[*Jpn. J. Agric. Econ.* Vol.19, pp.27-30, 2017]

Determinants of Early Cropping of Rice in Bangladesh: An Assessment as a Strategy of Avoiding Cyclone Risk

Md. Shah Alamgir[1], Jun Furuya[2*] and Shintaro Kobayashi[2]

In the cyclone prone coastal zone of Bangladesh, engaging in early cropping of rice may potentially enable farmers to reduce cyclone risks and reshape their livelihood by changing their income status. A binary logistic regression analysis is used to identify determinants for early cropping and finds that households with more educated household head, credit facility, and farms relatively in the south and middle of koyra upazila tend to adopt early cropping. The result implies that even if the early cropping can reduce the cyclone risk, it may be difficult for famers with less education and credit access to continuously adopt this technology.

Key words: rice production, adaptation strategy, logistic regression

1. Introduction

The coastal zone of Bangladesh is particularly prone to cyclones along with storm surges and faces more than one cyclone of various velocities every year: from 1980 to 2013, 169 cyclones and tornados occurred in Bangladesh (Islam *et al.*, 2014). The region covers about 20% of the country and over 30% of total cultivable area (Petersen and Shireen, 2001).

Bangladesh mainly experiences tropical cyclones from the Bay of Bengal from April to May and October to November. The former corresponds to the harvesting period of *boro* (dry season irrigated) rice and the latter corresponds to the harvesting period of aman (wet season) rice, both of which are the main agricultural crops in Bangladesh.

Climate-induced hazards, especially cyclones and sea level rise, is adversely affecting rice production in coastal Bangladesh (Rabbani *et al.*, 2013). Tropical cyclone has a great impact on agricultures and rural infrastructures (Hossain *et al.*, 2008). Tropical cyclones are among the most destructive of all natural hazards, causing considerable human suffering in about 70 countries around the world (Sivakumar *et al.*, 2005).

Numerous studies have conducted on the impact of cyclones on agriculture sectors worldwide; however, few have focused on cyclone risks in Bangladesh's agricultural production and the resultant changes in cropping patterns. Thus, identifying suitable adaptation strategies for agricultural production technologies against cyclones and weather risks can pave the way for sustainable productivity and coastal livelihoods.

In November 2007, one of the strongest cyclones, named Sidr, hit Bangladesh's south-west coast and caused extensive physical destruction and causalities (Paul and Dutt, 2010). In total about 2 million farm households were affected. In addition, 11,200 km^2 of wet season *aman* cropland fully destroyed, and nearly 13,900 km^2 incurred partial damage (Shamsuddoha *et al.*, 2013).

Again, in May 2009, the southwest coastal region in Bangladesh was hit by a huge tropical cyclone called Aila, leading to a long-term crisis and unprecedented sufferings in particular areas. Agricultural lands were inundated with saline water from cyclone-induced storm surges and the major crops (*boro* rice) were devastated.

However, it has found that some *boro* rice farmers transplanted their crops at an earlier stage, allowing them to harvest their crops before they were hit by cyclone Aila. To elaborate, because of the annual tropical cyclone, such farmers have begun practicing early cropping for their rice production to evade cyclone-associated risks in the coastal area of Bangladesh (Islam, 2012).

Early cropping is distinguished from late cropping. Late cropping farmers follow Bangladesh's national crop calendar (Bureau of Statistics, 2013) and transplant *boro* rice between mid-December and February, while early cropping farmers transplant boro rice before December 15.

[1]University of Tsukuba
[2]Japan International Research Center for Agricultural Sciences
Corresponding author*: furuya@affrc.go.jp

Given these observations, it is important to evaluate the potential of early cropping of rice in coastal zones to avoid the risks associated with cyclones. Therefore, this study aims to examine the economic situation of farming households and to identify determinants to adopt early cropping.

2. Methodology

1) Study area

We selected Koyra upazila of Khulna district as the study area because it is the closest the ocean, located in cyclone - prone southeast region of Bangladesh, and the most affected upazila by cyclone Aila (Roy *et al.*, 2009).

