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Land Use Change from Rice to Maize Farming in Northern Region of Bangladesh: Identifying Causes and Future Prospects

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Maize is gaining importance in recent years as a promising crop, but some constraints are intensifying with increased concern over input supply and soil-related environmental sustainability. So, we were interested to assess the financial profitability of maize production over the existing rice cropping system and factors responsible for changing land-use decisions in Northern Bangladesh. The comprehensive comparison revealed that maize farmers got higher returns than the farmers producing boro rice as the calculated BCR for the former (2.14) was higher than the later (1.29). The results of regression analysis showed that maize labor use, maize gross margin, availability of rice for home consumption, and the least rice-producing area had a significant effect on deciding to shift the land from rice to maize cultivation. Therefore, there was a great prospect of maize farming in the study area as a profitable enterprise.

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1. BACKGROUND

In Bangladesh, the land is the most important scarce means of production. Although the total land area is the same in each year, the total cultivated area is decreasing day by day which means current land-use patterns show a decreasing trend in the net-cropped area. Due to rapid population growth, urbanization, industrialization, and diversification of agriculture (redistribution of land between agricultural sub-sectors), per-capita cropland has been decreasing over time. Therefore, the efficient use of the small pieces of land is becoming a great challenge for the farm households of Bangladesh [1]. The country emphasizes replacing its traditional agricultural practices by applying green revolution technologies like high yielding varieties of seeds, chemical fertilizers, irrigation, pesticides, power tiller, etc.

Rice is the staple food crop in Bangladesh and nearly 75% of the country's total cropped area is devoted to rice production [2]. However, it has been widely noticed in recent years that in many areas of the country, there have been notable shifts of rice areas to other crops, especially maize. In the middle of the world's cereal crops, maize ranks second to wheat in production. Nonetheless, amongst the developing countries, maize ranks first in Latin America and Africa but third after rice and wheat in Asia and it occupies the first position for its yield per unit area [3]. Several countries of Asia like Pakistan, India, Nepal, Thailand, China, Japan, Turkey, Philippines, and different countries of Europe also prefer maize as food. Maize is thought to be the third important cereal crop in Bangladesh just after rice and wheat [4]. Bangladesh has the highest maize yield (with average farm yields around 7.0 tons per hectare) among the other Asian countries [2]. It was introduced as a relatively new crop in the cropping pattern of Bangladesh especially in the northern region [5]. Maize industry is a prospective industry and its escalation is also connected with national GDP. Maize in Bangladesh is fetching a vital crop in the rice grounded cropping system. Maize has always been considered a minor crop in Bangladesh. Production of maize is increasing both in Rabi and Kharif seasons since the last decade. Rabi season maize followed by T. Aman (monsoon) rice is becoming the major cropping system especially in the northern part of the country.

Although rice cultivation is essential to meet the need for home consumption, the adoption of maize cultivation has been rapidly increased and covered the maximum portion of this area. A significant increase has been noticed in maize yield, production, and area under maize cultivation due to an increase in potential demand in the various sectors [2]. Farmer's incentive to produce rice is decreasing by the years in northern Bangladesh. This shifting of land use from boro rice to maize farming is becoming one major concern for the country. Thus, the factors which influence farmers to convert their land from rice farming to maize farming must be analyzed. Although a number of researches has been conducted on maize production in Bangladesh [6, 7, 8, 9, 10, 11, 12, 13], research on current topic is still unexplored in the country.

The present research is an endeavor to contribute to the policy discussion by empirically assessing the determinants of such shifting, by exploring the present agricultural farming and land-use change scenario in the study areas, by comparing the productivity and profitability of boro-rice and maize cultivation and by finding out the future prospects of maize in the country. The findings of the research will be helpful for the makers to draw relevant policies for supporting both enterprises. It will help finding out the prevailing problems and will develop an understanding of the interrelated aspects of maize and boro rice cultivation and choice-making in the production of maize rather than boro rice. The study will provide a picture of the benefits and costs of these two initiatives, which will help individual researchers who will conduct further studies of similar nature and encourage in conducting a more comprehensive and detailed investigation in this field of the study. The study proceeds with the three specific objectives: (i) To compare the profitability of boro rice and maize cultivation; (ii) To determine the factors responsible to replace boro rice farming with maize; and (iii) To assess the maize marketing system and its prospects.

2. RESEARCH METHODOLOGY

2.1 Study Design

The present research attempts to answer several questions: What is the reason behind the shift to

maize production from rice? Will the farmers shift all their rice lands to maize cultivation? What is the prospect of maize cultivation in the area? The answers to these questions are of crucial need to the policymakers for the specific research region. Thus, this regional study gains the utmost importance for the northern region of Bangladesh. This research will follow the conceptual framework shown in Fig. 1.

2.2 Study Area Selection and Sample Size

Farm management investigation is generally done by selecting an area where the concerned crop is grown [14]. A preliminary survey in Puthia Upazila of Rajhashi district was conducted to check for data availability and co-operation from respondents (Fig. 2). On the basis of preliminary information, a number of villages from the selected sub-district were selected purposively because a large number of farmers grow maize and boro rice in those villages.

