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Farmers' supply response and perception of rice procurement program in Bangladesh

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Rice farmers in Bangladesh do not get proper returns due to lower market prices and many unexpected situations that affect the supply of rice. Hence, the government introduced the rice procurement program to minimise the financial risk of the farmers. This study tried to analyse the supply response to rice production and assess the farmers' perception of government procurement program, including their financial risk of rice production. Vector autoregressive (VAR) model was employed to analyse the supply response of rice using secondary data. Additionally, 100 Aman and Boro rice farmers were interviewed for assessing their financial risk and perception of the rice procurement program. The result reveals that production was significantly affected by the production of the last two years, rainfall and exchange rate. The financial risk was found more in Aman rice than that of Boro rice production, and this risk occurred due to a lower market price. It was also found that no farmers sold rice directly to the procurement centre, and they had no knowledge of the rules and regulations of the procurement program. Therefore, farmers were getting a lower price than the procurement price, that profited the middlemen. The study suggests direct rice collection from the farmers to make the procurement program effective, as well as the need to disseminate appropriate rules and regulations among the rice producers.

1. Introduction

Agriculture contributes 14.23 per cent of the total GDP of Bangladesh, and it is highly dominated by rice production (BER, 2018). Because of industrialisation, cultivated land decreased in some of the popular rice-growing regions (Rezvi, 2018). However, rural farmers tend to produce more rice by cultivating modern HYV varieties which are highly responsive to inorganic fertilisers and insecticides (Khan et al., 2012; Islam et al., 2017; Roy et al., 2020). The cultivation of these high yielding modern grain varieties of rice with effective soil management and water control helped the country to meet the increasing demand for food grain (Rasha et al., 2018). In FY 1972-73, total area and total production of Aman and Boro rice were 66.99 lac hectares and 76.57 lac metric tons respectively. Both the total area and production of Aman and Boro rice increased to 105.39 lac hectares and 335.69 lac metric tons respectively (Figure 1) over the last five decades (BBS, 2018).

The common characteristics of the price of rice are its instability and seasonal fluctuation (Rahman, 2019). In most cases, farmers get a comparatively lower price in the harvesting season (Nziguheba et al., 2010). Due to the risk of lower market price and unfavourable conditions of different factors, rice-producing farmers may not produce the same amount of rice the following year in their cultivated land. To resolve

