OPEN ACCESS
Saudi Journal of Economics and Finance
Abbreviated Key Title: Saudi J Econ Fin
ISSN 2523-9414 (Print) |ISSN 2523-6563 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: http://saudijournals.com

Original Research Article

Economic Study of Aman Rice Variety Binadhan-17 Production in Some Selected Areas of Bangladesh

Md. Mohsin Ali Sarkar[1*], Md. Habibur Rahman[2], Mohammad Rashidul Haque[1], Syful Islam[3], Razia Sultana[3]

[1]Senior Scientific Officer, Agricultural Economics Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh
[2]Principal Scientific Officer, Agricultural Economics Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh
[3]Scientific Officer, Agricultural Economics Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh

DOI: 10.36348/sjef.2021.v05i11.002 | **Received:** 28.09.2021 | **Accepted:** 04.11.2021 | **Published:** 11.11.2021

***Corresponding author:** Md. Mohsin Ali Sarkar

Abstract

This study was conducted to analyze the profitability of Aman rice Binadhan-17 producing farmers in Sunamganj, Rangpur, Gopalganj, Pabna and Magura districts of Bangladesh. This study was based on primary data which were collected from 200 Binadhan-17 producing farmers. In the sampled areas data were collected through pre-designed interview schedule from November-December, 2019 for achieving the purpose. In the study, costs and return analysis were done on both cash cost and full cost basis for estimating profitability. The cultivation of Binadhan-17 was profitable from the viewpoint of the farmers. The study found that Binadhan-17 production is profitable. The average net return per hectare was Tk. 34207.56. The net return was highest in Rangpur (Tk. 38536.88/ha) followed by Magura (Tk. 36091.84/ha), Gopalganj (Tk. 35783.18/ha), Pabna (Tk. 32345.11/ha) and Sunamganj (Tk. 28280.80/ha) respectively. Benefit cost ratio was 1.47 and 2.17 on full cost and cash cost basis implying that the Binadhan-17 cultivation at farm level was profitable. Cobb-Douglas production function was chosen to determine the factor affecting gross return of Binadhan-17 production. All of the factors namely, human labour cost, power tiller cost, seed cost, fertilizer cost and insecticides cost were statistically significant and positive. The regression coefficients of irrigation cost for Binadhan-17 under all areas were positive but not significant. The farmers in the study areas encountered some constraints to Binadhan-17 production. The first ranked constraint was unavailability of seeds in all areas (84%). Other constraints were lack of training (64%), lack of technical know-how (38%), lack of capital (30%), lack of storage facility (17%), natural calamities (14%) and low education level of farmers (10%). The economic return of Binadhan-17 production encouraging to the farmer's for more cultivation.

Keywords: Aman rice, Binadhan-17, Profitability, Factors affecting, Cobb-Douglas production function, Constraints.

INTRODUCTION

Rice is the backbone of Bangladesh's agriculture; here, like in many other countries, 'food security' almost entirely depends on 'rice security' (Brolley M, 2015); it alone contributes about 4.5% to the GDP (BBS, 2020). Rice is one of the dominant cereal dietary items of almost 15 million farm families (BBS, 2015) in Bangladesh. It provides one-sixth of rural household income, half of the rural employment (nearly 48%), two-thirds of per capita daily calorie intake, and half of per capita daily protein intake (Rahman F *et al.*, 2016). About 81 percent of the total cropped area and over 80 percent of the total irrigated area is planted to rice. Approximately 96 percent share of the total cereal supply comes from rice alone (Alam MS *et al.*, 2013).