A simple random sampling technique was followed to select the respondents in order to minimize cost, time and to achieve the ultimate objectives of the study. Two lists of farmers, who cultivated maize and boro rice, were collected with the help of agricultural extension personnel and elderly farmers of the study area. Then, a total of 60 farmers, 30 farmers for maize, and 30 farmers for boro rice were randomly selected from the list. Moreover, 7 *farias*[1], 10 wholesalers, and 5 *aratdars* [2] , hence, a total of 20 intermediaries were selected through a purposive sampling method to identify maize marketing system in the study area. Besides, the researcher talked with 4 feed mills to get ideas about their marketing functions. Data were collected for the whole production season of maize and boro rice. However, the formal data were collected from July to September 2018. Secondary data were gathered from different publications like Bangladesh Bureau of Statistics (BBS), different annual reports, papers, journals, theses, books, DAM (Department of Agricultural Marketing) reports, web site, email communication, etc.

[1] *Farias are intermediaries usually operating in the maize marketing process who purchases a small quantity of maize from farmer far away from the market and carry it to the terminal point and sell it to Aratdar or retailer.*

[2] *An Aratdar arranges or negotiates sales for the sellers on a commission basis. He often acts as a wholesaler. He is also the main provider of credit.*

2.3 Analytical Tools

In order to arrive at meaningful results, data for the present study were analyzed by employing both descriptive and statistical tools. The research made use of Microsoft excel and SPSS (Statistical Package for Social Science) software.

2.3.1 Tabular analysis

The tabular method was used for a substantial part of data analysis. The average, percentage, total cost, total return, undiscounted benefit-cost ratio (BCR), etc. were the simple measures employed to show the economic performance of boro rice and maize production.

2.3.2 Profitability analysis

Profitability analysis of boro rice and maize production were determined based on net return analysis. To determine the net returns from maize and boro rice production, gross costs (variable and fixed cost) were deducted from gross returns [15]:

$$\pi = P_r Q_r + P_b Q_b - \Sigma\,(Px_i . X_i) - TF \quad (1)$$

Where, Π is the net return (Tk./acre), P_r is for the per-unit price of the main product (Tk./kg), Q_r is the quantity of the main product (kg/acre), P_b stands for the per-unit price of by-products (Tk./kg), Q_b is the number of by-products (kg/acre), Px_i is the price per unit of ith (variable) inputs (Tk./kg), X_i is the quantity of the i^{th} inputs (kg/acre), i are 1, 2, 3…… n (number of inputs), and TFC denotes for the total fixed cost.

The BCR is a relative measure, which is used to compare benefit per unit of cost. The BCR was estimated as a ratio of gross returns and gross cost. The formula for calculating BCR (undiscounted) is shown below:

$$\text{BCR} = \frac{\text{Net worth of benefits}}{\text{Net worth of cost}} \quad (2)$$

2.3.3 Statistical analysis

Statistical analysis was used to show the effect of various related factors affecting the decision to cultivate maize instead of boro rice. Some regression models were initially estimated to determine the effect of independent variables on production. Those were linear and log-linear forms. Finally, a multiple regression model [16, 17, 18] was used based on the best fit and

significant results to analyze the empirical relationships between the ratio of land used for maize farming and influencing factors. It was hypothesized that a farmer's decision to produce maize is influenced by the combined effects of several factors related to the framer's objectives and constraints. The research employed the following linear regression model:

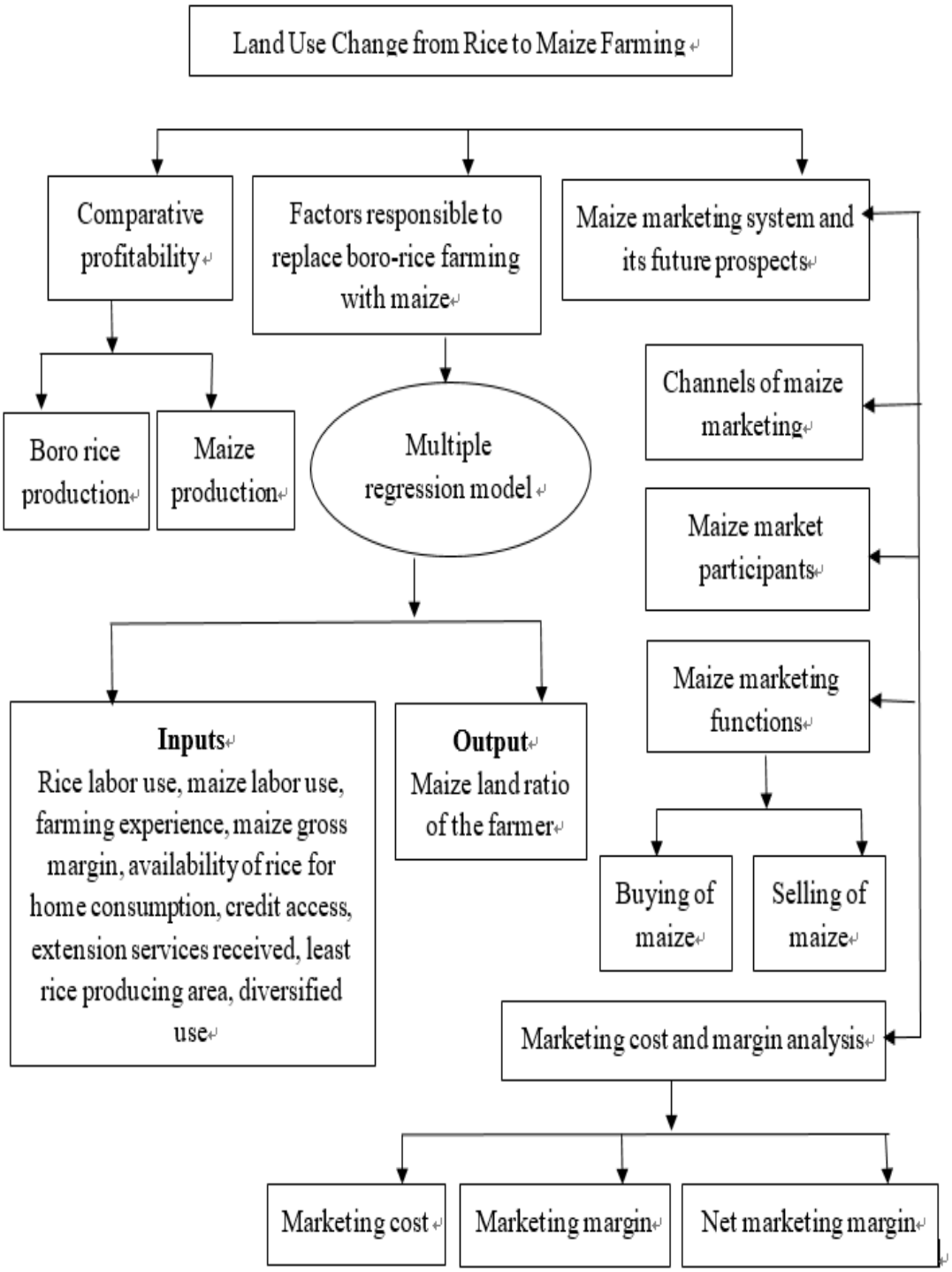

Fig. 1. Conceptual framework of the research

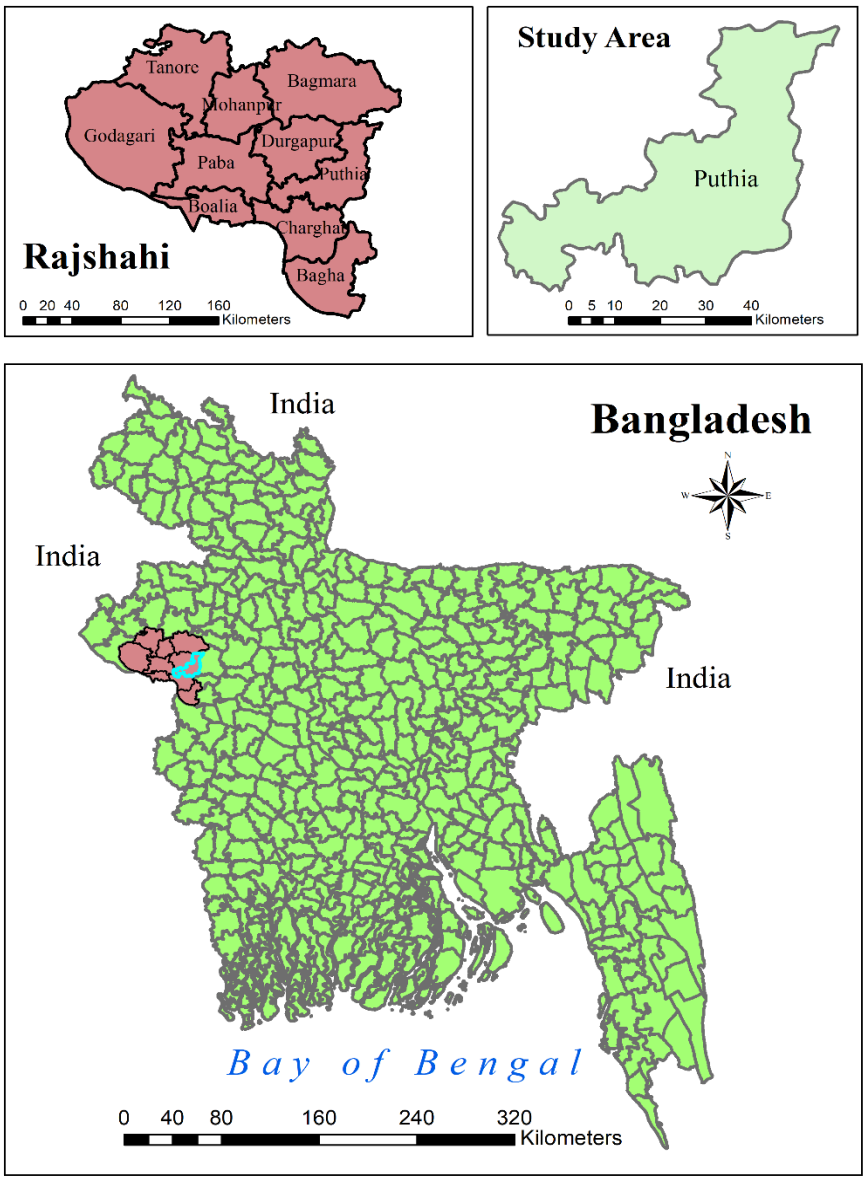

Fig. 2. Study area map for the research

$$Y=\alpha+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\beta_9X_9+\beta_{10}X_{10}+\epsilon_i \quad (3)$$