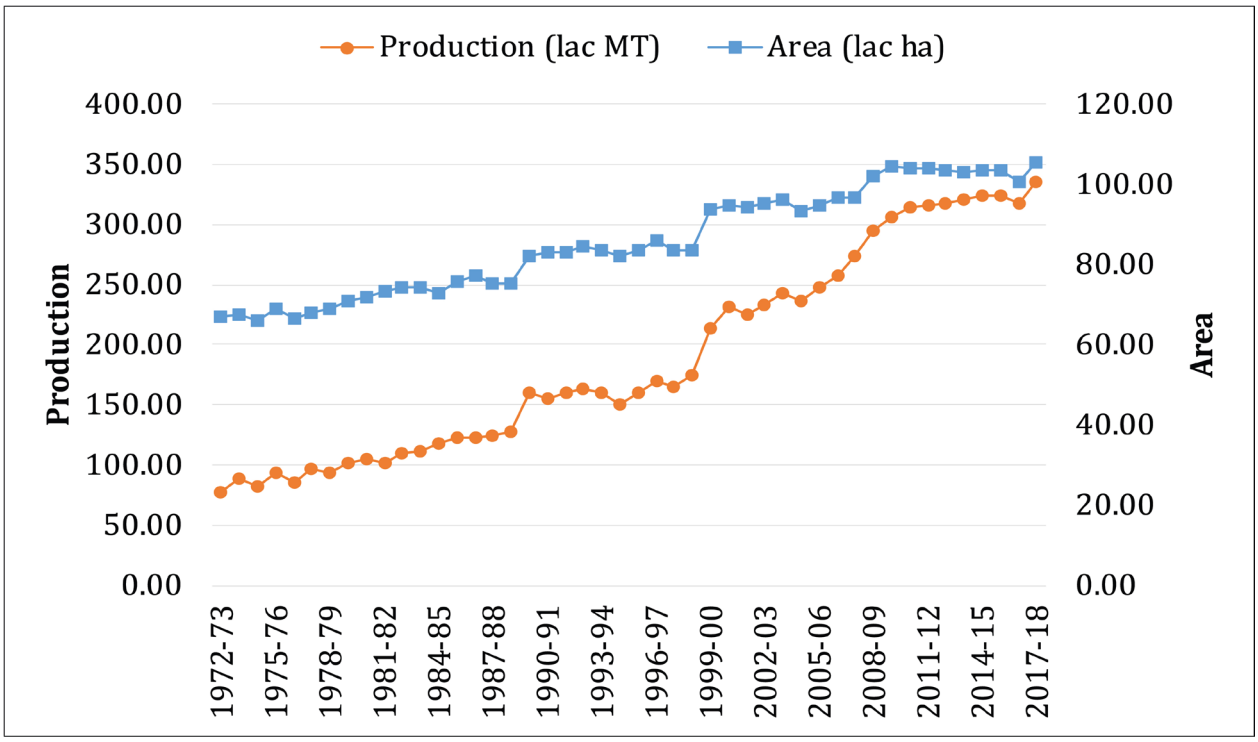

Figure 1. Area and production of rice (Aman and Boro) in Bangladesh, Source: BBS (2018).

this issue and support farmers against lower market prices, the government of Bangladesh has been procuring rice from the farmers since the 1970s (Alam et al., 2015). The government procurement program was formed to attain two goals. The first goal was to build rice stocks for the public food grain distribution system (PFDS), and the second was to provide income support to farmers (Alam et al., 2015). The procurement program would declare a price known as the minimum support price that takes all factors into account relevant to the production of rice. Procurement prices must be higher than the production cost to ensure a profit for the producers, which will embolden them to continue or increase rice production (Raha et al., 2013). Besides, the government has made several changes in the procurement program over the years to make it more effective such as listing farmers, increasing targeted quantity of procurement, procuring through a mobile app, etc. (Roy et al., 2019; Amin, 2020; Parvez, 2020). However, due to lack of information and communication, farmers do not get the benefits of this program, and intermediaries take advantage of this opportunity (Zahid, 2020). Incentives through procurement prices are based on the assumption that the market price of rice will be higher with a procurement program than without one. Besides, procurement centres were reported to collude with the millers and middlemen rather than buying from producers (Shahabuddin et al., 1999; Ali, 2010; Alam et al., 2020). So, if the procurement program fails in influencing the market price, the desired benefit will not be realised. Therefore, the effectiveness of procurement is a necessary condition for ensuring incentives to farmers.

However, farmers' supply response is mostly dominated by non-price factors over price factors (Krishna, 1962; Askari & Cummings, 1976; Gulati & Kelly, 1999; Ampadu-Ameyaw & Awunyo-Vitor, 2014). Non-price factors include the area of production, rainfall, import, exchange rate, etc. Because of the imperfect condition of such factors, farmers may become reluctant to grow more rice in the next production period. Different studies have been conducted on rice procurement programs and farmers' supply response. Khan et al. (2018) studied the supply response of rice in the Khyber Pakhtunkhwa province of Pakistan using time series data and found a positive effect of the lag market price on production. Ayinde et al. (2017) determined the responsiveness of rice supply to price risk in Nigeria and found that producers are more responsive not only to price and non-price factors but also to price risk and exchange rate. Edison (2015) analysed rice farmers' supply response, and input demand planting

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rice in the Jambi Province was estimated using profit function analysis. Alam et al. (2015) examined the effectiveness of the rice procurement program and analysed the factors influencing farm level rice stocks. Shemu et al. (2013) assessed the effectiveness of the government Boro paddy procurement program in the Mymensingh district of Bangladesh. Kuwornu et al. (2011) analysed the responsiveness of rice production in Ghana, and they found significant effects of output, rainfall, and the real price of maise and real price of rice on the land area cultivated of rice. Rahji & Adewumi (2008) examined the supply response and demand for local rice in Nigeria using OLS and 2SLS techniques. Despite these studies, there are limited studies on farmer's perception of the rice procurement program, financial risk and their supply response in Bangladesh. Hence, the main objective of this study is to estimate farmers' response to rice production in Bangladesh and to analyse farmers' perception of government rice procurement program, including the financial risk of rice production. Since procurement programs are implemented worldwide to support the farmers, the insights of this study might also facilitate the procurement policy decisions in other parts of the world, where applicable.