Rice is the single crop which plays the most important contribution to GDP, income and employment generation and meets the challenges to self sufficiency in food production (Hasnain MN *et al.*, 2015). Bangladesh is autonomous in rice (Mainuddin M *et al.*, 2015; Timsina J *et al.*, 2018). Production with an average per capita consumption of 134 kg per annum, compared to the world average of 57 kg per annum (Mottaleb KA *et al.*, 2016). It is the most leading crop and produces a major distribute of farmers' income and employment (Sarker MAR *et al.*, 2012; Alam MJ *et al.*, 2016). In Bangladesh, rice is grown in three distinct seasons; namely Boro (January to June), Aus (April to August) and Aman (August to December) (Bapari MY

et al., 2016). It is grown in four ecosystems viz., irrigated rice (Boro), rainfed or partially irrigated (transplanted Aus and Aman), rainfed upland (direct-seeded Aus), and deepwater (broadcast Aman).

Agriculture is the dominant sector of Bangladesh economy. It provides nearly 48 percent of rural employment, about two-thirds of total calorie supply and about one-half of the total protein intakes of an average person in the country. Besides, rice provides 76 percent of the people's average calorie intake and 66 percent of protein intake consumption. The country is now producing about 33.0 million tons to feed 160 million people (Barmon BK *et al.*, 2012). This indicates that the growth of rice production was much faster than the growth of population (Sarker MNI 2017). Food self-sufficiency mostly depends on rice production. The total contribution of the rice production is about 70 percent of the total agricultural contribution to GDP. Thus, it is often argued that self-sufficiency in food might be attained by enhancing the overall productivity of rice (Chowdhury NT 2013). Considering the food habit of the people of Bangladesh, 'rice security' should also address the 'nutrition security'. In this country, rice is not only the carbohydrate-supplying food, but also the major provider of protein, micronutrients, and health benefits. Antioxidants supplied by rice contribute to relieving oxidative stress, and preventing cancer, cardiovascular problems and complications of diabetes (Shozib HB *et al.*, 2020).

Aman is one of the most important crops in Bangladesh. Two types of Aman rice are grown in this country. One is called broadcast Aman which is sown in the month of mid March to mid April in the low lands and another is transplant Aman, which is planted during late June to August. At present it is the second largest crop in the country in respect of the volume of production after boro rice. Binadhan-17 is such type of short duration (life cycle 112-118 days) Aman rice variety which contributes significantly in changing farmer's income and employment generation and meets the challenges to self sufficiency in food production. It is notable that the area coverage of Aman is the largest as a single crop and boro remains the second in Bangladesh. Total Aman production areas are increasing day by day after introducing of this variety.

There are some studies about the profitability of rice production in Bangladesh (Anik A. R. 2003; Ismail MH *et al.*, 2010; Khan M. B. 2005; Mondal R. K. 2005; Tasnoova S *et al.*, 2006; Rahman M. C *et al.*, 2015; Noonari S *et al.*, 2015; Islam Z *et al.*, 2017; and Bwala M. A *et al.*, 2018). The present study is important for rice production in Bangladesh. The study not only analyses the profitability but also identify factors affecting gross return and the farmer's major constraints about rice productions. The results of the study will be helpful to the policy maker to formulate future policy considering farmers production constraints and the researcher for further study about rice farming in Bangladesh. The specific objectives of the study were i) to estimate the profitability of Binadhan-17 producers; ii) to assess the factors affecting gross return of Binadhan-17 and iii) to identify the major constraints to Binadhan-17 production.

MATERIALS AND METHODS

Selection of the study area, sample size and sampling technique

This study was conducted in the five districts namely Sunamganj, Rangpur, Gopalganj, Pabna and Magura in Bangladesh. A total of 200 Binadhan-17 farmers taking 50 farmers from each districts were randomly selected with the help of Department of Agricultural Extension (DAE) personnel for interview. Field investigators under the direct supervision of the researchers collected field level cross sectional data using pre-tested interview schedule.

Method of data collection and period of study

Data for the present study were collected from sample Binadhan-17 farmers through face to face interview method using a pre-tested interview schedule. Field level primary data were collected by the researcher with the help of trained enumerators for the period of November-December, 2019.