Where, Y is the maize land ratio of the farmer; X_1 is the rice labor use (man-day/acre); X_2 is the labor use (man-day/acre); X_3 is the farming experience (years); X_4 is the gross margin (Tk./acre);

X_5 is the availability of rice for home consumption (months); X_6 is the neighbor influence power (dummy 1= yes; 0 = no); X_7 is the credit access (dummy 1= yes; 0 = no); X_8 is the extension services received (dummy 1= yes; 0 = no); X_9 is the least rice producing area (decimal); X_{10} is the diversified use of land (dummy 1= yes; 0 = no); α stands for the intercept; $\beta_1 \ldots \beta_{10}$ are the coefficients of the respective independent variables; and ϵ_i denotes the random error term.

2.3.4 Analysis of marketing cost and margin

Marketing costs of farmers and middlemen were measured by the sum of all costs for the marketing of maize. It was measured by using the following formula [19, 20]:

$$C = C_{p1} + C_t + C_{s1} + C_e + C_r + C_m + C_w + C_{l1} + C_{s2} + C_{l2} + C_i + C_{p2} \quad (4)$$

Where, C is the total marketing cost; C_{p1} is the processing cost; C_t is the transportation cost; C_{s1} is the storage cost; C_e is the electricity cost; C_r is the rent; C_m is the market toll/tax; C_w is the weighing cost; C_{l1} is the labor cost; C_{s2} is the sack/packaging cost; C_{l2} is the loading and unloading cost; C_i is the information search cost, and C_{p2} is the personal expense.

The marketing margin is the difference between the purchase price and sale price. In this study, the absolute margin method was applied. This was as follows:

$$A_M = P_R - P_P \quad (5)$$

Where, A_M is the absolute margin; P_R is the total value of receipts per unit (sale price of maize), and P_p is the purchase value of maize per unit (purchase price).

Net marketing margin or profit is found by the difference between total marketing margin and marketing cost. It was determined by using the following formula:

Net margin (Tk./quintal) = Total marketing margin (Tk./quintal) – Marketing cost (Tk./quintal)

3. FINDINGS AND DISCUSSION

3.1 Changing Scenario of Rice and Maize Production

Fig. 3a shows that the area and production of boro rice exhibit a decreasing pattern over the period from 2009-10 to 2013-14; then in 2014-15 it increased and again it started decreasing over the period from 2015-16 to 2016-17. On the other hand, the area, production and yield of maize increased continuously over the period from 2009-2010 to 2016-2017 in Rajshahi district (Fig. 3a). The converted area from boro rice to maize of the sampled farmers is summarized in Fig. 3b. It is clear that large farmers converted more land from boro rice to maize than small and medium farmers in the study area[3].

3.2 Comparative Profitability Analysis

Profitability is one of the major criteria for the determination of acceptance of a crop. The results presented in Table 1 show that per acre human labor cost of boro rice and maize production are BDT 16,039.45 and BDT 8,629.93, respectively which covers 33.97% and 27.32% of the total cost. It indicates that human labor cost is higher for boro rice production than maize production. Per acre cost of power tiller is also less for maize production than boro rice. The seed rate was determined by its high-quality and availability. Per acre cost of seed for boro rice and maize cultivation is estimated at Tk. 858.90 and Tk. 4,275.25, respectively and it also represents 1.81 and 13.53% of the total cost, respectively (Table 1). It revealed that maize production has a cost of seed more than boro rice production. Further study shows that the cost of fertilizer, manure, pesticides, and irrigation is also higher for boro rice production than producing maize. By comparing the boro rice production with maize production, interest on working capital cost is higher (Tk. 1,100.57 and Tk. 474.90, respectively). Therefore, the total variable cost (TVC) of boro rice is also higher than maize. The results represented in Table 1 indicate that per-acre land use and depreciation costs for boro rice (Tk. 8,859.56 and Tk. 723.38 respectively) which is higher than maize cultivation (Tk. 6,856.56 and Tk. 512.63, respectively).