2. Materials and Methods

2.1 Sampling procedures and data description

This study used both primary and secondary data to achieve the objectives. To analyse the supply response to rice production, secondary data were collected from the Bangladesh Bureau of Statistics (BBS) and the Bangladesh Meteorological Department (BMD). Data included total cultivated area, total rice production, average yield, average rice price, average rainfall, quantity imported and the exchange rate of 43 years (from FY1972-73 to FY2015-16). Primary data was collected to assess financial risk and farmers' perception of the government procurement program. A field survey of different farmers who produce Aman and Boro rice was conducted following a three-stage procedure. Initially, Natore district was purposively selected as it is one of the districts where a significant share of annual rice in Bangladesh is produced. Secondly, five Upazilas (sub-districts) from the Natore district were selected based on production for core study areas. Finally, lists of rice-producing farmers were collected from the Upazila Agriculture Offices, and a total of 100 farmers were selected through simple random sampling technique. A draft interview schedule was developed and pre-tested with a few sample farmers. Then the interview schedule was corrected and finalised according to the objectives. Cross-sectional data included information on socioeconomic characteristics of the farmers, costs and returns of rice production and their knowledge regarding the government procurement program.

2.2 Analytical techniques

This study employed both descriptive statistics and econometric analysis to fulfil the objectives. Different summary statistics like sum, percentage, average, ratios, etc. were estimated and presented in tabular and graphical illustration form to assess the financial risk and perception of farmers.

2.2.1 Vector autoregressive (VAR) model for rice supply response

Vector autoregressive (VAR) model is advantageous in macroeconomic forecasting (Karlsson, 2013). This model was widely used to estimate the supply response in several studies (Ayinde et al., 2017; Yixian et al., 2018). A p^{th} order vector autoregression can be written as follows (Hamilton, 1994):

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \cdots + \beta_p Y_{t-p} + \varepsilon_t \quad (1)$$

where Y_t is an $(n \times 1)$ vector of a given realisation (at time t) of n variables, α is an $(n \times 1)$ vector of constants, β_j is an $(n \times n)$ matrix of autoregressive coefficients (with j having values from 1 to p), and ε_t is an $(n \times 1)$ vector describing noise in the data.

In supply response analysis, empirical work based on time series data assumes that the underlying time series is stationary. If a time series is stationary, its mean, variance and autocovariance remain the same no matter at what point they are measured; that is, they are time-invariant. When the non-stationary time series is used in any regression model, one may obtain significant relationships from unrelated variables. Stationary or non-stationary variables can be tested with the unit root test. Unit root test can be defined as follows:

Let the random walk model as:

$$Y_t = \rho Y_{t-1} + \varepsilon_t \text{, where } -1 \leq \rho \leq 1 \quad (2)$$

Here if ρ = 1, then the unit root problem is faced, which is a situation of non-stationarity. In this case the variance of Y_t is not stationary.

The Dickey-Fuller and Augmented Dickey-Fuller test is commonly used to check the unit root of time series data. The Augmented Dickey-Fuller (ADF) test is more satisfactory to test for a more extensive and more complicated set of time-series models and to accommodate some forms of serial correlation. The Augmented Dickey-Fuller test has been used to test the stationarity for this study.

To get the idea of the ADF test, first, the method of the DF test is briefly discussed. Let the stochastic process be as follows:

$$Y_t = \delta + \rho Y_t + \varepsilon_t \quad (3)$$

Where ρ =1 corresponds to a unit root. To test the null hypothesis that : $H_0 : \rho = 1$ that against the alternative hypothesis $H_1 : |\rho| < 1$, the Dickey-Fuller test can be written as:

$$DF = \frac{\rho - 1}{se(\rho)} \quad (4)$$

Here ρ is the ordinary least square (OLS) estimator and se(ρ) represents the usual OLS standard error.
The testing procedure for the ADF test is the same as the Dickey-Fuller test, but it is applied in the model with:

$$\Delta Y_t = \beta_1 + \beta_{2t} + \rho Y_{t-1} + \delta_i \sum_{i=1}^{m} \Delta Y_{t-1} + \varepsilon_t \quad (5)$$

Where ε is a pure white noise error term and $\Delta Y_t = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$ etc.

