

Yield Gap, Risk Attitude, and Poverty Status of Aman Rice Producers in Climate-Vulnerable Coastal Areas of Bangladesh

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ABSTRACT

Farmers of the coastal region in Bangladesh are vulnerable to various climatic hazards that affect agricultural productivity and livelihoods. This study investigated the yield gap, risk attitude, and poverty status of Aman rice farmers and also assessed the relationship among them in the climate-vulnerable southern coastal areas of Bangladesh. This study selected 125 Aman rice farmers using a simple random sampling technique to estimate three types of yield gaps. Risk attitude was calculated using the safety-first model, and the Foster–Greer–Thorbecke model was employed to estimate poverty status. Results revealed a significant amount of yield gaps in Aman rice production, while farmers had opportunities to increase their production through the optimal use and scientific management of inputs. The yield gaps are reflected in the farmers' risk aversion attitude, with the majority of farmers being highly risk-averse. The study also revealed that half of the sampled farmers were poor, with a poverty gap of 15%. However, an increased number of non-poor was revealed due to a reduction both in yield gaps and farmers' risk-aversion attitudes. Therefore, the study suggests limiting the yield gap to manage farmers' risk-aversion attitudes, which would also facilitate improving their poverty situation.

Keywords: Climate-vulnerable areas, Foster–Greer–Thorbecke model, Livelihood, Risk aversion, Safety-first model.

INTRODUCTION

South Asia is under serious threat from rising sea levels, soil erosion, saline water intrusion, etc., because of its diversified climatic zones and physical landscape (Hasnat *et al.*, 2018). Along with other South Asian countries, the agricultural sector of Bangladesh is affected by climate change. In particular, extreme temperatures, drought, salinity intrusion, etc. are responsible for declining crop yields in Bangladesh (Biswas, 2013). Salinity intrusion is a severe threat for agriculture in coastal areas, which in Bangladesh equates to 710 km, covering 32% of the country and accommodating nearly one-third of

Bangladesh's total population (Ahmad, 2019). However, average soil salinity level rises from 8.21 dSm⁻¹ to 22.6 dSm⁻¹ in recent years (Basu and Roy, 2018), and one million hectares of agricultural land are affected by salinity intrusion in the coastal areas of Bangladesh (SRDI, 2010). Other climatic events, such as cyclones and floods, significantly reduce the coastal areas' rice yield in every year (Basak, 2012).

Among the various agricultural crops, Aman (wet season) rice is the main crop for small (0.21 to 1.0 ha) and marginal (< 0.2 ha) farmers in coastal areas, usually using traditional local rice varieties, which are vulnerable to salinity and have low yields (Shelley, 2016). Farmers, therefore, are

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forced to cultivate salt-tolerant varieties of Aman rice to ensure their earnings and livelihood. However, salt-tolerant varieties of Aman rice cannot provide the expected yield because they are prone to water stresses at the reproductive or ripening stage (Biswas, 2014). Heavy rainfall and floods also cause crop damage at the seedling stage and delay planting (Shelley, 2016). Ultimately, adverse climatic conditions hinder farmers' expected rice production, creating a yield gap (contrasts between the modeled potential attainable crop yields under high-input and advanced management assumptions and the actual yields). Yield gaps also occur because coastal farmers are not adopting the best available production technologies, such as, setting up desalting plants, and improving the drainage system in their fields (Laborte *et al.*, 2012).

Similarly, farmers' crop yields and income are dependent on various exogenous factors, such as weather conditions and price fluctuations; hence, risk is ubiquitous in the context of farming decisions (Menapace *et al.*, 2012). Poor people are usually risk-averse, and they are unwilling to invest in the acquisition of modern assets because it involves taking risks (Mukasa, 2018). In such cases, farmers often prioritize investments such as hiring labor or ox-plowing rather than purchasing mechanized equipment or improved seeds to intensify production (Tittonell and Giller, 2013). On the other hand, the coastal population is relatively impoverished, and the production of Aman rice in coastal areas has decreased by approximately 15% due to climate change over the last ten years (Al-Amin *et al.*, 2017; Roy *et al.*, 2019). Moreover, due to the lower yield, farmers cannot obtain sufficient output to sell; consequently, their benefit from rice production is diminished, which creates a lack of confidence. Being risk-averse, farmers do not want to change fertilizer doses or adopt new production practices or new varieties in case this leads to production loss, which would lead them into the poverty situation. In Bangladesh, higher rice productivity largely depends on the expansion of hybrid and saline-tolerable variety of seeds, improved

management, and the timely supply of inputs (Islam *et al.*, 2017). However, the extent to which productivity leads to increased income and reduced poverty depends on efficiency in production and decreasing the yield gap. Poverty is also a factor that makes farmers less likely to take risks (Yusuf *et al.*, 2015), which increases the yield gap. Therefore, both high risk-aversion attitudes and higher yield gaps contribute to poverty.