The total return is calculated by multiplying the total amount of products by the average farm-gate price. In the study area, per acre output of boro rice and maize cultivation are 2,626.76 kg and 4,143.41 kg, respectively, and their respective values are calculated at Tk. 61,130.10 and Tk. 67,619.55, respectively. It may be noted that here the price per kg of boro rice and maize are stated as 22.18 Taka and 15.87 Taka, respectively which are the average farm gate price in the study areas. The study shows that although the market price is lower for maize, per acre gross return is higher for maize farmers (Table 2). Benefit-Cost Ratios (BCRs) are estimated at 1.29 and 2.14 for boro rice and maize producing farmers, respectively. This comprehensive comparison reveals that maize farmers get a higher return than the farmers producing boro rice as the calculated BCR for the former is higher than the latter. Thus, maize is a profitable crop in the selected area compared to boro rice (Table 2).

[3] *Small farmers having land 0.50 acre to 2.49 acre. Medium farmers are having 2.50-7.49 acres of land. Large farmers are having land above 7.49 acres.*

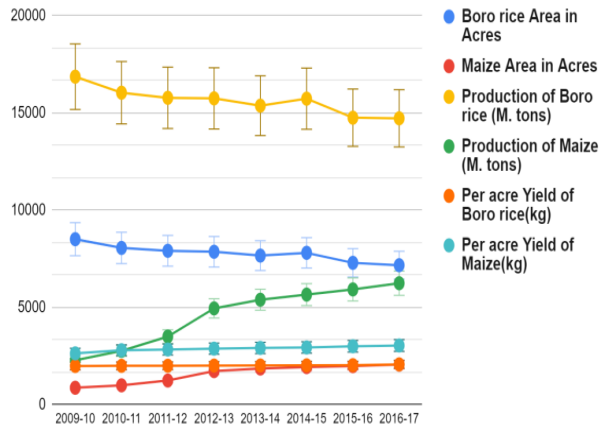

Fig. 3a. Changing scenario of rice and maize production in Rajshahi district

Source: [21]

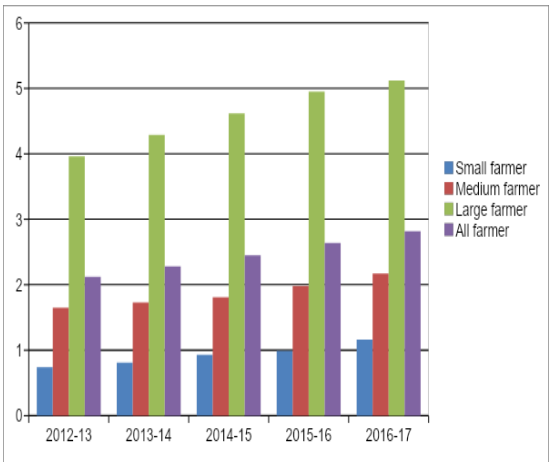

Fig. 3b. Converted maize area from boro rice

Source: Field Survey, 2018

Table 1. Comparative cost of boro rice and maize production

Items	Unit	Boro rice				Maize			
		Quantity	Unit price (Tk.)	Total cost (Tk.)	% of total cost	Quantity	Unit price (Tk.)	Total cost (Tk.)	% of total cost
Variable costs									
Labor	Tk.			16093.45	33.97			8629.93	27.32
Power tiller	Tk.			3141.40	6.63			1520.23	4.81
Seeds	kg/acre	12.27	70	858.90	1.81	9.5	450	4275.25	13.53
Urea	kg/acre	78.38	16	1254.08	2.65	55.45	16	887.25	2.80
TSP	kg/acre	56.01	22	1232.22	2.60	40.74	22	896.28	2.84
MoP	kg/acre	42.32	15	634.80	1.34	28.28	15	424.20	1.34
Gypsum	kg/acre	20.3	6	121.80	0.26	8.38	6	50.28	0.16
Boron	kg/acre	0	0	0	0	3.28	130	426.40	1.35
Manure	Tk./acre			303.03	0.64			200	0.63
Pesticides	Tk.			4055.66	8.56			2114.65	6.69
Irrigation	Tk.			7489.90	15.81			3103.45	9.82
Other cost	Tk.			1500.59	3.17			1217.17	3.85
Interest on operating capital	Tk.			1100.57	2.32			474.90	1.50
Total variable cost (TVC)				37786.40	79.77			24219.99	76.67
Fixed costs									
Land use cost	Tk.			8859.56	18.70			6856.56	21.71
Depreciation cost	Tk.			723.38	1.53			512.63	1.62
Total fixed cost (TFC)	Tk.			9582.94	20.23			7369.19	23.33
Total cost (TVC+TFC)				47369.35	100			31589.18	100

Source: Calculation done by authors based on field survey, 2018

Table 2. Gross return of boro rice and maize cultivation

Items	Boro rice			Maize		
	Yield (kg/acre)	Price (Tk./kg)	Total Return (Tk.)	Yield (kg/acre)	Price (Tk./kg)	Total Return (Tk.)
Main product	2626.76	22.18	58261.54	4143.41	15.87	65755.92
Value of by-product	-	-	2868.56	-	-	1863.63
Gross Return (Tk./acre)	-	-	61130.10	-	-	67619.55
Total cost (Tk./acre)	47369.35			31589.18		
Net return (Tk./acre)	13760.75			36030.37		
BCR (undiscounted)	1.29			2.14		

Source: Calculation done by authors based on field survey, 2018

3.3 Factors Responsible to Replace Boro Rice Farming with Maize

3.3.1 Variance inflation factors (VIF)

To obtain the causes of land-use change, many explanatory variables were chosen at first. It should be expected that some variables are correlated with others. The Variance Inflation Factor (VIF) was applied in regression analysis, which explains the degree of multicollinearity amongst the predictors [19, 20]. Variance Inflation Factors of selected variables are presented in Table 3.