In ADF, we test whether ρ=0. The ADF statistics, used in the test, is a negative number. The more negative it is, the stronger the rejections of the null hypothesis suggesting that there is a unit root at some level of confidence. Alternatively, the corresponding p-value of the test statistics can also be used to find the significance of the null hypothesis.

The number of lagged difference terms to include in the ADF test may be determined by minimising the Schwarz or Bayesian Information Criterion (SIC) or minimising the Akaike Information Criterion (AIC), or lags are dropped until the last lag is statistically significant. If the time series has a unit root (non-stationary), the first differences of such time series are stationary (Gujarati et al., 2003). Once time-series data exhibits the stationarity property, the statistical inferences can then be conducted on it. The result of the ADF unit root test is summarised in Table 1.

Using the ADF unit root test on the levels and first difference of the economic series, no variables were found stationary at the level. At the same time, virtually all were stationary at first difference. Natural logarithm was taken to linearise the variable for easy attainment of stationarity. Besides, the t-test and F-test were used for the test of significance, and Durbin Watson (DW) test was used to detect the first-order autocorrelation for this study. The result of Durbin's alternative serial autocorrelation confirmed that there was no serial autocorrelation. Therefore, the empirical model in this study was as follows:

$$Y_t = \alpha_0 + Y_{t-1} + Y_{t-2} + Y_{t-3} + yield_t + import_t + price_t + rainfall_t + exchangerate_t + \varepsilon_t \quad (6)$$

Where,
Y_t= total production; Y_{t-1}= previous year production; Y_{t-2} = two years back production; Y_{t-3}= three years back production; $yield_t$ = total yield of rice; $import_t$ = quantity imported of rice; $price_t$= price of rice; $rainfall_t$ = average rainfall; $exchangerate_t$ = exchange rate of Dollar and Bangladeshi Taka(BDT); ε_t= error term.

2.2.2 Financial risk analysis

The financial risk of rice was calculated as the difference between expected return and actual return, where the standard deviation and coefficient of variation were used to examine the level of risk (Barry, 1984). The coefficient of variation is expressed as the ratio of standard deviation and mean. A higher coefficient of variation indicates higher risk and vice versa.

3. Result and discussion

3.1 Rice farmers' supply response in Bangladesh

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Table 1. Result of the ADF unit root test for level and 1st difference

Unit Root Test	Time Series Variables	Test statistics	1% critical value	5% critical value	Decision
Augmented Dickey-Fuller (lag=2)	Area in level	-0.889	-3.641	-2.955	Nonstationary
	Production in level	-0.701	-3.641	-2.955	Nonstationary
	Import in level	-1.248	-3.641	-2.955	Nonstationary
	Price in level	-0.337	-3.641	-2.955	Nonstationary
	Exchange in level	-2.763	-3.641	-2.955	Nonstationary
	Rainfall in level	-2.707	-3.641	-2.955	Nonstationary
	Area in first difference	-4.171	-3.648	-2.958	Stationary
	Production in first difference	-4.028	-3.648	-2.958	Stationary
	Import in first difference	-3.779	-3.648	-2.958	Stationary
	Price in first difference	-4.678	-3.648	-2.958	Stationary
	Exchange in first difference	-4.660	-3.648	-2.958	Stationary
	Rainfall in first difference	-5.623	-3.648	-2.958	Stationary

On analysing the data using vector autoregression, the supply output response of rice forms an equation with the production, producer price, yield, quantity imported, rainfall and exchange rate. The results of the vector autoregressive model for the supply response of rice in Bangladesh are presented in Table 2.

Results revealed that the production of the last two years had significant effects on the present year's production of rice. It implies that their previous two-year production influenced farmers' decision about the present year's production, but they could not recall more than two years back production in decision making. Rainfall had significant effects on the production of rice. That means the amount of rainfall in the previous year influenced farmers' decision on producing rice since it is a crucial component of rice production in Bangladesh. This result was also supported by Rokonuzzaman et al. (2018). The exchange rate also had a significant effect on the production of rice, which may have occurred due to an expected decrease in rice importation. The results are consistent with the studies of Ammani (2013), Tanko & Alidu (2016) and Ayinde et al. (2017). Though price is the most critical factor in supply response, it showed an insignificant effect. Most of the farmers in Bangladesh produce rice for consumption as well as commercial purposes (Ahmed, 2004). Therefore, farmers may not emphasise much on the previous year's price of rice in the present year's production plan during the rice season. However, their return depends on the market price, and it is relevant to analyse their financial risk to assess how market price affected their return.