To increase production, more areas under cultivation are required; attention must be focused on decreasing the yield gap (Mondal, 2011) and increasing efficiency (Laborte *et al.*, 2012). In recent years, crop yield gaps have been evaluated extensively worldwide (e.g. Grassini *et al.*, 2015; Van Oort *et al.*, 2015; Marin *et al.*, 2016; Guilpart *et al.*, 2017). In this context, Roy *et al.* (2019) conducted a study focusing on the yield gap and inefficiency among Aman rice farmers in coastal areas. Further, some studies have been conducted on Aman rice cultivation in Bangladesh (Mamun *et al.*, 2015; Zakaria *et al.*, 2014). However, studies on Aman rice in the climate-vulnerable coastal areas of Bangladesh focusing on the yield gap, risk attitude, and poverty are rare.

Therefore, this study contributes to the literature by examining the yield gap and the efficiency of Aman rice producers, which are linked to both the attitude toward risk and the poverty status. The findings can facilitate policy development by exploring the relationship among risk attitude, yield gap, and poverty, in order to develop a rational strategy for alleviating poverty in the study area and other similar regions.

MATERIALS AND METHODS

Study Area and Data Collection

Two stages of sampling procedure were used to select the Aman rice producers. First, the Dacope *Upazila* (a sub-district of the Khulna district) was selected purposively; it is located in the southern coastal area of Bangladesh (Figure 1). With

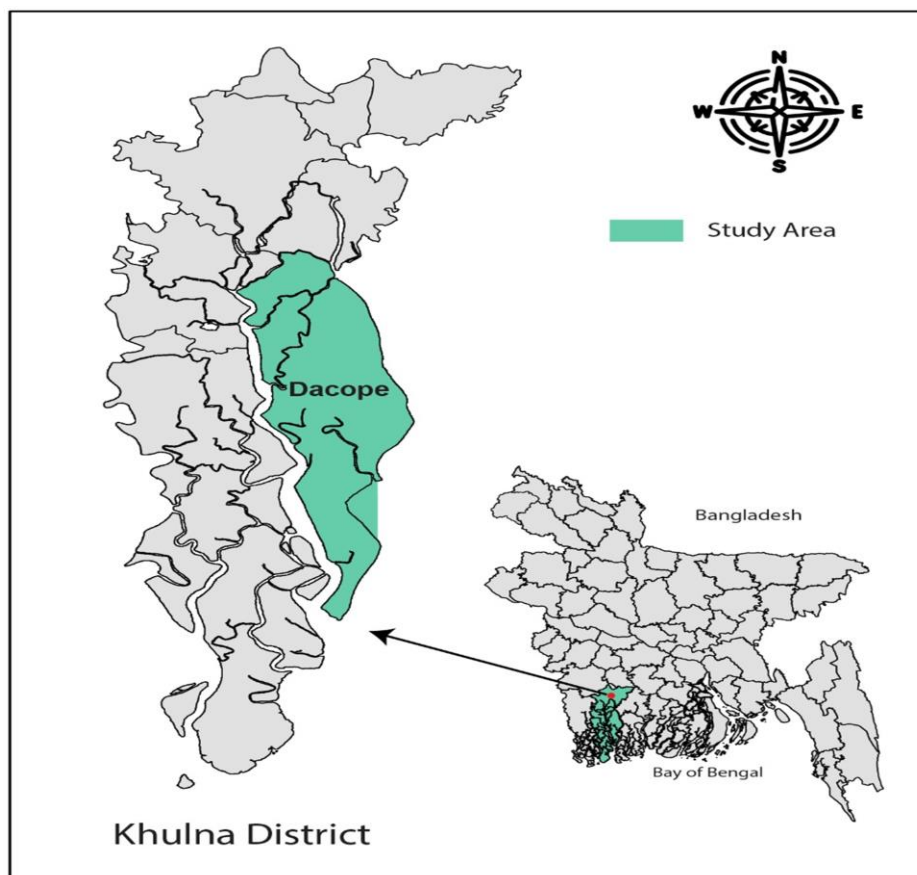


Figure 1. Map of the study area.

