropping and remains fallow for most of the part of the year [6,7]. The cropping patterns of Bangladesh are usually rice-based [8]. *Boro* rice is the main crop in the beel area but it requires a huge amount of water resources [9]. Research findings indicated that broadcast *aman* (B. *aman*) could be grown after *boro* rice in some parts of Bangladesh [10]. There is little scope for improvement of the cropping system in low land and it is very critical or hard work because rice is often only the crop on the low land [8]. However, previous research findings indicate that there is a possibility of improving the rice-based cropping system through the inclusion of short-duration non-rice crops in the existing pattern of beel area (medium low land) for higher productivity as compared single *boro* rice (monoculture) [5]. Moreover, the adaptation of short-duration non-rice crops in the rice-based cropping system along with their improved production technologies will enhance food crop production in the country [10,11].

Citation: Mian MAK, Begum AA (2024) Improving crop productivity in low land through crop intensification in Bangladesh. Ann Environ Sci Toxicol 8(1): 001-005. DOI: https://dx.doi.org/10.17352/aest.000074

Previous surveys and experience indicate that farmers grow mustard, pea, maize, wheat, onion, garlic, lentil, lathyrus, and potato in the beel area especially upper side land (Kandha) or upper Catena of beel [12,13]. Mustard, onion, potato, pea, and maize are five important non-rice crops in Bangladesh. Adaptation and dissemination of mustard cultivation in the Mustard-*Boro* rice cropping pattern in the beel area can supplement the edible oil demand of the country and also can save foreign currency for importing edible oil. Moreover, soybean oil has some disadvantages and side effects on human health like exposure to carcinogens, chronic inflammation, throat itch, mineral deficiencies, and block of protein digestion [14]. Onion is an important nutritious and medicinal spice. It is rich in folic acid, vitamin C, calcium, phosphorus, zinc, vitamin $B_{6,}$ and other minerals [9].

Recently two years, the price of onion has gone up higher and it is a burning issue to reduce onion market price by increasing country production. Potato, pea, and maize are three important non-rice food crops, and they are important for diversified food consumption and changing food habits as nutritional aspects. Potato is a starch-rich nutritious vegetable and pea is a good source of plant protein. Maize has diversified uses as human, poultry, and fish feed, animal food, and fodder [15]. Therefore, the development and adaptation of new cropping patterns including these non-rice crops in the rice-based cropping system is imperative to enhance food security as well as the national security of the country. However, rice will not be omitted from the developing new cropping patterns where more new crops will be added to the rice-based cropping system when total system productivity will be improved or increased. Indirectly, crop intensification/more cropping in the pattern will help to reduce more carbon from the atmosphere as a mitigation process [16]. Therefore, two experiments were undertaken to improve the rice-based cropping system through non-rice crops in the beel area of Bangladesh.

Materials and methods

Two Experiments were conducted at two locations (Chalan Beel, Sirajgonj, and Mongler Beel-Boalmari, Faridpur-Map attached in Annexture-1) to fulfil the objectives of the project. The experiments were conducted in RCB design with five replications. Treatments (cropping patterns) of Experiments were as follows:

Experiment -1. (Location: Chalan Beel, Sirajgonj)

T_1=Mustard-*Boro* rice

T_2=Mustard- Jute

T_3=Potato-*Boro* rice

T_4=Fallow-*Boro* rice

Experiment -2. (Location: Monglar Beel, Faridpur)

T1=Onio-Jute

T2=Onion-(broadcast *aman*) B. *aman* rice

T3=Lathyrus- B. *aman* rice

T4=Fallow-*Boro* rice

The crops were sown/planted/transplanted in season timely. Fertilization (Table 1) [17], irrigation, weeding, and other management were done as per the recommendation of each crop [13,18]. Mustard, potato, and onion required 1, 2-3, and 2-3 times flood irrigation respectively depending on available soil moisture. *Boro* rice requires 6 - 8 times flooding irrigation depending on rainfall. Jute requires one irrigation for germination of seed. B. *aman* needed no irrigation. One time weeding was done for winter crops. Jute crop needed 2 times weeding at 15 Days After Emergence (DAE) and 40 DAE. *Boro* rice and B. *aman* rice needed one weeding at 30 days - 45 days after transplanting or sowing. Lathyrus needed no fertilizer, weeding, or irrigation. Crops were harvested at maturity. Relevant data was collected carefully and analyzed accordingly. Economic evaluation was done for each cropping pattern. Farmers' opinions about improved (new) cropping patterns were recorded and reflected in the report. Rice Equivalent Yield (REY) and Production Efficiency (PE) were calculated as follows.