3.2 Assessing the financial risk of the farmers

Price risk is the result of price uncertainty that affects producers when they make production, and the market price is remarkably lower than expected (Gemech et al., 2011). It may be downside when the actual price is lower than the expected price or upside when the actual price is higher than the expected price. Producers are more concerned about the downside risk due to apprehension of low income. However, upside risk also affects the farmers in a loss of opportunity for higher production and higher income (Mohan, 2007; Dick & Wang, 2010; Pasaribu, 2010; Wolf, 2012). Farmers always try to produce higher production, and they expect a higher return, but the actual situation becomes different. So, they fall at risk of not getting expected proper returns. The results of the financial risk analysis of Aman and Boro rice in this study are shown in Table 3.

Aman producing farmers' average expected return was BDT 67631 per hectare, and the average actual return was BDT 53204 per hectare. The financial loss/risk in Aman rice was BDT 14427 per hectare. On the other hand, Boro producing framers' total expected return was BDT 202311 per hectare, and the total ac-

tual return was BDT 163113 per hectare. Therefore, its financial risk/loss was BDT 39198 per hectare. Results partially support the findings of Lucky et al. (2018) and Chanda et al. (2019). Standard Deviation of Aman and Boro rice was found 6806 and 9322, respectively, and the coefficient of variation (CV) for Aman rice was 76%, and for Boro rice, it was 35%. It implies that the risk in Aman rice production was higher than Boro rice production. Boro season is most suitable for rice production, and its production is higher due to proper operational management and weather condition (Rahman et al., 2013). Although the price is lower at times, higher production can cover the production cost of the farmers. However, the Aman rice season is affected severely by many natural hazards, mainly floods and droughts (Paul & Rasid, 1993; Mondal, 2010). Therefore, the production of Aman rice and the price of rice is simultaneously lower. For that reason, most of the farmers do not want to produce Aman rice as the same amount of Boro rice.

Consequently, the risk in Aman rice is higher than

Table 2. Result of vector autoregressive model for supply response

Variables	Coefficient
d-production L1	-0.8909***
	(0.1509)
d- production L2	-0.4551**
	(0.1917)
d- production L3	-0.1029
	(0.1515)
d-Lnprice	0.0001
	(0.0001)
d-Lnyield	0.0013
	(0.0012)
d-Lnimport	0.0000
	(0.0002)
d-Lnrainfall	0.0001**
	(0.0000)
d-Lnexchangerate	0.6814***
	(0.2550)
Constant	-0.6846
	(0.8313)

[Note: (***), (**), (*) denotes 1% and 5%, 10% significance level respectively and value in the parentheses indicates standard error.]

Table 3. Results of financial risk analysis of Aman and Boro rice

Items	**Aman**	**Boro**
Expected price (BDT/kg)	23.73	27.79
Actual price (BDT/kg)	20.33	23.84
Expected production (kg/ha)	2850	7280
Actual production (kg/ha)	2617	6842
a. Expected Return (Tk./ha)	67631	202311
b. Actual return (BDT/ha)	53204	163113
Financial risk (BDT/ha) (a-b)	**14427**	**39198**
Standard Deviation	6806	9322
Coefficient of Variation (%)	**76**	**35**

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Boro rice. Because of this financial risk, the government procurement program was introduced to support rice farmers of the country. Thus, the following section discusses the existing procurement system as well as assesses the farmers' perception of the procurement program.