28,557 ha of land area, Dacope *Upazila* has a predominantly single T. Aman cropping pattern, with a cropping intensity of only 114% (Rashid *et al.*, 2017) where total area under the rice cultivation is 10.5 million ha and cropping intensity is 190 in Bangladesh (BBS, 2018). Second, information on Aman rice producers was collected from the Italicize Agricultural Officer (UAO), and a total of 125 Aman rice farmers were selected using a simple random sampling technique. The farmers were chosen based on various criteria, namely, having cultivated Aman rice in the previous year, having agricultural land near the coastal belt where saline water may intrude, and having at least ten years' farming experience (in relation to understanding climate change). The sample size was estimated in accordance with the

Slovin's formula (Asaduzzaman *et al.*, 2017):

$$n = \frac{N}{1 + Ne^2} = \frac{645}{1 + 645 * (0.08)^2} = 125.78 \text{ (125}$$

farmers)

Where, n is the sample size, N is the total number of farmers in the study area who met the mentioned criteria, and e is a margin of error (8%). Data were collected by directly interviewing sample farmers, through a well-developed interview schedule, from August to October in 2018. The interview schedule was pre-tested with ten farmers in the study area in order to improve, rearrange, and modify the interview schedule in the light of the practical examinations. Before collecting the data, each respondent was briefed regarding the purpose of the study. Secondary data were



also obtained from the Bangladesh Rice Research Institute (BRRI).

Analytical Techniques

Yield gap measurement

Three types of yield gaps, namely, modeled yield gap (YG_M), highest recorded yield gap (YG_R), and experimental yield gap (YG_E) were estimated as follows:

YG_M = Modeled yield potential – Average farmers' yield (1)

YG_R = Highest recorded yield – Average farmers' yield (2)

YG_E = Experimental yield – Average farmers' yield (3)

The model-based yield represents the highest potential yield attained by farmers through favorable combinations of soil, climate, and crop management in selected locations (Meng *et al.*, 2013). The highest recorded yield is the yield achieved by farmers at the selected locations under the most favorable ecological conditions with extensive inputs, regardless of the economic cost and environmental risk (Chen *et al.*, 2012). The experimental yield is the yield of a demonstration site published in the literature. The highest yield was calculated taking the average yield of the five most productive farmers from data to avoid the outlier problem. The experimental yield of Aman production was collected from the BRRI website: 5.50 ton/ha for the BBRI *dhan-23* variety (BRRI, 2017). The farmer's average yield was determined by dividing the total yield by the total number of sample farmers. The stochastic frontier model was employed to estimate the potential yield for calculating the modeled yield gap. After model validation, the stochastic (Aigner *et al.*, 1977; Meeusen and van den Broeck, 1977) production function, with the flexible functional form, was used, specified as follows:

$$\ln Y = \ln \alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \dots + \beta_i \ln X_i + V_i - U_i \quad (4)$$

Where, Y = Yield of Aman rice (kg ha^{-1}), X_1 = Seed (kg ha^{-1}), X_2 = Urea (kg ha^{-1}), X_3 = TSP (kg ha^{-1}), X_4 = MoP (kg ha^{-1}), X_5 = Insecticides (kg ha^{-1}), X_6 = Labor (man-days ha^{-1}), and $V_i - U_i$ = The disturbance term. The technical inefficiency effect model is defined as:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + W_i \quad (5)$$

Where, U_i = Inefficiency, δ = Parameter, Z_1 = Experience, Z_2 = Access to training, Z_3 = Access to credit, Z_4 = Access to extension services, and Z_5 = Number of earnings family members.

Risk attitude measurement

The risk attitude of Aman rice farmers was determined by employing the Safety-First model (Roy, 1952) of risk measurement, where the risk parameter was calculated as follows:

$$K(s) = \frac{1}{\theta} \left(1 - \frac{P_i X_i}{P f_i \mu_y} \right) \quad (6)$$

Where, $K(s)$ = Risk parameter, θ = Coefficient of variation of yield, P_i = Factor price [fertilizer (NPK)], X_i = Amount of fertilizer (NPK), μ_y = Mean yield, f_i = Elasticity of production of major input (NPK), and P = Price of Aman rice.

