



ASSESSING FACTORS FOR SHIFTING FARMERS FROM BORO RICE TO MAIZE FARMING IN THE NORTHERN REGION OF BANGLADESH

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ABSTRACT

The study mainly focused on the factors that influence the boro rice farmers in shifting into maize farmers in two districts namely Dinajpur and Lalmonirhat under Rangpur division of northern region of Bangladesh consisting of 300 samples from several villages. A total of 300 households were selected for the study from two districts by using random sampling method. Probit model was applied to analyze the data using statistical software small STATA (12.0 version). The estimated results revealed that the grain income (7.24), credit availability (2.32), local influence/high demand (3.03) and access to extension officer (1.97) all had significant positive influence ($P < 0.01$) on farmers to adopt the decision to shift into maize production from boro rice production. It is also found that training on maize cultivation and income from other sources were also found significant ($P < 0.01$) with negative sign in response to adopting the decision of maize cultivation. Increased income, credit availability, high demand of maize and high access of extension services are the driving factors to shift in maize production. The maize production is profitable to the farmers and concerned authority of the government should help and support the farmers to continue with this high value crop.

Key words: Bore rice, maize farmers, factors shifting, northern region

INTRODUCTION

Agriculture plays an important role to the economic growth and development in Bangladesh. The dependence of Bangladesh on imported cereal crop such as wheat and a small portion of rice due to the dominance of their demand over the local production is significant threat to its economy. Reliance on maize as a substitute to this cereal crop becomes necessary at least to ensure food security. Shifting of agriculture in the northwestern Bangladesh, especially from rice cultivation to maize farming, has been going on for more than a decade (Gurung *et al.* 2016). The farmers are losing interest in boro cultivation due to “high production cost against a low market price and shifting to other robi crops like maize, wheat, potato, soya and pulses. This is in fact a very positive change in our farmers’ crop selection as it is a highly beneficial practice both income

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issue and environmentally. The Bangladesh government has already started promoting crop diversification considering the hazards associated with the general practice of growing a single type of crop around the year.

Maize production was 1.34 (Million MT.) with an area of 0.22 (Million Ha.) in year of 2008 where that figure increased to 3.29 (Million MT.) with an area of 0.40 (Million Ha.) in 2018 (BBS 2019). On the contrary, boro rice production was 17.76 (Million MT.) with an area of 4.61 (Million Ha.) in year of 2008 where that figure increased to 19.57 (Million MT.) with a reduction of area to 4.48 (Million Ha.) in 2018 (BBS, 2019). Farmers are involving to Maize production instead of increasing their participation in boro rice cultivation due to several reasons. Since, they are becoming risk adverse, they decide to diverse (Mesfin *et al.* 2011 and Rehima *et al.* 2013). Other factors such as size of land holding, age of respondent, education level of respondent, farming experience of respondent, off farm income, availability and demand of market etc. also positively affect the shifting of farmers decision from existing crop production to a new crop production (Ashfaq *et al.* 2008 and Rehima *et al.* 2013). Simplicity of credit availability and training on some specialized crop cultivation and local peoples' influence may also attract farmers to shift from their present production pattern to a new (Gurung *et al.* 2016). Climatic uncertainty and soil fertility management also affect the farmers to stay in one crop production. Basak *et al.* (2009) estimated that the boro rice cultivation will reduce about 11-14% up to 2030, 21-25% for 2050 and 54-58% for 2070 due to responses of farmers to changing climatic condition, market vulnerabilities and weak pricing policies. In response to these scenarios, maize production and yield has experienced an explosive growth in Bangladesh in recent years.

Maize has now positioned itself as the 1st among the cereals in terms of yield rate (6.15 t/ha in 2011) as compared to Boro rice (3.90 t/ha in 2011) and wheat (Rahman *et al.* 2014). Moreover, maize is more profitable crop cultivation than rice and mustard in Bangladesh (Rahman *et al.* 2016) and maize production is not only profitable but also technically and economically efficient which is much higher than that of rice and wheat production (Rahman *et al.* 2016 and Rahman, 2012). Another study conducted by Hasan in 2008 on maize production in the northern region of Bangladesh especially on Dinajpur and Panchagarh revealed that the returns to scale of the selected inputs for maize production were 0.72 and 0.68 respectively in the study areas. Economic analysis of maize and maize-based cropping pattern in comparison to Boro rice and Boro-based cropping pattern indicates the high profitability of maize production system than that of Boro rice. Hasan (2008) also identified that maize produced higher gross return (60,981 Tk/ha), gross margin (38,145 Tk/ha) and net return (33,741Tk/ha) compared to Boro rice gross return (32,340 Tk/ha), gross margin (12,662 Tk/ha) and net return (6,883 Tk/ha). But maize incurred higher variable cost for human labor, seed and fertilizer. On the other hand, irrigation cost for Boro rice is near about five times higher than that of maize. So, gross return from maize cultivation is another diver to move ahead maize production instead of traditional boro rice cultivation.