The values of VIF are not more than 3, for any variable, which explains there is no objectionable degree of multicollinearity amongst the predictors. Therefore, one dependent variable and ten independent variables were selected finally for regression analysis.

3.3.2 Descriptive statistics of explanatory variables

Table 4 shows that the average labor use for rice farming is 82.57 man-days per acre and labor use for maize farming is 45.67 man-days per acre. The farming experience of maize farmers is 8.30 years and maize gross margin is Tk. 41,129.54 per acre. Farmers in the study area are satisfied with this margin. The average results show that farmers can provide 10.89 months of rice consumption requirement from their fields. About 50% of maize farmers are influenced by their neighbor farmers. On average, 48% of maize farmers have access to credit. In the study area, about 67% of maize growing farmers get extension services and it enhances the ability to acquire and use the information required for increasing production of maize. The average minimum rice-growing area desired by farmers in the study area is 178.28 decimals per household. Maize is a high yielding grain crop having multiple uses and doesn't need to make any large investments. In the study area, about 83% of maize growing farmers opine about this (Table 4).

3.3.3 Factors affecting farmers land use decision

It has been revealed from Table 5 that the variables: maize labor use, maize gross margin, availability of rice for home consumption and least rice producing area significantly increased the adoption of maize production. On the other hand, variables such as, rice labor use, farming experience, neighbor influence power, extension services received, credit access and diversified use, which were expected to influence the adoption of maize and were included in the model, are found to be insignificant regarding their influence on the adoption of maize cultivation. The result of the regression also shows that if maize farming labor use is increased by 1 man-day per acre, the maize land ratio decreases by 1.336 %, keeping other factors constant. The estimated regression coefficient of maize gross margin is positive and significant at a one % level. If farmers get a high gross margin from maize, they would convert more land from boro rice to maize production.

But most of the farmers in the study area cannot provide an entire year home consumption rice requirement from their farmland. If farmers want to increase their rice supply by 1 month from their rice land, they must decrease 0.162% of maize farming land area, other things remaining constant. Most of the farmers are not interested in converting their entire land for maize cultivation. However, if the farmers want to increase the availability of rice land by one decimal, then they must decrease 0.191% of maize land from farming,

other things remaining constant (Table 5). Therefore, Maize labor use, maize gross margin, availability of rice for home consumption, and least rice-producing area have a significant effect on deciding on maize land use. These factors have highly influenced the farmers to shift their land from rice to maize farming.

Table 3. Variance Inflation Factors (VIF) values of explanatory variables

Variables	Collinearity statistics	
	Tolerance	VIF
Rice labor use	0.584	1.712
Maize labor use	0.684	1.462
Farming experience	0.769	1.301
Maize gross margin	0.621	1.611
Availability of rice for home consumption	0.698	1.433
Neighbor influence power	0.705	1.418
Credit access	0.931	1.074
Extension services received	0.563	1.776
Least rice producing area	0.601	1.664
Diversified use	0.580	1.724

Source: Estimation done by authors based on field survey, 2018

Table 4. Descriptive Statistics of explanatory variables

Variables	Mean	Standard Deviation
Rice labor use (man-days/acre)	82.57	26.99
Maize labor use (man-days/acre)	45.67	16.97
Farming experience (years)	8.30	3.02
Maize gross margin (Tk./acre)	41129.54	5499.24
Availability of rice for home consumption (months)	10.89	2.73
Neighbor influence power	0.50	0.50
Credit access	0.48	0.50
Extension services received	0.67	1.45
Least rice producing area (decimal)	178.28	83.98
Diversified use	0.83	0.38

Source: Calculation done by authors based on field survey, 2018

Table 5. Factors affecting farmers land use decision

Model	Unstandardized Coefficients		Standardized Coefficients	p-value
	B	Std. Error	Beta	
(Constant)	-0.716	0.091		0.112
Rice labor use (man-days/acre)	0.003	0.002	1.244	0.174
Maize labor use (man-days/acre)	-0.005	0.002	-1.336	**0.051**
Farming experience (years)	0.015	0.007	0.728	0.136
Maize gross margin (Tk./acre)	0.0008	0.000	0.723	**0.002**
Availability of rice for home consumption (months)	-0.004	0.006	-0.162	**0.046**
Neighbor influence power	0.009	0.017	0.077	0.585
Credit access	0.016	0.015	0.135	0.299
Extension services received	0.011	0.006	0.257	0.179
Least rice producing area (decimal)	-0.007	0.000	-0.191	**0.015**
Diversified use	0.002	0.021	0.013	0.919
Dependent variable: Maize land ratio of the farmer				
R-square: 0.686				
Adjusted R-square: 0.592				
F-value: 2.244				

Source: Estimation done by authors based on field survey, 2018

3.4 Maize Marketing System and its Prospects

3.4.1 Channels of maize marketing

The marketing channel may be short or long for a commodity depending on the quality of the product, nature, and number of consumers and producers, intermediaries, marketing services needed, etc. It has been seen from the table that the maximum amount of maize (about 50% of total marketed maize) is moved through the channel III (farmer– *aratdar*– feed mill). It is followed by channels IV, V, II, and I and total marketed maize moved through these channels are 20.5%, 12.5%, 10%, 7%, respectively (Table 6).