The farmers were classified into four groups based on risk parameter K . A farmer was considered to be risk-preferring if $K < 0$, low risk-averse if $0 \leq K < 0.4$, intermediate risk-averse if $0.4 \leq K \leq 1.2$, and high risk-averse if $1.2 \leq K \leq 2$ (Moscardi and de Janvry, 1977).

Poverty measurement

The income poverty level was estimated using the Foster-Greer-Thorbecke (FGT) (1984) model specified as;

$$P_\alpha = \frac{1}{n} \sum_{i=1}^q \left(1 - \frac{Y_i}{Z} \right)^\alpha \quad (7)$$

Where, P = Poverty index, α = Non-negative parameter (which takes the value 0, 1, or 2, indicating head-count ratio, poverty gap, or poverty severity), n = Total number

of farmers, q = Number of poor farmers, z = Poverty line relevant to a given income, and Y_i = Per capita income. The poverty line (z) for Bangladesh of US \$1.90 per adult per day was considered to measure poverty according to World Bank (2017). When α is 0, the equation is considered to show the incidence of poverty or head-count ratio, which is specified as:

$$P_\alpha = \frac{q}{n} \quad (8)$$

The head-count index indicates the proportion of poor farmers. When α takes the value of 1, then the equation will be:

$$P_1 = \frac{1}{n} \sum_{i=1}^q \left(1 - \frac{Y_i}{z}\right)^1, P_2 = \frac{1}{n} \sum_{i=1}^q \left(1 - \frac{Y_i}{z}\right)^2 \quad (9)$$

The Gini coefficient (Gini, 1921) was estimated to see whether the income of farmers was equally distributed or not.

To show the relationship between poverty, yield gap, and risk attitude for Aman rice farmers, polynomial regression was employed. Further, the empirical relationship between poverty, yield gap, and risk attitude, a logit model was used:

$$\ln\left(\frac{P}{1-P}\right) = Z = \alpha + \beta_1 X_1 + \beta_2 X_2 + \mu_i \quad (10)$$

Where, Z = The probability which measures the total contribution of the independent variables in the model and the dependent variable (poverty status), known as logit, Y = Poverty status of farmers [apart from different dimensions of poverty, if $Y=0$ the person is poor; if $Y=1$ the person is non-poor according to the World Bank (2017) poverty line (income US \$1.90/day/person)], X_1 = Attitude of farmers towards risk, and X_2 = Yield gap of rice production.

RESULTS

Yield Gap of Aman Rice Production

To determine the yield gap, farmers' average yield was calculated as 3.57 ton ha⁻¹, while the highest yield among sample farmers was recorded as 4.94 ton ha⁻¹, and the modeled yield was estimated at 4.67 ton ha⁻¹. The modeled yield gap, highest recorded yield gap, and experimental yield gap were estimated as 1.09, 1.3, and 1.93 ton ha⁻¹, respectively (Table 1). Among the three types of yield gap, the experimental yield gap was the highest.

There are many causes of yield loss, such as climate hazards, low quality of inputs, and inefficient use of inputs. However, farmers can control only the latter through the optimal use of inputs. Therefore, farmers' technical efficiency was estimated to see how much production could be increased through the existing level of inputs used. To estimate the efficiency level, Aman rice production was explained using several variables, namely, labor, seed, urea, TSP, MOP, and insecticides. The estimated parameters following the maximum likelihood estimation method of the Cobb–Douglas stochastic production frontier are presented in Table 2. The results reveal that labor, seed, urea, and insecticides have a significant effect on production volume; the greater the application of labor, seed, urea, and insecticides, the greater volume of production.

Table 2 also presents the inefficiency results, which show the contribution of socioeconomic variables to the technical inefficiency of Aman rice production. The inefficiency function is explained by five

Table 1. Yield gaps of Aman rice production in the study area.

| Yield type | Yield (ton ha ⁻¹) | Average yield (ton ha ⁻¹) | Yield gap (ton ha ⁻¹) |
|-----------------------------------|-------------------------------|---------------------------------------|-----------------------------------|
| Modeled potential yield (Y_M) | 4.07 | 3.57 | 0.50 |
| Highest Recorded yield (Y_R) | 4.94 | 3.57 | 1.37 |
| Experimental yield (Y_E) | 5.50 | 3.57 | 1.93 |

Note: 1 ha= 247 decimals.