Because Koyra upazila is prone to cyclones, some farmers of Koyra had already adopted the technique of early cropping for rice production at the time when cyclone Aila came.

2) Data collection

To meet the objectives of this study, a draft interview schedule was prepared and tested in December 2009 for the data collection of 2008-2009 *Boro* rice production. Note that 2008-2009 *Boro* rice was planted before cyclone Aila, but it was damaged by cyclone Aila among late cropping farmers. Final data collected using standardized questionnaires through interviews for sampled respondents, jointly conducted by the Bangladesh Rice Research Institute (BRRI) and Japan International Research Center for Agricultural Sciences (JIRCAS) in October 2010. We treated one man per farm household as a respondent and an entire farm household as a sample unit. We randomly selected 84 respondent farms and farm households from all the seven unions in Koyra upazila.

3) Data analysis

We adopted a binary logit model to identify determinants of early cropping, where the dependent variable is a dichotomous (binary) variable taking 1 for early cropping farmers and 0 for late cropping farmers. The possible independent variables influencing cropping date are labor force from family (X_1), farming experience (X_2), education (X_3), access to credit (X_4), planted farm size (X_5), location of farms (X_6), and specific farmers (X_7). Location of farms (X_6) is a vector of dummies for locations namely Bagali, Amadi, Maheshwaripur, Maharajpur, Koyra, and Dakhinbedkashi unions, setting Uttarbedkashi union as reference category and specific farmers (X_7) is a vector of dummies for 3 farmers (i.e., farmer no 25, farmer no 75, and farmer no 79). Setting these farmers dummies because only they had university level of education but they cropped late and this effect the significant result of education. Access to credit indicates the actual borrowing of money in the cropping season from rice trader, moneylender, relative, non-relative, neighbor, NGOs, bank, or any other financial institutions.

3. Results

1) Descriptive statistics of sampled farms

In the 2008–2009 *boro* season, farmers transplanted BRRI Dhan-28 cultivar for their dry season rice (*boro*) production (Table 1). Of the 84 farms households, 49 farms fell under the early-cropped category and 35 under the late cropped.

Table 1. Descriptive statistics for the sampled farms

Variables	Early cropped farms	Late cropped farms	Total
Variety of crop (*boro* rice)	BRRI Dhan-28		
Number of farms	49 (58.34)	35 (41.66)	84 (100)
Farmers' age (yr)	44.26 (11.42#)	51.45 (14.36#)	47.26 (13.14#)
Labor force from family (number)	1.45	1.14	1.32
Farming experience (yr)	20.85 (12.05#)	27.11 (13.66#)	23.46 (13.04#)
Education (yr)	9.28 (2.32#)	8.80 (3.50#)	9.08 (2.86#)
Access to credit	21 (43)	14 (40)	35 (42)
Planted farm size	0.49 (0.29#)	0.69 (0.54#)	0.57(0.42#)
Bagali union	2 (4.08)	10 (28.57)	12 (24.28)
Amadi union	7 (14.28)	5 (14.28)	12 (14.28)
Maheshwaripur union	11 (22.44)	1 (2.85)	12 (14.28)
Maharajpur union	10 (20.40)	2 (5.71)	12 (14.28)
Koyra union	9 (18.36)	3 (8.57)	12 (14.28)
Uttarbedkashi union	1 (2.04)	11 (31.42)	12 (14.28)
Dakhinbedkashi union	9 (18.36)	3 (8.57)	12 (14.28)

Note: Values in parentheses are percentage, # indicates standard deviations, and unions are north to south direction.

The average years of schooling was nine years (Table 1), implying that the sampled farmers had secondary level education. Educated farmers tend to adopt early cropping. The average planted land size in the case of late cropped farms was 0.69 ha, which shows marginally larger than the early cropped ones (0.49 ha).