Analytical techniques

Collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. The data were analyzed with the help of suitable statistical measures as frequencies, percentages, mean and standard deviation. Descriptive statistics were used to analyze and compare the socioeconomic characteristics. The total cost was composed of total variable costs (TVC) and total fixed costs (TFC). The gross return (GR) was computed as total mustard output multiplied by the market price of Binadhan-17. Profits or gross margin (GM) was defined as GR-TVC, whereas the net return (NR) was defined as GR-TC. Finally, the Benefit Cost Ratio (BCR) was computed as GR/TC (Begum MEA *et al.*, 2019).

Statistical Analysis

The following Cobb-Douglas type production function was used to estimate the parameters. The functional form of the Cobb- Douglas multiple regression equation was as follows:

$Y= AX_1^{b1}X_2^{b}2.....X_n^{bn}e^{ui}$

The production function was converted to logarithmic form so that it could be solved by least square method i.e.

$\ln Y= a+b_1 \ln X_1 + ... + b_n \ln X_n + e^{ui}$

The empirical production function was the following:

$\ln Y= a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + Ui$

Where,
Y = Yield/Gross return (kg/ha)
X_1 = Human labor (Man days/ha)
X_2 = Power tiller (Tk./ha)
X_3= Seed (kg/ha)
X_4=Fertilizer (kg/ha)
X_5= Irrigation (Tk./ha)
X_6= Insecticides (Tk./ha)
a= Constant value
b_1 b_2 ..... b_6= Co-efficient of the respective variables and
U_i= Error term.

RESULTS AND DISCUSSION

Cost of Binadhan-17 cultivation

The cost of human labour, power tiller, seed, fertilizers, pesticides, and irrigation were taken into consideration, while calculating cost of Binadhan-17 production. Beside this, interest on operating capital was also considered as the cost of Binadhan-17 production. Total cost consists of variable cost and fixed cost that covered 68.5% and 31.5% of total cost for Binadhan-17 production.

The average costs of Binadhan-17 cultivation were Tk. 72557.75 and Tk. 49678.95 per hectare on full cost and cash cost basis, respectively. The highest production cost was for human labour (57.2%), followed by power tiller (9.2%), land use (8.6%) and irrigation (6.6%). The cost of Binadhan-17 cultivation was found highest in Pabna (Tk. 74276.05/ha) followed by that in Magura (Tk. 73923.56/ha), Gopalganj (Tk. 71929.00/ha), Rangpur (Tk. 70898.73/ha) and Sunamganj (Tk. 69766.87/ha), respectively (Table 1).

Table 1: Per hectare cost of Binadhan-17 production in different locations

Cost component	Cost of production (Tk./hectare)					All areas	% of total cost
	Sunamganj	Rangpur	Gopalganj	Pabna	Magura		
(A) Variable Cost	**45466.87**	**48614.73**	**48507.00**	**50738.05**	**51787.56**	**49678.95**	**68.5**
Hired labour (Man days)	24404.49	24732.00	26543.00	26021.00	27859.00	26175.10	36.1
Power tiller	6410.00	6298.00	6534.00	7040.00	6817.00	6676.40	9.2
Seed	1037.40	907.73	824.00	778.05	972.56	933.66	1.3
Fertilizers:							
Urea	2519.40	2267.00	2413.00	2141.00	2393.00	2342.68	3.2
TSP	2778.75	2408.00	2552.00	2594.00	2864.00	2701.75	3.7
MP	629.85	703.00	698.00	667.00	652.00	660.77	0.9
Gypsum	355.68	385.00	424.00	445.00	402.00	397.94	0.5
Zinc	440.00	550.00	610.00	660.00	418.00	497.20	0.7
Cow dung	2223.00	3705.00	2456.00	3129.00	3479.00	3203.00	4.4
Pesticides	1111.50	1324.00	1365.00	1409.00	1267.00	1275.70	1.8
Irrigation	3556.80	5335.00	4088.00	5854.00	4664.00	4814.76	6.6
(B) Fixed Cost	**24300.00**	**22284.00**	**23422.00**	**23538.00**	**22136.00**	**22878.80**	**31.5**
Family labour	16269.00	15158.00	15831.00	15281.00	15001.00	15342.00	21.1
Int. on operating capital	1430.00	1325.00	1289.00	1529.00	1184.00	1330.40	1.8
Land use cost	6601.00	5801.00	6302.00	6728.00	5951.00	6206.40	8.6
Total Cost (A+B)	**69766.87**	**70898.73**	**71929.00**	**74276.05**	**73923.56**	**72557.75**	**100**