**Table 2.** Maximum likelihood estimates for parameters of the Cobb–Douglas stochastic production function and the effect of technical inefficiency on Aman rice farmers.

| Variable | Coefficients | Standard error |
|-----------------------------|--------------|----------------|
| Intercept | 3.173*** | 0.349 |
| Labor | 0.258*** | 0.043 |
| Seed | 0.098* | 0.057 |
| Urea | 0.370*** | 0.056 |
| TSP | -0.029 | 0.085 |
| MoP | 0.082 | 0.075 |
| Insecticides | 0.230*** | 0.050 |
| Inefficiency model | | |
| Intercept | 0.196*** | 0.032 |
| Experience | 0.002 | 0.001 |
| Access to training | -0.062* | 0.037 |
| Access to credit | -0.059* | 0.034 |
| Access to extension service | 0.033 | 0.032 |
| Earning members | 0.007 | 0.023 |
| Variance Parameter | | |
| Sigma-square | 0.011*** | 0.002 |
| Gamma | 0.999*** | 0.002 |
| Mean efficiency | 0.8448 | |

Note: *** and * denote significance at the 1 and 10% levels, respectively.

variables, namely, experience, access to training, access to credit, access to extension services, and number of earning family members. The results reveal that the farmers' access to training and credit has a statistically significant effect on technical inefficiency. That means, if farmers have received training and credit for Aman rice production, their efficiency would be increased, due to farmers learning about new technology and gained knowledge from training related to production and applied in the field. Farmers can also invest in the production process if credit is available to them. Further, the gamma (γ) parameter was significant, implying that inefficiency factors have a significant impact on rice production and inefficiency among the sample farmers. The overall mean efficiency was found to be 84.48%, implying that approximately 16% of yield gaps could be reduced through the optimal use of inputs.

Risk Attitude of Aman Rice Farmers

Risk-preferring farmers are inclined to change the major input doses or adopt new

cultivation techniques or rice varieties. Low risk-averse farmers might decide to be risk-preferring or not, but they are unlikely to take risks. However, risk-averse farmers showed no risk-taking propensity, and their decisions in terms of taking risks were guided by their skeptical attitude concerning yield loss. Specifically, due to the loss of yield, their economic condition would be worsened and they may fall into the poverty trap to an event greater extent than before. Fertilizer was selected as a major input in calculating the coefficient of attitude towards risk because it is important for increasing yield, based on the agronomical perspective. Farmers first need to be certain of the appropriate amount of fertilizer to use in the field. The results show that 64.52 % and 27.42% of the selected farmers were high and intermediate risk-averse, respectively, implying that most farmers had no risk-bearing ability (Table 3). Only 1.61% of the farmers were found to be risk-preferring; willing to change the major input doses or adopt new cultivation techniques. Further, the results show that 6.45% of the farmers were low risk-averse, indicating that

Table 3. Distribution of farmers according to risk attitudes.

| Risk attitudes of farmers | Frequency | Percentage | Cumulative percentage |
|---------------------------|------------------|------------|-----------------------|
| Risk-preferring | 2 | 1.61 | 1.61 |
| Low risk-averse | 8 | 6.45 | 8.06 |
| Intermediate risk-averse | 34 | 27.42 | 35.48 |
| High risk-averse | 80 | 64.52 | 100 |
| Total | 125 ^a | 100 | |

^a Is the total sample size in the study.

Table 4. Poverty and inequality measurement of Aman rice farmers.

| Parameter | Value |
|--|-------|
| The incidence of poverty or head-count ratio | 0.51 |
| Poverty gap | 0.15 |
| Gini coefficient | 0.21 |

only a small number of farmers were somewhat likely to take risks.

Poverty Status of Aman Rice Farmers

The yield gap and risk-taking propensity related to input use might have a substantial effect on the poverty status of Aman rice producers since they are highly dependent on rice production. The results indicate a head-count ratio of 0.51, implying that 51% of farmers in the study areas were living below the poverty line (Table 4). Furthermore, the level of poverty or poverty gap was found to be 0.15, indicating that the mean income of the farmers fell 15% below the poverty line. The value of the Gini coefficient was 0.21, implying that there was an approximately equal distribution of income among the sampled farmers.

Relationship among Yield Gap, Risk Attitude, and Poverty

Relationships among yield gap, risk attitude, and poverty were examined in two ways: graphical presentation with polynomial regression line and logit model. Polynomial regression reveals the relationship between the yield gap and risk attitude.