2) Cost and income for *boro* rice cultivation

Table 2 compares income from 2008-2009 *boro* rice between early and late-cropped farms. It shows that there is

little difference in the revenue, but that production cost is higher for the late-cropped farms than the early-cropped farms. As a result, income is higher for the early-cropped farms than the late-cropped farms. Considering that the late cropped farms were damaged by cyclone Aila, the fact that there is no difference in revenue from 2008-2009 *boro* rice may imply that the late cropped farms could have much higher revenue if cyclone Aila did not come as shown in Table 2 as expected revenue. The higher cost paid by the late-cropped farms will support this conjecture since the higher cost is due to higher dose of application of chemical fertilizer, which was made before cyclone Aila.

Table 2. Rice and off-farm income for 2008-2009 *boro* rice production

Items	Early cropped farms (Tk/ha)	Late cropped farms (Tk/ha)	Average (Tk/ha)
Expected revenue (without Aila damage)	84,975 (65,651)	104,582 (81,988)	93,144 (73,080)
Revenue	85,534 (70,499)	86,760 (95,377)	86,044 (80,761)
Total cost	70,644 (24,371)	77,293 (50,853)	73,415 (37,375)
Income	14,890 (77,624)	9,467 (113,635)	12,629 (93,150)
Total off farm income (Tk/yr)	110,531 (65,078)	134,331 (77,704)	120,448 (70,723)

Note: Values in parentheses are indicates standard deviations.

As for the income from off-farm activities farmers who planted *boro* rice late earned more than those who planted early. This is because early cropping farmers lost the opportunities to earn off-farm income during the period when they planted *boro* rice before December 15.

However, note that off-farm income shown in Table 2 is for whole year, not specifically before or after Aila. When the farmers were involved in rice cultivation, and during the rice cultivation, farmers lost off-farm income. Nevertheless, some farmers had other enterprises simultaneously with rice cultivation they earned off-farm income. Some farmers are involved in shrimp cultivation, open fishing, sale labor, teaching, vegetable cultivation, renting power tiller, driver, small rice trader, fertilizer smaller etc. also. Most of the farmers concentrate on rice farming and partially they are engaged in off-farm activities.

As a whole Table 2 suggests that, the cost of risk reduction by early cropping is lower *boro* rice income if no cyclone comes as well as lower off-farm income than late cropping. Therefore, we can consider that early cropping is a "low risk but low income" strategy for *boro* rice production under the risk of cyclone.

3) Determinants of early cropping

Table 3 shows farming experience is significant (Sig. = .062) and negatively related with early cropping (B = −.067). Thus, farmer who has more years of experience (more age) has a negative influence to the early cropping of agricultural farms in the study areas. Oppositely, it implies that young age farmers, who has low years of experiences, adopted early cropping.

Table 3. Parameter estimates for logit model to cope with early cropping

Variables	B	S.E.	Marginal effects
Labor force from family	−.115	.340	−.076
Farming experience	−.067	.036*	−.015
Education	.326	.168*	.081
Access to credit	2.307	1.089*	.517
Planted farm size	−.269	.979	−.114
Bagali union	2.802	1.846	.419
Amadi union	6.239	2.011**	.596
Maheshwaripur union	6.070	1.813**	.610
Maharajpur union	5.874	1.732***	.623
Koyra union	5.021	1.678***	.577
Dakhinbedkashi union	4.010	1.458**	.529
Constant	−5.866	2.462***	

Note: ***, **, * indicate significance level of 1%, 5%, 10% respectively.

Farmers are usually working for jobs other than cropping between *aman* and *boro* rice cultivation. In the peak season of transplanting and harvesting time of rice cultivation, hired labor demand increases due to labor scarcity, because many working labor migrate to nearby city for higher income. This time farmers also sell labor to other farms. That is why farmer with family supplied labor initiate into late cropping on their own farm and labor sale or involvement in other activities in peak season of rice production.

The education variable is also found to be significant (Sig. = .053) and positively related with early cropping and averting cyclone-related risks (B = .326).

With respect to the farm location, farmers in Maheshwaripur union, Maharajpur union, and Koyra union are significantly more likely to conduct early cropping than those in Uttarbedkashi union, the reference category. Since Maheshwaripur, Maharajpur, and Koyra union are located south and middle of Koyra upazila and very close to Bay of Bengal, the finding implies that farmers in riskier unions tend to adopt early cropping.