Source: Field survey, 2019

Return from Binadhan-17 production

The average return from Binadhan-17 production in different locations is shown in Table 2. The average yield of Binadhan-17 was 5789.83 kg/ha. The yield was highest at Rangpur (5976.32 kg/ha) followed by Gopalganj (5894.41 kg/ha), Magura (5802.80 kg/ha), Pabna (5692.62 kg/ha) and Sunamganj (5583.01 kg/ha). The total return from Binadhan-17 production consists of the values of Binadhan-17 and straw. The average gross margin was found Tk. 57343.56/ha on variable cost basis. Gross margin was highest in Rangpur (Tk. 60820.88/ha) followed by Gopalganj (Tk. 59205.18/ha), Magura (Tk. 58227.84/ha), Pabna (Tk. 55883.11/ha) and Sunamganj (Tk. 52580.80/ha), respectively. The average net return per hectare was Tk. 34207.56. The net return was highest in Rangpur (Tk. 38536.88/ha) followed by Magura (Tk. 36091.84/ha), Gopalganj (Tk. 35783.18/ha), Pabna (Tk. 32345.11/ha) and Sunamganj (Tk. 28280.80/ha), respectively. Benefit cost ratio was estimated at 1.47 and 2.17 on full cost and variable cost basis implying that the Binadhan-17 cultivation at farm level was profitable.

Table 2: Profitability of Binadhan-17 cultivation in different locations

Type	Study areas					All areas
	Sunamganj	Rangpur	Gopalganj	Pabna	Magura	
Yield from Binadhan-17 (Kg/ha.)	5583.01	5976.32	5894.41	5692.62	5802.80	5789.83
Return from Binadhan-17 (Tk./ha)	92119.67	104585.60	103152.18	102467.16	104450.40	101355.00
Return from straw (Tk./ha)	5928.00	4850.00	4560.00	4154.00	5565.00	5011.40
Total return (Tk./ha)	98047.67	109435.60	107712.18	106621.16	110015.40	106366.40
Total variable cost (Tk./ha)	45466.87	48614.73	48507.00	50738.05	51787.56	49022.84
Total Cost (Tk./ha)	69766.87	70898.73	71929.00	74276.05	73923.56	72158.84
Gross margin (Tk./ha)	52580.80	60820.88	59205.18	55883.11	58227.84	57343.56
Net return (Tk./ha)	28280.80	38536.88	35783.18	32345.11	36091.84	34207.56
Benefit Cost Ratio (BCR)						
BCR on full cost	1.41	1.54	1.50	1.44	1.49	1.47
BCR on variable cost	2.16	2.25	2.22	2.10	2.12	2.17

Source: Field survey, 2019

Factors affecting gross return of Binadhan-17 production

To determine the effects of the explanatory variables, linear and Cobb-Douglas model were initially estimated for Binadhan-17 rice production. Some of the key variables are explained according to Table 3 which is mentioned below:

Human labour cost (X_1)

Most of the parameters were statistically significant and positive. The regression coefficients of human labour cost for Binadhan-17 under all areas were positive and significant at 5 % level implying that the 1 percent increases in the labour use cost increase the gross return from rice by 0.287 percent. The regression coefficients of under Sunamganj, Rangpur, Gopalganj, Pabna and Magura districts were positive and significant. The coefficient of Sunamganj, Gopalganj and Pabna districts were significant at 5% level implying that the 1 percent increases in the labour use cost increase the gross return from rice by 0.099, 0.259 and 0.391 percent, respectively. The coefficient of Rangpur and Magura district was significant at one percent level and it was 0.234 and 0.224 percent, respectively. This indicated that 1 percent increase in human labour cost keeping other factors constant, would increase the gross returns by 0.234 and 0.224 percent.