Rice Equivalent Yield (REY): (Yield crop ×price of crops)/ price of rice

Production Efficiency (PE): REY/365

Results and discussion

Location: Chalan beel, (Dobila), Sirajganj

The average yield of mustard, potato, *boro* rice, and jute is given in Table 2. The yield of mustard varied from 1.497-1.501 t/ha in T_1 and T_2 (Table 2). Jute fiber yield was obtained at 4.85 t/ha and potato tuber yield was 16.77 t/ha (Table 2). Potato tuber yield was noticed to lower because of short duration variety and early harvesting of potatoes to get the opportunity of *boro* rice transplanting season. The results have been supported by Mian, et al. [19]. *Boro* rice yield (3.45-3.59 t/ha) was lower in

Table 1: Nutrient doses for different crops in the patterns.

Crops in the pattern	(kg/ha)					
	N	P	K	S	Zn	B
Mustard	30	9	32	5	1.5	1
Potato	90	20	100	10	2.5	2
Onion	100	30	110	16	3	2
Lathyrus	-	-		-	-	-
Jute	60	10	30	10	2	1
Boro rice	120	25	100	18	3	1.5
B. *aman* rice	30	10	30	8	1.5	1.0

Table 2: Yield performance of crops in the cropping patterns at Chalan Beel (Dobila), Sirajganj (2021-2022).

Treatment (Cropping pattern)	Yield of Crops (t/ha)					
	Mustard	Potato	*Boro* rice		Jute	
			Grain	Straw	Fiber	Stick
T_1 = Mustard-*Boro* rice	1.497	-	3.59	4.63	-	-
T_2 = Mustard-Jute	1.501	-			4.85	5.91
T_3 = Potato-*Boro* rice	-	16.77	3.45	4.57	-	-
T_4 = Fallow-*Boro* rice	-	-	4.97	6.13	-	-

Citation: Mian MAK, Begum AA (2024) Improving crop productivity in low land through crop intensification in Bangladesh. Ann Environ Sci Toxicol 8(1): 001-005. DOI: https://dx.doi.org/10.17352/aest.000074

T_1 and T_3 as compared to T_4 due to later transplanting of *boro* rice in T_1 and T_3 (Table 2). Growing mustard and potato delayed the transplanting of *boro* rice in T_1 and T_3. The results are in agreement with the report of BARI [18]. However, *boro* rice yield was obtained at 4.97 t/ha in T_4 due to optimum transplanting time. Rice Equivalent Yield (REY) and Production Efficiency (PE) are presented in Table 3. The mustard-Jute cropping pattern (T_2) gave the highest REY (14.58 t/ha) and PE (39.95 kg/ha/day) followed by the Potato-*Boro* rice cropping pattern (T_3) (Table 3) but lower values of REY and PE were noticed in T_4. The results revealed that all cropping patterns showed better performance over existing cropping patterns like Fallow-*Boro* rice (T_4) with respect to REY and productivity (PE). The inclusion of non-rice crops in the rice-based cropping system enhanced crop productivity in the system. Similar results also have been reported by Kakon, et al. [11] and Mian, et al. [19]. T_2, T_3, and T_1 patterns showed 165%, 149%, and 39% higher productivity as compared to T_4. Gross return (Tk. 466140 - 495720/ha), gross margin (Tk. 258970 - 292560/ha), and BCR (2.25 - 2.44) were also recorded higher in T_2 and T_3 cropping patterns (Tables 4,5). However, Mustard-Jute and Potato-*Boro* rice cropping patterns were found superior with respect to productivity and economic returns as compared to existing cropping of Fallow-*Boro* rice cropping (T_4). The results have been supported by the findings of Ayesha, et al. [20] and BARI [21].