3.3 Present scenario of rural rice market and government procurement system

The price of rice is determined mostly by domestic factors rather than by international price fluctuations because rice is a non-exported good in Bangladesh (Talukder & Chile, 2014). There are substantial seasonal variations in rice prices in the rural markets. The seasonal variations could be attributed to local seasonal demand and supply responses. Rice syndicates work as intermediaries in the market between producer and consumers. Most survey respondents expressed the opinion that rice syndicates dominated the market in rural areas. These syndicates are a group of predominantly urban rice traders and merchants. They work in association with rural elites such as the managers of rural rice markets, political leaders, and local rice traders. They seized the opportunity from seasonal rice price changes, buying at the lower price during the peak seasons, and selling at a much higher price during the lean seasons. Therefore, they captured most of both producers' share and consumers' share. The supply chain of rice from the producers to the procurement centre and actors involved is shown in Figure 2.

The demand for rice decreases drastically during the peak season because all farmers consume their self-grown rice. But, the supply of rice significantly increases because all farmers sell rice for meeting their usual household expenditure and loan repayments, including small farmers, some of whom are predominantly net buyers, (Talukder & Chile 2014). These demand and supply responses jointly push rice prices down to achieve equilibrium in the local rice market. However, the main goal of this procurement price is to provide a support price higher than the cost of production to ensure that farmers do not produce at a loss. But this procurement program provides support to the middlemen rather than farmers. Middlemen such as traders at the local market, bepari (local wholesaler), miller, etc. purchase rice from farmers at a lower rate but sell it at a higher rate to government procurement centre. Moreover, setting procurement prices substantially above market prices encourages rent-seeking behaviour and corruption (Auriol et al., 2016).

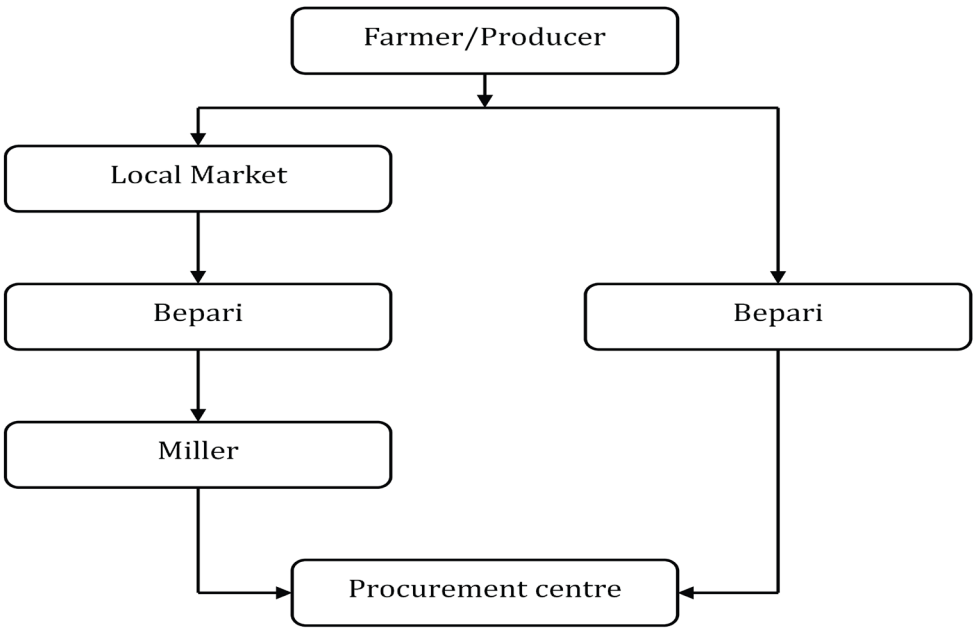

Figure 2. The supply chain of rice from the producers to the procurement centre.

Table 4 shows that the average procurement price was higher than the actual market price in both Aman and Boro rice. Survey results revealed that the difference between the average procurement price and the market price was BDT 4.52 for Aman rice and BDT 6.01 for Boro rice. So, it is evident that rice farmers in Bangladesh are incurring losses through the existing procurement program. Alam et al. (2020) reported similar findings

3.4 Farmers' perception of the government procurement program

In the government rice procurement system, there are four groups principally involved: farmers, millers, government officials at the procurement centres and central government authority at the Ministry of Food (MoF). The last two groups are essentially the management service providers in the system, and the

Table 4. Average price difference between government procurement price and actual market price in last year

Particular	Aman (BDT/kg)	Boro(BDT/kg)
Procurement Price	24.85	29.82
Actual market Price	20.33	23.81
Difference	4.52	6.01