To validate the above mentioned reasons, this study has been taken and the main objective of this study was to examine what factors are forcing farmers to be shifted from boro rice cultivation to maize cultivation in Northern region of Bangladesh. This present study was conducted on two district of northern region of Bangladesh to assess the drivers for farmers more clearly caused shifting from boro rice cultivation to maize cultivation.

MATERIALS AND METHODS

Study area and data collection

For the present study, primary data were collected from Lalmonirhat and Dinajpur districts. Three upazilas under Lalmonirhat (Patgram, Kaliganj and Sadar), and three upazilas under Dinajpur (Sadar, Birganj and Bochaganj) were selected for the study.. This study used Bartlett *et al.* (2001)'s sample size determination formula in the determination of the appropriate sample size. That is

$$n = \frac{t^2(p)(q)}{d^2} c \dots\dots\dots (1)$$

Where,

n = sample size

t = value for selected alpha level of 0.025 in each tail = 1.96 (the alpha level of 0.05 indicates the level of risk the researcher is willing to take that true margin of error may exceed the acceptable margin of error)

p = proportion of population engaged in maize production activities

q = proportion of population who do not engage in maize production activities

d = acceptable margin of error for proportion being estimated = 0.05 (error researcher is willing to accept)

According to the (DAE 2017), 26.5.5% of households who harvested staple and or cash crops in the last twelve months before September, 2017 were maize farmers (DAE 2018). Assuming 95% confidence level and 5% margin of error, the sample size was calculated as follows:

$$n = \frac{1.96^2 \times 0.265 \times 0.735}{0.05^2} = 299.30. \text{ That is } 300$$

Therefore, a total of 300 households were selected for the study from two districts by using random sampling method. From each district, 150 respondents were randomly sampled to interview with a multistage questionnaire prepared in English including their socioeconomic conditions of farmers which was collected by a group of 12 graduate students of Economics Department of the Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh in 2019-2020 production seasons.

Analytical techniques:

For analyzing what factors causes the boro rice producers to migrate in maize production, probit model was used using statistical software STATA 12.0 version.

Probit model ascends from Cumulative Distribution Function (CDF) that is, if a variable x follows a normal distribution with mean μ and variances σ^2 and its Probability Density Function (PDF) is as

$$f(x) = \frac{1}{\sqrt{2\sigma^2\pi}} e^{-(x-\mu)^2/2\sigma^2} \dots\dots\dots (2)$$

and its CDF is as

$$F(x) = \int_{-\infty}^{x_0} \frac{1}{\sqrt{2\sigma^2\pi}} e^{-(x-\mu)^2/2\sigma^2} \dots\dots\dots (3)$$

Here, x_0 is some specified value of x .

For formulating the probit model, considering dependent variable as whether farmers adopt decision to transfer in maize production or not relying on an unobservable utility index indicated by I_i that is determined by explanatory variables and the greater the value of index implying that the greater the probability of transforming the farmers decision to maize production (Gujarati and Damodar 2009). Let Y^* be an unobserved or latent variable, then considering probit model, the studied function on variables can be specified as follows:

$$Y = \delta_0 + \delta_1 x_1 + \delta_2 x_2 + \dots + \delta_k x_k + u_k \dots\dots\dots(4)$$

Then, $Y_i = 1$ if $0 < Y_i^* < \infty$
 * $Y_i = 0$ Otherwise.

Where,

x_1, x_2, \dots, x_k represent vectors of random variables, β 's represent vectors of unknown parameters and u represents a random disturbance term. Therefore, the probit model for this study to analyze farmers' decision about transform or not to transform from Boro rice to Maize cultivation can be expressed as follows:

$$Y_i = \delta_0 + \delta_1 X_{1i} + \delta_2 X_{2i} + \delta_3 X_{3i} + \delta_4 X_{4i} + \delta_5 X_{5i} + \delta_6 X_{6i} + \delta_7 X_{7i} + \delta_8 X_{8i} + \delta_9 X_{9i} + \delta_{10} X_{10i} + u_i \dots\dots(5)$$

The descriptive statistics regarding variables in this present study were presented in table 1 where calculated mean and standard deviation are shown also. The dependent variable (table 1) was presented as dummy measuring in terms of 1 and 0. All the explanatory variables were measured in binary form except the income farmers generated from other sources instead of maize production which is measured in terms of taka. u was the stochastic disturbance term including all other factors that may affect the model and in equation (5), i represented number as 1,2,3,.....,n.