The bulb yield of onion (20.89-21.07 t/ha) was good in T_1 and T_2 at Monglar Beel, Faridpur (Table 6). Jute fiber and stick yield were 4.93 t/ha and 6.02 t/ha respectively in T_1 (Table 7). Lathyrus yield was 1.68 t/ha and broadcast *aman* (B.*aman*) rice grain yield was 2.47 t/ha in T_3 while B.*aman* rice grain yield was noticed lower (1.42 t/ha) in T_2 (Table 6). Pulse crops like lathyrus inclusion in the cropping pattern (T_3) enhanced the yield of B.*aman* rice. Similar results have been described by Ayesha, et al. [20]. *Boro* rice grain yield was observed at 4.93 t/ha in T_4 (Table 7). Rice equivalent yield (REY: 16.84 t/ha) and production efficiency (PE:46.14 kg/ha/day) were computed higher values in the Onion-Jute cropping pattern (T_1) followed by Onion-B.*aman* (T_2) rice cropping pattern while the lowest value was observed in Fallow-*Boro* rice cropping pattern T_4 (Table 7). The results indicated that the inclusion of non-rice crops in the rice-based cropping system increased productivity. Productivity increased 208%, 165%, and 9% respectively in T_1, T_2, and T_3 respectively over T4 (Fallow-*Boro* rice) cropping pattern. Similar results have been described by Mian, et al. [19]. Economic evaluation is shown in Table 8. Higher gross return (Tk. 572560/ha), and gross margin (Tk. 193710/ha) were calculated in T_1 followed by T_2 (Table 8). T_3 and T_4 showed higher BCR but with lower gross return and gross margin. Lower gross return and gross margin happened in T_3 and T_4

Table 3: Rice equivalent yield and production efficiency (PE) of the cropping patterns at Chalan Beel (Dobila), Sirajganj (2021-2022).

Treatment (Cropping pattern)	REY (t/ha)	PE (kg/ha/day)
T_1 = Mustard-*Boro* rice	7.68	21.04
T_2 = Mustard-Jute	14.58	39.95
T_3 = Potato-*Boro* rice	13.71	37.56
T_4 = Fallow-*Boro* rice	5.51	15.10

Table 4: Cost and return analysis of the cropping patterns at Chalan Beel (Dobila), Sirajganj (2021-2022).

Treatment (Cropping pattern)	Gross return (Tk./ha)	Cost of production (Tk./ha)	Gross margin (Tk./ha)	BCR
T_1 = Mustard-*Boro* rice	261120	199330	61790	1.31
T_2 = Mustard-Jute	495720	203160	292560	2.44
T_3 = Potato-*Boro* rice	466140	207170	258970	2.25
T_4 = Fallow-*Boro* rice	261120	119320	68020	1.57

Table 5: Market price of crops, straw, and input in the cropping patterns at Chalan Beel (Dobila), Sirajganj (2021-2022).

Sl. No.	Crops/straw	Price (Tk./kg)	Price (Tk./t)
1	Mustard seed	80	80000
2	*Boro* rice grain	34	34000
3	*Boro* rice straw	3	3000
4	Jute Fibre	75	75000
5	Jute stick	2	2000
6	Potato tuber	20	20000
Input			
7	Labour	450.00/day	-
8	Urea	18.30/kg	-
9	TSP	26.00/kg	-
10	MoP	16.00/kg	-
11	Gypsum	15.00/kg	-
12	Zinc Sulphate	230.00/kg	-
13	Boric Acid	250.00/kg	-
14	Tillage	1000/33 decimal	-
15	Irrigation	1500/33 decimal	-
16	Mustard seed	80.00/kg	-
17	*Boro* rice seed	40.00/kg	-
18	Jute seed	200.00/kg	-

Table 6: Yield performance of crops in cropping patterns at Monglar Beel, Faridpur (2021-2022).

Treatment (Cropping pattern)	Onion	Lathyrus	Rice	
	Onion bulb yield (t/ha)	Seed yield (t/ha)	*Boro* rice/ B.*aman* rice grain yield (t/ha)	*Boro* rice / B.*aman* straw yield (t/ha)
T_1 = Onion-Jute	21.07	-	-	-
T_2 = Onion-B. *aman* rice	20.89	-	1.42	2.38
T_3 = Lathyrus-B. *aman* rice	-	1.68	2.47	2.87
T_4 = Fallow-*Boro* rice	-	-	4.93	6.02

Table 7: Yield performance of crops in cropping patterns at Monglar Beel, Faridpur (2021-2022).