Power tiller cost (X_2)

The regression coefficients of power tiller cost for Binadhan-17 under all areas were positive and significant at 5 % level implying that the 1 percent increases in the labour use cost increase the gross return from rice by 0.257 percent. The coefficient of power tiller cost in Rangpur and Magura district was 0.234 and 0.010, which was found to be significant at 5 percent level. It indicates that an 1 percent increase in power tiller cost keeping other factors constant would be able increase the gross returns by 0.234 and 0.010 percent, respectively. The coefficient of power tiller cost under Sunamganj, Gopalganj and Pabna districts were positive but not significant.

Seed cost (X_3)

The regression coefficients of seed use cost for Binadhan-17 under all areas were positive and significant at 10 % level implying that the 1 percent increases in the labour use cost increase the gross return from rice by 0.184 percent. The coefficient of seedling cost of the Binadhan-17 production was statistically significant at 5 percent level of significance for Gopalganj and Magura district. The result implies that 1 percent increase in the seedling cost for Gopalganj and Magura district, keeping other factors constant, would result in an increase in gross return from rice by 0.150 and 0.702 percent. The coefficient of seedling cost of the rice production was statistically significant at 10 percent level of significance for Sunamganj, Rangpur and Pabna districts were 0.620, 0.301 and 0.230. The result implies that 1 percent increase in the seedling cost for Sunamganj, Rangpur and Pabna districts farming systems, keeping other factors constant, would result increase in gross return from rice by 0.620, 0.301 and 0.230 percent, respectively.

Fertilizer cost (X_4)

The regression coefficients of fertilizer cost for Binadhan-17 under all areas were positive and significant at 10 % level implying that the 1 percent increases in the labour use cost increase the gross return from rice by 0.410 percent. The coefficient of fertilizer cost was statistically significant at 10 percent level of significance for Sunamganj and Pabna district. The result implies that 1 percent increase in the fertilizer cost for Sunamganj and Pabna district, keeping other factors constant, would result in an increase in gross return from rice by 0.257 and 0.280 percent. The coefficient of fertilizer cost under Rangpur, Gopalganj and Magura districts were positive but not significant.

Irrigation cost (X_5)

The regression coefficients of irrigation cost for Binadhan-17 under all areas were positive but not significant. The coefficient of irrigation cost in Rangpur and Pabna district was 0.050 and 0.079, which was found to be significant at 10 percent level. It indicates that an 1 percent increase in irrigation cost keeping other factors constant would be able increase the gross

returns by 0.050 and 0.079 percent, respectively. The coefficient of irrigation cost under Sunamganj, Gopalganj and Magura was positive but not significant.

Insecticides cost (X_6)

The regression coefficients of insecticides cost for Binadhan-17 under all areas were positive and significant at 5 % level implying that the 1 percent increases in the of insecticides cost increase the gross return from rice by 0.331 percent. The coefficient of insecticides cost in Sunamganj, Gopalganj and Pabna districts were 0.258 0.184 and 0.221, which was found to be significant at 5 percent level. It indicates that an 1 percent increase in insecticides cost keeping other factors constant would be able increase the gross returns by 0.258 0.184 and 0.221 percent, respectively. The coefficient of insecticides cost was statistically significant at 10 percent level of significance for Rangpur and Magura district was 0.181 and 0.480. The result implies that 1 percent increase in the insecticides cost for Rangpur and Magura districts, keeping other factors constant, would result increase in gross return from rice by 0.184 and 0.480 percent, respectively.