Farmers in the study area are more intended to sell their maize directly to *aratdars* in expectation of higher prices for their maize. They sell their maize to *farias* in case of quick selling for meeting immediate cash requirements. From Fig 4, the following channels are identified:

Table 6. Marketing of maize through the major marketing channels

Channels	Marketing channels	% of product handled	Rank
i.	Farmers – *Farias*– Wholesalers – *Aratdars*- Feed mills	7.0	5
ii.	Farmers–Wholesalers– *Aratdars*- Feed mills	10.0	4
iii.	Farmers – *Aratdars*- Feed mills	50.0	1
iv.	Farmers – Wholesalers- Feed mills	20.5	2
v.	Farmers – *Farias* – *Aratdars*- Feed mills	12.5	3
Total		100.0	

Source: Calculation done by authors based on field survey, 2018

Channel I: Farmers → Farias → Wholesalers → Aratdar → Feed mills
Channel II: Farmers → Wholesalers → Aratdars → Feed mills
Channel III: Farmers → Aratdars → Feed mills
Channel IV: Farmers → Wholesalers → Feed mills
Channel V: Farmers → Farias → Aratdars → Feed mills
Channel VI: Farmers → Farias → Wholesalers → Poultry Farms
Channel VII: Farmers → Wholesalers → Aratdars → Poultry Farms

Among these, the first 5 identified channels are most prominent through which the maize moves from farmers to the end-users or feed mills (Table 6).

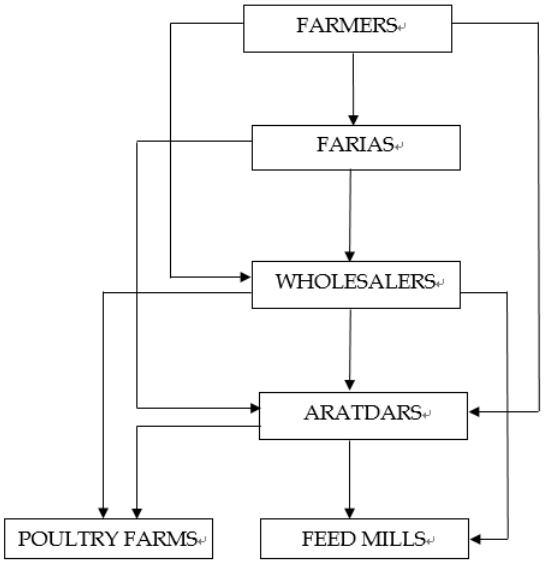

Fig. 4. Marketing channels of maize in Puthia Upazila of Rajshahi district

3.4.2 Maize market participants and their functions

Apart from farmers and consumers, several intermediaries are involved in the marketing of maize in the study area like are *farias*, wholesalers, and *aratdars.* Marketing channels of maize start from the maize-growing farmers. Farmers sell their maize to intermediaries both at the market and from the farmyard. Farmers in Puthia Sub-district sell 35%, 25%, and 40% of their produce to the *Farias*, wholesalers, and *Aratdars*, respectively (Table 7). *Farias*, found in the study area purchase maize from the producer at the farm gate or in the local village market and sell to the wholesalers and *aratdars*. The wholesalers have fixed establishments in the marketplaces with adequate storage facilities. They purchase a large amount of maize from farmers and a small amount of maize from *farias* in the village market. They sell a large amount of maize to feed mills and a small amount to *aratdars* at local markets.

Maize *aratdars* are the last intermediary in the channel before the feed mills or ultimate users of maize in the study area. They have permanent business premises in the sub-district market. Generally, they purchase maize from *Farias* and wholesalers. Sometimes, they buy wet maize from the farmers on the understanding that the farmers could ask them for immediate cash at any time. They supply dry maize to the feed mills within one to two days of taking an order. They purchase 40% of maize from the farmers and the rest from the *farias* and wholesalers. Feed mills are the ultimate user of maize who buys dry maize from wholesalers and *aratdars*. Then, they process the dried and cleaned maize into different forms like poultry feed, fish feed, etc. They buy a large amount of maize in peak season and store it for the lean season to maintain pace in their daily business. Several activities were observed in marketing the maize from farmers to ultimate users such as buying and selling, transportation, storage, packaging, market information, etc. Buying and selling are the functions of the exchange. In the study area, farmers are only producers of maize. They sell 100% of their maize to *farias*, wholesalers, and *aratdars*. The ultimate buyer of maize is feed mills, they buy dried maize from the wholesalers and *aratdars*. Wholesalers buy their maize from farmers, *farias*, and *aratdars*. The wholesalers and *aratdars* sell a little percentages of maize to poultry farms because there are a few poultry farms in the study area.