Treatment (Cropping pattern)	Jute		Rice equivalent yield (t/ha)	PE (kg/ha/day)
	Jute fiber yield (t/ha)	Jute stick yield (t/ha)		
T_1 = Onion-Jute	4.93	6.02	16.84	46.14
T_2 = Onion-B. *aman* rice	-	-	14.49	39.70
T_3 = Lathyrus-B. *aman* rice	-	-	5.98	16.38
T_4 = Fallow-*Boro* rice	-	-	5.46	14.96

Citation: Mian MAK, Begum AA (2024) Improving crop productivity in low land through crop intensification in Bangladesh. Ann Environ Sci Toxicol 8(1): 001-005. DOI: https://dx.doi.org/10.17352/aest.000074

because of lower productivity. On the contrary, higher BCR occurred in T_3 and T_4 due to low production cost involvement in T_3 and T_4 (Table 9) as compared to other cropping patterns. T_3 and T_4 cropping patterns were not encouraging because of lower productivity and lower economic returns although they showed higher BCR (1.54 - 1.67) than other cropping patterns. However, Onion-Jute and Onion-B. *aman* rice were found as the most productive cropping pattern with better economic benefits over existing cropping patterns.

Conclusion

Mustard-jute and Potato-*Boro* rice cropping patterns were found superior with respect to productivity and economic returns as compared to the existing cropping of the Fallow-*Boro* rice cropping pattern at the Chalan Beel area (Sirajgonj).

Table 8: Cost and return analysis of cropping pattern at Monglar Beel, Faridpur (2021-2022).

Treatment (Cropping pattern)	Gross return (Tk./ha)	Cost of production (Tk./ha)	Gross margin (Tk./ha)	BCR
T_1 = Onion-Jute	572560	378850	193710	1.51
T_2 = Onion-B. *aman* rice	492660	332800	159860	1.48
T_3 = Lathyrus-B. *aman* rice	203320	121740	81580	1.67
T_4 = Fallow-*Boro* rice	185640	120860	64780	1.54

Table 9: Market price of crops, straw, and input in the cropping patterns at Monglar Beel, Faridpur (2021-2022).

Sl. No.	Crops/straw	Price (Tk./kg)	Price (Tk./t)
1	Onion bulb	20	20000
2	*Boro* rice grain	34	34000
3	*Boro* rice straw	3	3000
4	B.*aman* rice grain	38	38000
5	B.*aman* rice straw	3	3000
6	Jute Fibre	75	75000
7	Jute stick	2	2000
8	Lathyrus seed	60	
Input			
9	Labour	450.00/day	-
10	Urea	18.30/kg	-
11	TSP	26.00/kg	-
12	MoP	15.00/kg	-
13	Gypsum	12.00/kg	-
14	Zinc Sulphate	230.00/kg	-
15	Boric Acid	250.00/kg	-
16	Tillage	1000/33 decimal	-
17	Irrigation	1500/33 decimal	-
18	Potato seed	32.00/kg	-
19	Mustard seed	80.00/kg	-
20	*Boro* rice seed	40.00/kg	-
21	Jute seed	200.00/kg	-
22	Onion seed	3000.00/kg	-
23	Lathyrus seed	60.00/kg	-

Again, Onion-Jute and Onion-B. *aman* rice were found as the most productive cropping pattern with better economic benefit in the Monglar Beel area (Faridpur). Farmers are interested to adopt in these improved cropping patterns in the beel area. They will get more economic returns.

Acknowledgement

The researcher acknowledged the relevant authority of the Ministry of Science and Technology for providing a research grant (SRG-221007).

(Annexture)

References

1. Aziz MA, Alom MS, Mian MAK, Chowdhury JA, Begum AA. Unfavourable ecosystem: Crop production under Hill and Haor ecosystem (Book). Agronomy Division. Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. 2016; 1701: 114.

2. Mostafa ARH, Nahiduzzaman M, Abu Sayeed M, Ekram Azim M, Abdul Wahab M, Paul G. The Chalan beel in Bangladesh: Habitat and biodiversity degradation, and implications for future management. Lakes & Reservoirs: Research and Management. 2009; 14: 3–19.

3. Abedin MA. Climate Change impacts on agriculture in climate hot spots areas of Bangladesh. In Train Manual: Climate Change, Carbon Sequestration and Adaptation Strategies (4th batch). BARC, Farmgate Dhaka. 2021; 12015: 57-66.