Figure 2 illustrates the relationship of the three kinds of yield gap with the risk attitude of farmers, indicating that, with increasing risk aversion, the yield gaps significantly increase, meaning that, if the farmers are not willing to take risks, they subsequently obtain less yield. In coastal areas, farmers tend not to be interested in taking risks to explore the potential and highest level of production through improving the technological practices and scientific input management. Thus, the potential and highest recorded yield gap increase in line with farmer's risk attitude.

The coefficients of both yield gap and risk attitude were negative but statistically significant at the 5% level, meaning both yield gap and risk attitude had a significant negative impact on the poverty status of Aman rice producers (Table 5). This implies that farmers who had more yield gap had less probability of being non-poor, that is yield gap and poverty were positively related. At the same time, if other factors remain the same, but farmers are more risk-averse, the probability of being non-poor decreases, that is the probability of being poor increases. This means, if the risk-aversion attitude of farmers and yield gaps increase, poverty will also be increased. The yield gap should therefore be reduced, while farmers also need to be engaged in other types of income-generating activities as well as rice production in coastal areas.

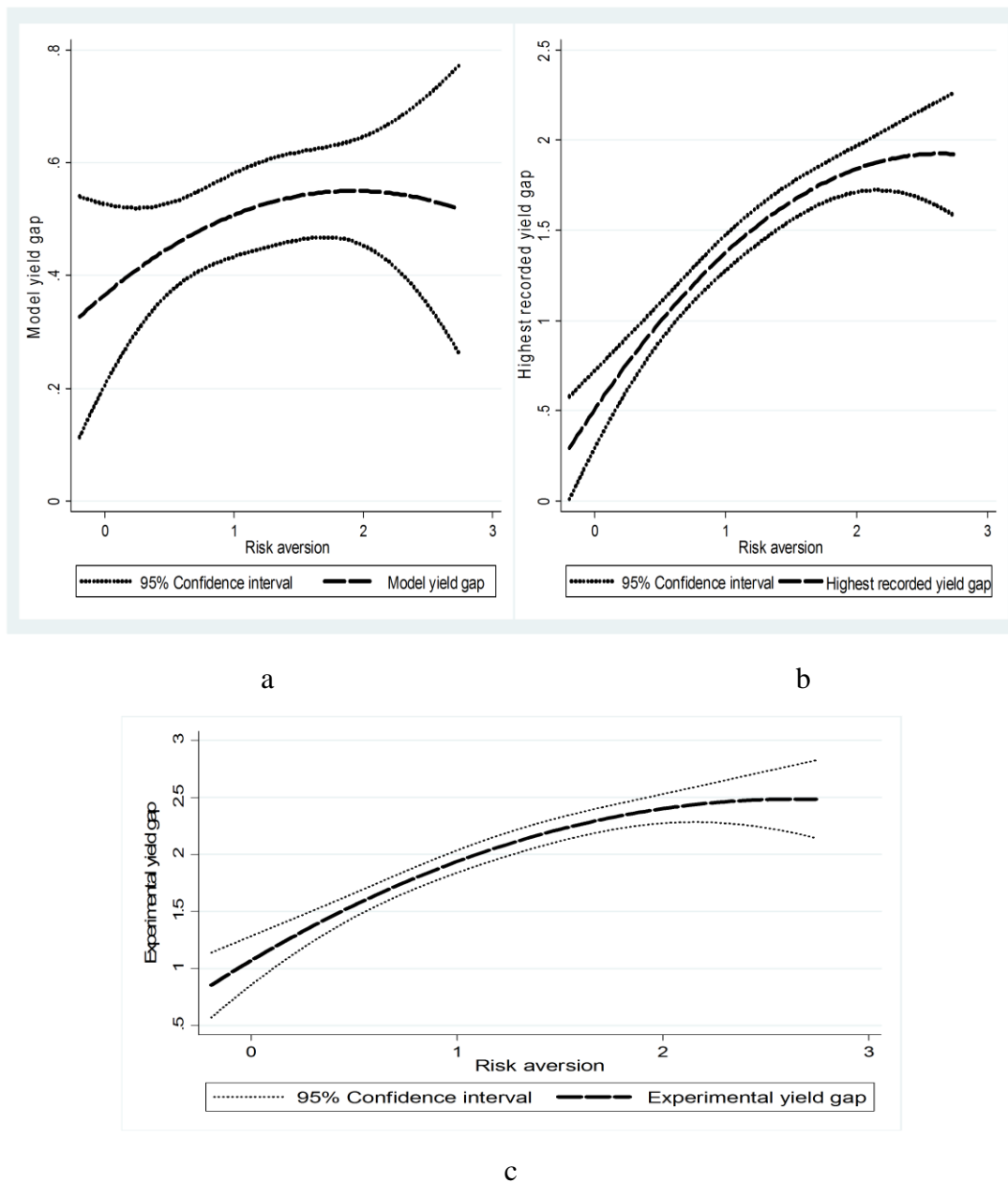


Figure 2. Relationship between (a) Modeled yield gap and risk aversion, (b) Highest recorded yield gap and risk aversion, and (c) Experimental yield gap and risk aversion.