Coefficient of multiple determination (R^2)

The coefficient of multiple determination (R^2) tells how well the sample regression line fits the data. It is evident the values of R^2 were 0.738, 0.790, 0.770, 0.820 and 0.835 for Sunamganj, Rangpur, Gopalganj, Pabna and Magura districts, respectively. This means that around 74, 79, 77, 82 and 84 percent of the variations in gross return for Binadhan–17 rice, respectively were explained by the independent variables included in the model.

F-value

The F-values of Sunamganj, Rangpur, Gopalganj, Pabna and Magura districts were 8.950, 9.267, 8.436, 10.114 and 11.238 which were highly significant at 1% level of probability implying that all the explanatory variables were important for explaining the variations in gross returns of the Binadhan–17 variety in the study area.

Return to Scale

The summation of all the production coefficient indicates return to scale. The sum of elasticity coefficients were 1.015, 1.056, 1.020, 1.078 and 1.034 in case of Binadhan–17 meaning increasing returns to scale. This means that, 1 percent increase in all inputs simultaneously would result on average 1.015, 1.056, 1.020, 1.078 and 1.034 percent increase in gross return of Binadhan–17. This value being greater than 1 means that the farmers are operating at the region of increasing return to scale. More clearly, the farmers still have the scope to allocate more inputs in their rice field as it will generate a higher return than production cost.

Table 3: Estimated values of regression co-efficient and related statistics of Cobb-Douglas revenue type production function for Binadhan–17 production

Explanatory variables	Study areas										All areas	
	Sunamganj		Rangpur		Gopalganj		Pabna		Magura			
	Estimated Co-efficient	T- values	Estimated Co-efficient	T- values	Estimated Co-efficient	T- values	Estimated Co-efficient	T- values	Estimated Co-efficient	T- values	Estimated Co-efficient	T- values
Intercept	2.524 (0.831)	4.030	3.780 (1.441)	5.420	4.850 (0.510)	9.680	4.150 (0.750)	4.690	5.037 (1.406)	8.690	3.890 (1.650)	4.851
Human labour cost (X_1)	0.099** (0.080)	1.720	0.234*** (0.110)	2.136	0.259** (0.090)	2.871	0.391** (0.181)	3.831	0.224*** (0.085)	4.813	0.287** (0.061)	4.420
Power tiller cost (X_2)	0.204 (0.010)	1.836	0.234** (0.075)	3.308	0.312 (0.084)	2.885	0.059 (0.526)	2.182	0.010** (0.010)	1.680	0.257** (0.078)	3.408
Seed cost (X_3)	0.620* (0.150)	8.410	0.301* (0.085)	3.462	0.150** (0.080)	2.010	0.230* (0.180)	2.169	0.702** (0.284)	4.279	0.184* (0.120)	1.440
Fertilizer cost (X_4)	0.257* (0.061)	4.713	0.233 (0.091)	2.541	0.225 (0.081)	2.830	0.280* (0.120)	4.420	0.054 (0.140)	2.282	0.410* (0.161)	3.412
Irrigation cost (X_5)	0.020 (0.300)	0.530	0.050* (0.040)	1.120	0.086 (0.076)	2.132	0.079* (0.122)	2.350	0.420 (0.418)	3.425	0.056 (0.510)	2.082
Insecticides cost (X_6)	0.258** (0.108)	3.129	0.181* (0.146)	1.556	0.184** (0.152)	1.221	0.221** (0.148)	2.881	0.480* (0.162)	4.876	0.331** (0.180)	3.241
Coefficient of multiple determination (R^2)	0.738		0.790		0.770		0.820		0.835		0.801	
F-value	8.950***		9.267***		8.436***		10.114***		11.238***		10.228***	
Returns to scale	1.015		1.056		1.020		1.078		1.034		1.051	

Source: Field survey, 2019

Note:

*** Significant at 1% level

** Significant at 5% level

* Significant at 10% level

(Figures in the parentheses indicates the standard errors)

Major constraints to Binadhan-17 cultivation

Binadhan-17 is a profitable rice variety in the study areas. The farmers in the study areas encountered some constraints to Binadhan-17 production. The first ranked constraint was unavailability of Binadhan-17 varieties' seeds in all areas (Table 4). Other constraints were lack of training (64%), lack of technical know-how (38%), lack of capital (30%), lack of storage facility (17%), natural calamities (14%) and low education level of farmers (10%).