4. Mian MAK, Islam MR, Hossain J. Assessing agro-climatological model of summer munbean. Bull Inst Trop Agr Kyushu Univ. 2019; 42:12-22.

5. Rashid MM, Yasmeen R. Cold injury and flash flood damage in boro rice cultivation in Bangladesh: A review. Bangladesh Rice J. 2017; 21(1): 13-25.

6. Islam MN, Hossain MA, Mohiuddin M, Mian MAK, Biswas M, Akteruzzaman M. Crops and cropping of char areas in Bangladesh. Bangladesh Agron J. 2012; 15(2):1-10.

7. BARC (Bangladesh Agril. Res. Coun.). In: KGF BKGET Project brief (TF 07 C). KrishiGobeshona Foundation. BARC. Farmgate. Dhaka. 2013; 1215:2.

8. Nasim M, Shahidullah SM, Saha A. Bangladesh Rice J. Bangladesh Rice Res Inst. (BRRI). Gazipur. 2017; 1017: 21(2):1-55.

9. Mian MAK, Begum AA, Kakon SS. Onion production technology in low land (In Bangle). Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. 2020; 1701: 16.

10. Mian MAK, Alom MS, Begum AA. Suitable Agronomic technology for beel area (In Bangle). Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. 2017; 1701: 18.

11. Kakon SS, Chouwdhury JA, Mian MAK. Improvement of existing cropping pattern in Chalanbeel area (In Bangle). Agromony division, Bangladesh Agricultural Research Institute (BARI), Gazipur. 2020; 1701: 24.

12. BARI (Bangladesh Agril Res Inst) 2016. Survey on crops and cropping at Chalon beel areas of Bangladesh. In: Annual research Report. Agronomy Division. BARI. Gazipur 1701. PP.171-180.

13. BARI (Bangladesh Agril Res Inst) 2017. Improvement of cropping system. In: Annual Report. On-Farm Research Division, BARI. Gazipur. 1701. PP.89-175.

14. Tarantino O. Eat this, Not that. 14 Things that happen to your body when you eat soy. (https://www.eat this.com/soy-side-effects/visited on 27 June 2021). 2016.

Citation: Mian MAK, Begum AA (2024) Improving crop productivity in low land through crop intensification in Bangladesh. Ann Environ Sci Toxicol 8(1): 001-005. DOI: https://dx.doi.org/10.17352/aest.000074

15. Islam MR, Hoshain S. A brief review on the present status, problems, and prospects of maize production in Bangladesh. Res Agric Livest Fish. 2022; 9(2): 89-96.

16. Haughey E, Neogi S, Portugal-Pereira J, Diemen VR, Slade RB. Sustainable intensification and carbon sequestration research in agricultural systems: A systematic review. Environmental Science and Policy. ELSEVIER. 2023; 143:14-23.

17. BARC (Bangladesh Agricultural Research Council) 2018. Fertilizer Recommendation Guide. BARC, Farmgate Dhaka. 2018; 1215:73-109.

18. BARI (Bangladesh Agril Res Inst) 2019. Improvement of cropping system. In: Annual Report. On-Farm Research Division, BARI. Gazipur 1701; 83-200.

19. Mian MAK, Kakon SS, Begum, Choudhury JA. Effect of management practices on potato at Chalan Beel area. In: Annual Report. Agronomy Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. 2022; 1701:301-303.

20. Ayesha F, Singh VK, Babu S, Singh RK, Upadhyay PK, Rathore SS, Kumar B, Hasanain M, Parween H. Food production potential and environmental sustainability of different integrated farming system models in northwest India. Indian Agricultural Research Institute, Division of Agronomy. Front Sustain Food Syst. 2023; 7: (https://doi.org/10.3389/fsufs.2023.959464).

21. BARI (Bangladesh Agril Res Inst.) 2020. Improvement of cropping system. In: Annual Report. On-Farm Research Division, BARI. Gazipur. 1701: 69-298.

Citation: Mian MAK, Begum AA (2024) Improving crop productivity in low land through crop intensification in Bangladesh. Ann Environ Sci Toxicol 8(1): 001-005. DOI: https://dx.doi.org/10.17352/aest.000074