Table 5. Effects of yield gap and risk attitudes on poverty.

| Variable | Coefficient | Standard error |
|---------------|-------------|----------------|
| Intercept | 2.139*** | 0.589 |
| Yield gap | -0.002** | 0.001 |
| Risk attitude | -0.649** | 0.316 |

Note: *** and ** denote significance at the 1 and 5% levels, respectively.

DISCUSSION

Yield gaps exist when farmers are producing less than the expected yield. The yield gap of Aman rice production was estimated higher because the coastal area is affected greatly by natural disasters. Roy *et al.* (2019) found similar results in another coastal district of Bangladesh named Satkhira. The difficulty lies in reducing the experimental yield gap because the experimental yield is obtained only in good agronomic conditions and with proper doses of inputs. Soil and environmental conditions do not, however, always remain the same in all production areas. In contrast, the potential yield gap might be lessened if farmers are able to manage the inputs efficiently to attain the highest possible efficiency level. However, the yield gap is rising in coastal areas because the potential yield of rice gets hampered due to the changing climate conditions such as the radiation, temperature, and precipitation during the growing season (Guo *et al.*, 2019). Moreover, the phenology of rice is very sensitive to changes in climatic parameters and farmer's force to change their plating date (Guo *et al.*, 2021); consequently, actual yield of rice is decreasing in climate vulnerable coastal areas. To secure the maximum attainable yield, farmers in the study area may augment the usage of labor, urea, and insecticides to boost Aman rice production with existing technology since they have a significant positive effect. The results show that the per hectare productivity could be increased, on average, to 4.07 ton ha⁻¹ from 3.57 ton ha⁻¹ if farmers utilize their production input at the maximum efficiency level. This finding is supported by other studies such as Hasnain *et al.* (2015) and Khan *et al.* (2010), who found that Aman rice production could be increased by 10–14% in Bangladesh.

Farmers' yield gap and inefficiency in the use of inputs depend on their risk-taking propensity. The majority of farmers had no-

bearing ability; hence, their decisions in relation to taking risks were influenced by concerning yield loss, resulting in their economic condition worsening and potentially finding themselves in a situation of indigence. A similar result was found by Aye and Oji (2007), who reported that only 0.83% of farmers were risk-preferring. However, the yield gap and risk attitude of the sampled farmers lead to the poverty situation, with almost half of the respondents living below the poverty line. This figure is far above the national level of 21.8% (BBS, 2018), due to small and marginal farmers in the coastal region relying on rice production, which is hampered both by salinity and natural disasters. Moreover, most coastal farmers are vulnerable to climate change and have fewer adoption capacities to salinity intrusion. If their agricultural land is severely flooded with saline water, the land cannot easily be re-used for agricultural purposes because of the non-availability of freshwater and irrigation facilities. Consequently, their production is hampered, which may lead to the increased incidence of poverty. Further, small farmers cannot easily switch from rice farming to, for example, commercial shrimp farming, which is more capital-intensive. The sampled coastal farmers remained poor because of less diversification of income activities, less profitable rice cultivation, the high cost of transformation from rice to more profitable shrimp production, lower production of crops due to saline water. There is, therefore, a need to transfer cash to poor people to enable them to lift themselves out of poverty.

Notably, poverty, farmer's attitude toward risk, and the yield gap in production may be interlinked. Due to poor living conditions, farmers cannot find the funds necessary to purchase inputs; they also suffer from a poor lifestyle and poor food. Consequently, they cannot acquire the required number of inputs, while simultaneously suffering from physical inefficiency. The ultimate result is inefficiency in rice production. This inefficiency causes the yield gap and



production losses. The loss of production affects farmers' attitudes towards accepting the risk of adopting new technology. Thus, the yield gap and farmers' attitude toward risk result in a monetary loss for farmers and a reduction in further risk-taking propensity, which hampers further production as well as negatively affecting their livelihood. Thus, a strong relationship among yield gap, farmers' attitude toward risk, and poverty is established. If a yield gap arises, then the farmer tends to become more risk-averse, and the yield gap causes poverty. The yield gap should be reduced and farmers also need to engage in other types of income-generating activities, along with rice production, in the coastal areas of Bangladesh.