Table 1. Descriptive statistics

Variables	Vectors	Description	Mean	SD
Dependent Variable				
Decision To Adopt Maize Production	Y	1 if the respondent transforms to maize cultivation, 0 otherwise.	0.80	0.39
Explanatory Variables				
Education	X_1	Measured in years of schooling;	6.62	4.98
Age	X_2	Measured in years;	48.25	11.78
Credit availability	X_3	1 if the easy of credit access for maize cultivation, 0 otherwise;	0.1	0.30
Local influence/high demand	X_4	1 if the demand for maize cultivation is high, 0 otherwise;	0.14	0.35
Training	X_5	1 if the respondent receives any training for maize cultivation, 0 otherwise;	0.83	0.37
Land type	X_6	1 if the land type is sandy lome for maize cultivation, 0 otherwise;	0.24	0.43
Seed availability	X_7	1 if the Seed for Maize cultivation is easily available, 0 otherwise;	0.07	0.26

Grain Income	X ₈	Measured in taka;	53786.4	10521.2
Income from others	X ₉	Measured in terms of taka;	9915.17	2574.1
Extension officer access	X ₁₀	Number of visits by agricultural extension officer.	2.50	0.93

Source: Authors' own computation from field survey, 2017

RESULTS AND DISCUSSION

Land shifted from boro rice to maize production in the study areas

The volume of cultivable lands in Bangladesh is limited, within these lands, different crops are produced. Rice and maize are the most important crops out of the other crops that tilled in the country. Farmers of the country's northern region are gradually increasing maize cultivation in their fields as they obtained bumper production and fairly profitable price from the crop in recent year. A survey of Bangladesh Agricultural Research Institute (BARI 2017) revealed that Chuadanga, Dinajpur, Bogura and Lalmonirhat, these four districts have become the main maize cultivation area of the country.

Table 2. Land converted from boro rice to maize production in the study area

Year	Maize Land (Acres)	Boro-rice Land(Acres)	Land converted into maize(Percentage) %
Before 2013	0.88	0.65	-
2014	0.92	0.56	12.5
2015	0.99	0.53	7.95
2016	1.10	0.43	12.5
2017	1.30	0.33	22.73

Source: Field Survey, 2017

Table 2 shows that the maize area was continuously increased compared with boro-rice cultivation. During 2013 to 2017 maize area were increased by 12.5 %, 7.95%, 12.5% and 22.73%, respectively compared with base year 2013. On the other hand, boro-rice area was decreasing day by day in the study area of northern region. So it's found in the northern region of Bangladesh that the boro rice production area tended to decrease and that production area was replaced by the maize cultivation. The reason behind increasing maize production was due to have more suitable for maize cultivation. Thus, maize production resulted in high productivity and high profitability over the last five years.

Estimated results of probit model

The results of probit model analysis on the factors affecting farmers' decision whether or not to transform in Maize cultivation is presented in Table 3. The results show that the probability of farm being involved in maize cultivation is determined by education, profitability, credit availability, high demand, training, land type, seed availability, income, and access to extension officer. The coefficient of seed availability, education, land type and income except maize production was 1.22 (0.93), 0.32 (0.25), 0.05 (0.80) and 1.72 (1.90), respectively and found to be positive but insignificant effect on shifting farmers from Boro rice to Maize production.

Table 3. Probit regression of factors affecting farmers' decision whether or not to transform in Maize cultivation

Variables	Parameters	Coefficients	Z-statistics
Constant	δ_0	220.43*** (65.56)	3.36
Education	δ_1	00.32 (00.25)	1.31
Age	δ_2	00.60* (0.34)	1.75
Credit availability	δ	32.32*** (0.67)	3.49
Local influence/high demand	δ_4	3.03*** (0.71)	4.27
Training	δ_5	-1.27** (0.59)	-2.17
Land type	δ_6	0.05 (0.80)	0.06
Seed availability	δ_7	1.22 (0.93)	1.32
Grain income	δ_8	7.24*** (1.39)	5.17
Income from others	δ_9	1.72 (1.90)	0.91
Extension officer access	δ_{10}	1.97*** (0.46)	4.28
LR chi ²	-	161.87***	
Pseudo R ²	-	0.54	
Log likelihood	-	- 67.78	
Number of observations	-	300	

Note: *, ** and *** refers to 10%, 5% and 1% significance level, respectively. Figures in the parentheses indicate Standard Error.