Table 4: Major constraints to Binadhan-17 cultivation in the study areas

List of constraints	Percent of farmers' responded						Rank
	Sunamganj	Rangpur	Gopalganj	Pabna	Magura	All areas	
1. Unavailability of seed	88	85	82	89	76	84	1
2. Lack of training	56	82	88	67	28	64	2
3. Lack of technical know-how	30	25	65	53	15	38	3
4. Lack of capital	17	50	49	12	25	30	4
5. Lack of storage facility	12	15	24	16	19	17	5
6. Natural calamities	10	13	13	15	17	14	6
7. Low education level of farmers	10	12	11	8	9	10	7

Source: Field survey, 2019

CONCLUSION

Binadhan-17 production in the study areas is profitable. All of the factors namely, human labour cost, power tiller cost, seed cost, fertilizer cost and insecticides cost are very important for Binadhan-17 cultivation. The yield performance and economic return of Binadhan-17 production encouraging to the farmer's for more cultivation. In the study areas cultivation of this variety increasing day by day. But some constraints and factors were influenced throughout the production process. There is a need of proper guide to farmers about Binadhan-17 production management practices in the study areas.

Conflict of Interest

This manuscript is original and contains not any published material. The corresponding author confirms that all of the others authors have read and approved the manuscript and thus declare no conflicts of interest.

REFERENCES

- Alam, M. S., & Islam, M. A. (2013). Long-Term Assessment of Rice Production Scenario in Bangladesh: A Macro Dynamics. *Bangladesh Journal of Agricultural Research*, 38(2), 257–269.
- Alam, M. J., McKenzie, A. M., Begum, I. A., Buysse, J., Wailes, E. J., & Van Huylenbroeck, G. (2016). Asymmetry price transmission in the deregulated rice markets in Bangladesh: Asymmetric Error Correction model. *Agribusiness*, *32*(4), 498-511.
- Anik, A. R. (2003). Economic and financial profitability of aromatic and fine rice production in Bangladesh. M.S. thesis, Department of Agricultural Economics, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh.
- BBS (Bangladesh Bureau of Statistics). (2020). Yearbook of Agricultural Statistics-2019. Bangladesh Bureau of Statistics (BBS), Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.
- BBS (Bangladesh Bureau of Statistics). (2015). Statistical Pocketbook Bangladesh 2015. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh.
- Bapari, M. Y., & Joy, M. A. K. (2016). Estimation of Rice Production Function in Rajbari District, Bangladesh: an Econometric Analysis. *Asian Journal of Humanity, Art and Literature, 3 (1)*, 99-112.
- Barmon, B. K., & Chaudhury, M. (2012). Impact of price and price variability on acreage allocation in rice and wheat production in Bangladesh. *The Agriculturists*, *10*(1), 23-30.
- Begum, M. E. A., Miah, M. M., Rashid, M. A., Islam, M. T., & Hossain, M. I. (2019). Economic analysis of turmeric cultivation: evidence from Khagrachari district. *Bangladesh Journal of Agricultural Research*, *44*(1), 43-58.
- Brolley, M. (2015). Rice security is food security for much of the world. Rice Today. International Rice Research Institute (IRRI), DAPO Box 7777, Metro Manila, Philippines. PP. 30-32.
- Bwala, M. A., & John, A. U. (2018). Profitability Analysis of Paddy Production: A Case of Agricultural Zone 1, Niger State Nigeria. *Journal of Bangladesh Agricultural University*, 16(1), 88–92
- Chowdhury, N. T. (2013). Marginal product of irrigation expenses in Bangladesh, *Water Resour Econ*, 4, 38–51.
- Hasnain, M. N., Hossain, M. E., & Islam, M. K. (2015). Technical Efficiency of Boro Rice Production in Meherpur District of Bangladesh: A Stochastic Frontier Approach. *American Journal of Agriculture and Forestry*, 3(2), 31-37.
- Islam, Z., Begum, R., Sharmin, S., & Khan, A. (2017). Profitability and Productivity of Rice