CONCLUSIONS

Most farmers in the climate-vulnerable coastal region of Bangladesh are producing Aman rice as their staple food item, but rice production has been affected by various natural calamities. As a result, yield gaps may arise and farmers' risk aversion may increase. Therefore, this study tried to estimate the yield gap, risk attitude, and poverty status of Aman rice producers in the coastal region of Bangladesh. It is evident from the results that a substantial yield gap exists in the study area. However, the farmers could obtain greater yields if they could increase their efficiency level. Risk aversion and yield gap are significantly related to poverty. If a farmer is risk-averse and a yield gap exists in their production process, then the farmer is likely to fall into situation of poverty. Based on the findings for the measurement of risk attitude, it is clear that most farmers in coastal areas are risk-averse. Therefore, the risk attitude of farmers needs to be changed. As half of the sampled farmers are in poverty in the study area, an increase in production by reducing yield gaps and changing behavior in relation to risk can bring economic improvement to poor farmers' lives.

Finally, this paper suggests that the reduction of yield gaps can be achieved if farmers attempt to either follow trail-field rice cultivation techniques or those of farmers who obtain the best returns from Aman rice cultivation in coastal areas. Improvement in agronomic practices can also narrow all types of yield gaps. Emphasis should be given to developing new, high-yield, salt-tolerant rice varieties, and these should be disseminated among farmers in coastal areas. The relevant government offices and NGOs can prescribe the appropriate doses of fertilizer and insecticides, along with ensuring the regular supply of inputs at a subsidized price to coastal farmers.

Although the study comes up with interesting findings, like any study, there are some limitations, which pave the way for future research. Firstly, the study employed relatively conventional methods due to unavailability of data, therefore, the advanced method such as machine learning and deep learning should be explored in the future analysis. However, rice phenology (planting date) should be considered for analyzing the yield gap since it can be affected by climate change. Secondly, this was a field-level study using face-to-face interviews; hence, the responses are dependent on respondents' honesty and reliable recall. Thirdly, because of time and budget limitations, it was not possible to cover all coastal areas. Therefore, the study results cannot be generalized to all coastal areas of the country.

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شکاف عملکرد، نگرش خطر پذیری، و وضعیت فقر برنجکاران فصل بارانی در مناطق ساحلی آسیب پذیر به آب و هوا در بنگلادش

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چکیده

کشاورزان مناطق ساحلی در بنگلادش در برابر صدمات آب و هوایی که بهره وری کشاورزی و معیشت را تحت تاثیر قرار می دهد آسیب پذیر هستند. در این پژوهش، شکاف عملکرد، خطر پذیری، و وضعیت فقر برنجکاران فصل بارانی (Aman rice) بررسی شده و نیز رابطه بین آنها در مناطق ساحلی آسیب پذیر به آب و هوا در جنوب بنگلادش ارزیابی شد. به این منظور، ۱۲۵ برنجکار با روش ساده نمونه برداری اتفاقی برای تعیین شکاف عملکرد انتخاب شدند. برای محاسبه خطر پذیری، از مدل اول-خطر (safety-first model) استفاده شد و مدل Foster-Greer-Thorbecke برای برآورد وضعیت فقر به کار رفت. نتایج تحقیق برای برنج فصل بارانی شکافهای عملکردی مهمی را آشکار ساخت، در حالیکه کشاورزان این موقعیت را داشتند تا با استفاده بهینه و مدیریت علمی از نهاده ها، محصول را افزایش دهند. شکاف های عملکردی انعکاسی بود از نگرش خطر گریزی کشاورزان که بیشتر آن ها بسیار خطر گریز بودند. این پژوهش همچنین آشکار ساخت که نیمی از کشاورزان مزبور فقیر بودند و دارای شکاف فقر ۱۵٪. با این وجود، به علت کاهش در شکاف عملکردی و درخطر گریزی کشاورزان، تعداد غیر-فقیران افزایش نشان داد. بنا براین، نتایج تحقیق چنین اشاره دارد که برای مدیریت نگرش خطر گریزی کشاورزان، شکاف عملکرد باید کم شود، که این امر بهبود وضعیت فقر آنها را نیز تسهیل می کند.