Access to credit is significant (sig. = .034) and positively influences the decision of early cropping (B = 2.307). The coefficient of 3 farmers dummies are B = −25.116, B= −25.948, and B= −26.501 respectively and not significant with early cropping.

In sum, education, access to credit, and farmers relatively from south and middle of Koyra upazila are found to have significantly positive effect on the early cropping.

4. Conclusions

This study concludes that the main production factors contributing to early cropping are education, credit facilities for farms, and the farms located in riskier unions. It is not possible to prevent the natural disasters, like cyclone but ex-ante coping with cyclone is easily possible (Ahamed *et al.*, 2012). The repercussions of tropical cyclones for agricultural production in coastal zones will continue to be severe if the concerned stakeholders do not take the necessary and prompt actions to prevent such losses. So adopting the concepts of early cropping would be a useful strategy to promote sustainable agriculture in the cyclone risks areas.

To this effect of early cropping in agricultural production, the findings of the present study also have important implications for those involved in framing environmental planning policies. Policymakers should aim to encourage low risk and high-income mix of off-farm and on-farm activities based on early cropping, higher education and farm management training, credit access, and the dissemination of information to farmers about early cropping. It is difficult to promote credit support for all farmers but education may help them to understand the importance of insurance.

This study has attempted to bridge the gap between academic research and professional practices in the context of early crop production to avoid damages from cyclones. Because of the relatively small sample size, the statistical power of this analysis may be low. Thus, future research should attempt to confirm the relationships presented in the study and strengthen the results using a larger sample.

Acknowledgement

We thank the Bangladesh Rice Research Institute (BRRI) and Japan International Research Center for Agricultural Sciences (JIRCAS) for providing us with the primary data.

References

Ahamed, S., M. M. Rahman, and M. A. Faisal, (2012) Reducing Cyclone Impacts in the Coastal Areas of Bangladesh: A Case Study of Kalapara Upazila. *Journal of Bangladesh Institute of Planners,* 5:185-197.

Bureau of Statistics (2013) *Yearbook of Agricultural Statistics*, Government of the People's Republic of Bangladesh, April 26 2015

Hossain, M. Z., M.T. Islam, T. Sakai, and M. Ishida (2008) Impact of Tropical Cyclones on Rural Infrastructures in Bangladesh. *Agricultural Engineering International*: the CIGR Ejournal, 2(X):1-13

Islam, M. R. (2012) Crop diversification of cyclone Sidr-affected areas of Bangladesh, *Food and Agricultural Organization of the United Nations,* Dhaka, Bangladesh, 1–71.

Islam, A. R., M. T., A. Tasnuval, T. M. Islam, and R. M. Haque, (2014) Management Approach to Disaster Scenario in Bangladesh: an Overview, *International Journal of Scientific and Research Publications,* 4(3):1–7.

Paul, B.K., and S. Dutt (2010). Hazard Warnings and Responses to Evacuation Orders: The Case of Bangladesh's Cyclone Sidr. The Geographical Review, 100(3):336-355.

Petersen, L. and S. Shireen (2001) *Soil and water salinity in the coastal area of Bangladesh*, SRDI, 56-57.

Rabbani, G., A. Rahman, and K. Mainuddin (2013) Salinity-induced loss and damage to farming households in coastal Bangladesh, Int. J. Global Warming, 5(4):400–415

Roy, K., U. Kumar, H. Mehedi, T. Sultana, and D. M. Ershad (2009) Initial Damage Assessment Report of Cyclone Aila with focus on Khulna District. Unnayan Onneshan-Humanity Watch- Nijera Kori, Khulna, Bangladesh, 31

Sivakumar, M. V. K., R. P. Motha, and H. P. Das (2005) Natural Disasters and Extreme Events in Agriculture, Springer, Netherlands, 12

Shamsuddoha, M., M., M. Islam, M. A. Haque, M. F. Rahman, E. Roberts, A. Hasemann and S. Roddick (2013) Loss and Damage: Insights from Cyclone-affected Communities in Coastal Bangladesh, CRPD, Dhaka, Bangladesh, 1-28