Production in Selected Coastal Area of Satkhira District in Bangladesh. *International Journal of Business, Management and Social Research*, 3(01), 148–153.

- Ismail, M. H., & Verbeke, W. (2010). Evaluation of Rice Markets Integration in Bangladesh, *The Lahore Journal of Economics*, 15(2), 77-96.
- Khan, M. B. (2005). Processing of Boro paddy and its marketing in selected areas of 12 Sherpur district. M. S. Thesis, Department of Cooperation and Marketing, Bangladesh Agricultural University, Mymensingh.
- Mainuddin, M., & Kirby, M. (2015). National food security of Bangladesh to 2050. *Food Security*, 7, 633–646.
- Mondal, R. K. (2005). An Economic study of input use and productivity of HYV Boro paddy producing farms by tenancy in some selected areas of Gaibandha district. M.S. Thesis, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh.
- Mottaleb, K. A., & Mishra, A. K. (2016). Rice consumption and grain-type preference by household: a Bangladesh case. *Journal of Agricultural and Applied Economics*, 48, 298–319.
- Noonari, S., Irfana, M., Memon, N., Jatoi, A. A., Bux, M., Bhatti, M. A., & Shah, T. (2015). Analysis of Rice Profitability and Marketing Chain: A Case Study of District Analysis of Rice Profitability and Marketing Chain: A Case Study of District Sukkur Sindh Pakistan, (September). *International Journal of Business and Economics Research*, 4(3), 133-143.
- Rahman, F., Shammi, S. A., Parvin, M. T., Akter, N., Khan, M. S., & Haque, S. (2016). Contribution of Rural Women to Rice Production Activities in Two Different Areas of Bangladesh. *Progressive Agriculture*, 27(2), 180–188.
- Rahman, M. C., Nafisa, C. N. B. Hossain, M. R., Rahaman, M. S., & Chowdhury, A. (2015). Comparative Profitability and Efficiency Analysis of Rice Farming in the Coastal Area of Bangladesh: The Impacts of Controlling Saline Water Intrusion. *IOSR Journal of Agriculture and Veterinary Science*, 8(10), 89-97.
- Sarker, M. A. R., Alam, K., & Gow, J. (2012). Exploring the relationship between climate change and rice yield in Bangladesh: An analysis of time series data. *Agricultural Systems*, *112*, 11-16.
- Sarker, M. N. I. (2017). An introduction to agricultural anthropology: pathway to sustainable agriculture. *Journal of Sociology and Anthropology*, *1*(1), 47-52.
- Shozib, H. B., Siddiquee, M. A., Rahman, N. M. F., Mamun, M. A. A., Sarkar, M. A. R., Rabbi, S. M. H. A., ... & Kabir, M. S. (2020). Grain quality research of rice for ensuring nutritional food security. *Bangladesh Rice Journal*, *24*(2), 103-117.
- Tasnoova, S., & Iwamoto, I. (2006). Kataribhog rice marketing system in Dinajpur District, Bangladesh. *Memoirs of the Faculty of Agriculture, Kagoshima University*, *41*(20060220), 19-50.
- Timsina, J., Wolf, J., Guilpart, N., Van Bussel, L. G. J., Grassini, P., Van Wart, J., ... & Van Ittersum, M. K. (2018). Can Bangladesh produce enough cereals to meet future demand?. *Agricultural systems*, *163*, 36-44.