The coefficient of training was found to be negative as -1.27 (0.59) and significant at 5% with p value of $P < 0.05$ implying that decision to shift maize farmers declines with increase in training. The negative and significant effects of the training decrease the probability of farmer's involvement in maize cultivation. Similarly, farmers' income from maize production with coefficient of 7.24 (1.39) also affects negatively with 1% level of significance. On the contrary, profitability, credit availability, local influence and access to extension officer with coefficients of 2.32 (0.67), 3.03 (0.71), and 1.97 (0.46), respectively implying that all affect positively to the

farmers' decision to shift from Boro rice cultivation to maize cultivation with 1% level of significance ($P < 0.01$) indicating an increase of amount of these positively affected variables results in a significant rise in mutation from boro rice farmers to maize farmers in the sampled areas.

CONCLUSION

The consumption of maize grain in Bangladesh has been increasing gradually since 2000s due to rapid expansion of poultry industry as it is used a prime food for poultry farming. To meet up the increasing demand, expansion of maize production seems a promising option in terms of market dynamics, cropping patterns and profitability. Farmers in the study areas perceived maize as profitable crop compared to other winter crops like wheat, lentils, Rice and Jute. However, this is completely an issue of subjective thought process and the study cannot conclude on the fact that which crops are less or more profitable in comparison to maize. However, this study finds several factors such as credit access, training availability on maize production, market demand, and extension access which all are significantly influenced the boro farmers to shift into maize farmers in northern region of Bangladesh.

ACKNOWLEDGMENTS

The authors acknowledge the financial support by the Ministry of Science and Technology, Bangladesh.

REFERENCES

- Ashfaq M, Hassan S, Naseer MZ, Baig IA, and Asma J. 2008. Factors affecting farm diversification in rice-wheat. *Pakistan Journal of Agriculture Science*. 45(3): 91-94.
- BARI 2017. Annual Report; Agricultural Economics Division , BARI: Gazipur, Bangladesh.
- Bartlett JE, Kotrlík JW and Higgins CC. 2001. Organizational Research: Determining Appropriate Sample Size in Survey Research. *Information Technology, Learning, and Performance Journal*. 19: 43-50.
- Basak J K, Ali MA, Islam M N and Alam MJB. 2009 February. Assessment of the effect of climate change on boro rice production in Bangladesh using CERES-Rice model. In Proceedings of the international conference on climate change impacts and adaptation strategies for Bangladesh. 18-20.
- BBS 2011. Yearbook of Agricultural Statistics of Bangladesh 2011. Bangladesh Bureau of Statistics, Dhaka, Bangladesh.
- BBS 2019. Yearbook of Agricultural Statistics of Bangladesh, Bangladesh Bureau of Statistics (BBS), Ministry of Planning, Dhaka, Bangladesh.
- DAE.2017. Department of Agricultural Extension. Ministry of Agriculture, Government of the People's Republic of Bangladesh, Khamarbari, Dhaka.
- DAE.2018. Department of Agricultural Extension. Ministry of Agriculture, Government of the People's Republic of Bangladesh, Khamarbari, Dhaka.

- Gujarati and Damoder. 2009. Basic econometrics. Tata McGraw-Hill Education. Gurung K, Bhandari H, and Paris T. 2016. Transformation from rice farming to commercial aquaculture in Bangladesh: Implications for gender, food security, and livelihood. *Gender, Technology and Development*. 20(1): 49-80.
- Hasan M F. 2008. Economic efficiency and constraints of maize production in the northern region of Bangladesh. *Journal of Innovative Development Strategy*. 2(1): 18-32.
- Mesfin W, Fufa B, and Haji J. 2011. Pattern, trend and determinants of crop diversification: empirical evidence from smallholders in eastern Ethiopia. *Journal of Economics and Sustainable Development*. 2(8): 78-89.
- Rahman S, and Rahman S. 2014. Exploring the potential and performance of maize production in Bangladesh. *International Journal of Agricultural Management*. 3(2): 99-106.
- Rahman S, Kazal M M H, Begum I A and Alam MJ. 2016. Competitiveness, profitability, input demand and output supply of maize production in Bangladesh. *Agriculture*. 6(2): 21.
- Rahman S, Rahman M S, and Rahman M H. 2012. Joint determination of the choice of growing season and economic efficiency of maize in Bangladesh. *Journal of the Asia Pacific Economy*. 17(1): 138-150.
- Rehima M, Belay K, Dawit A, and Rashid S. 2013. Factors affecting farmers' crops diversification: Evidence from SNNPR, Ethiopia. *International Journal of Agricultural Sciences*. 3(6): 558-565.