3.4.3 Marketing margin analysis

According to [19], the cost of marketing represents the cost of performing various marketing functions and operations by the various agencies involved in the marketing process. In the study area, maize farmers and traders must bear various costs for the marketing of maize. The marketing cost of farmers includes all cost items i.e. transportation, market toll or tax, packaging (sack), weighing and sewing, load or unload, information search, and personal expenditure involved in the selling of maize. The average cost of maize marketing per 100 kg for *farias*, wholesalers and *aratdars* is calculated at Tk. 65.20, Tk. 144.88 and Tk. 102.77, respectively (Table 8).

Table 7. Buying of maize (%)

Buyer	Seller						Total
	Farmer	Faria	Wholesaler	*Aratdar*	Feed mill	Poultry farm	
Faria	100	-	-	-	-	-	100
Wholesaler	65	35	-	-	-	-	100
Aratdar	55	20	25	-	-	-	100
Poultry Farm	-	-	68	32	-	-	100
Feed mill	-	-	-	100	-	-	100
Seller	Buyer						
	Faria	Wholesaler	*Aratdar*	Feed mill	Poultry farm		
Farmer	35	25	40	-	-		100
Faria	-	50	50	-	-		100
Wholesaler	-	-	40	55	5		100
Aratdar	-	-	-	90	10		100

Source: Calculation done by authors based on field survey, 2018

Table 8. Marketing margin of different intermediaries (Tk. Per 100 kg)

Intermediaries	Purchase price	Sale price	Marketing Margin	Marketing cost	Net marketing margin	Net marketing margin (%)
Faria	862.5	944.67	82.17	65.20	16.97	15.13
Wholesaler	944.67	1129.5	184.83	144.88	39.95	35.62
Aratdar	1129.5	1287.5	158	102.77	55.23	49.25
Total			425	312.85	112.15	100

Source: Calculation done by authors based on field survey, 2018

The cost of marketing for wholesalers is the highest among all intermediaries and the lowest for *farias*. The total marketing cost incurred by farmers and all intermediaries in the study area is calculated at Tk. 393.22 per 100 kg of maize. The total marketing margin usually consists of margins at different stages of marketing and in each case; the margin is the difference between the buying and selling prices of each intermediary. In the study area, the marketing margin for *farias*, wholesalers, and *aratdars* is calculated at Tk. 82.17, Tk. 184.83 and Tk. 158, respectively (Table 8). The marketing margin of wholesalers is the highest for the big volume of buying and selling and lowest for *farias* due to a small amount of buying and selling. *Aratdars*' margin is middle between wholesalers and *farias* (Table 8).

Net marketing margin or profit is found by the difference between gross margin and marketing cost. In the study area, % of profit or net marketing margin of different intermediaries is 15.13% for *farias*, 35.62% for wholesalers, and 49.25% for *aratdars*, respectively. *Aratdars* receive the highest net marketing margin (49.25%) whereas *Farias* receives the lowest net margin (15.13%) for 100 kg of maize. Though the marketing margin of wholesalers is high, the net margin of wholesalers is less than those of *aratdars* due to their relatively higher marketing cost (Table 8).

4. CONCLUSION

This shifting of land use from rice to maize farming is becoming one major concern for Bangladesh. The present research is an endeavor to contribute to the policy discussion by empirically assessing the determinants of such shifting, its impact on farm profitability, and finding out the prospects of maize in the country. Findings showed that the area devotion to boro rice in the study area has decreased substantially over the years and this decrease in boro rice area is due to the high cost of boro rice cultivation and low yield. On the other hand, area devotion to maize has increased both in the rainfed and unfavorable areas over the period from 2009-10 to 2016-17. The average yield of maize is higher in the study area which enabled the farmers in achieving higher gross return and net return as well. The comprehensive comparison reveals that maize farmers get a higher return than the farmers producing boro rice as the calculated BCR for the former is higher than the latter. Thus, maize production is a profitable enterprise as compared with boro rice.

Farmers are highly influenced by maize labor use, maize gross margin, availability of rice for home consumption and least rice-producing area to shift their land from rice to maize farming. The study identified the five most prominent channels of maize marketing. The ultimate buyer of maize is feed mills, they buy dried maize from wholesalers and *aratdars*. Wholesalers buy their maize from farmers, *farias* and *aratdars*. The wholesalers and *aratdars* sell a little percentage of their maize to poultry farms because there are a few poultry farms. The study reveals that the cost of marketing for wholesalers is the highest among all intermediaries and the lowest for *farias*. However, *aratdars* receive the highest net marketing margin whereas *farias* receives the lowest net margin for 100 kg of maize. Though the marketing margin of wholesalers is high, net margin of wholesalers is less than those of *aratdars* due to their relatively higher marketing cost. The findings of the study have important policy implications for accelerating or hindering the process of maize land allocation for agricultural development of the country.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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