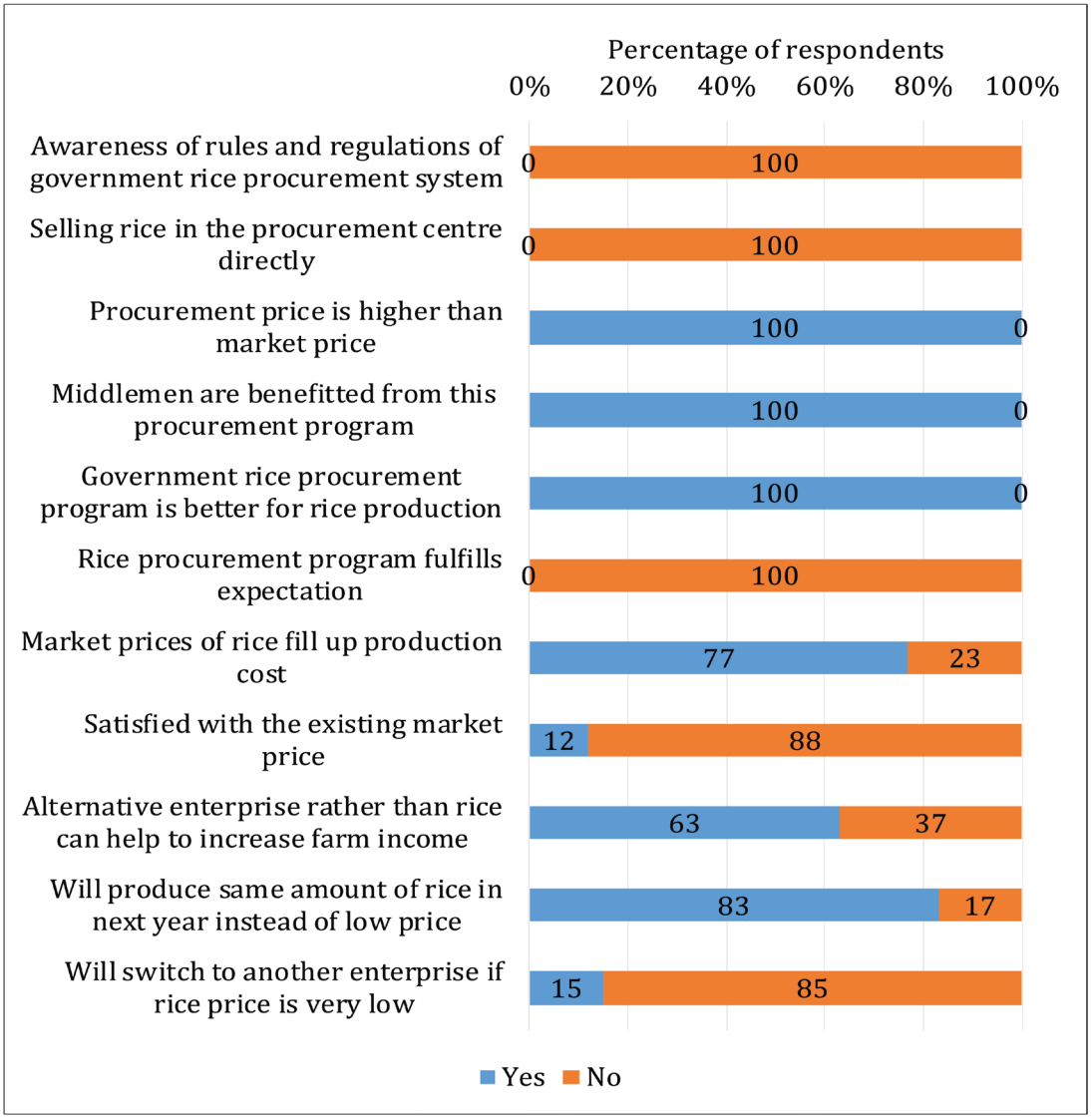

Figure 3. Farmer' perceptions of rice procurement program and existing market price.

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first two groups are the goods providers and support receivers. Since most of the farmers do not participate directly in the rice procurement system, it is vital to know their general degree of perception about that system. Figure 3 reveals the survey responses from farmers about their perception of government procurement programs and existing market price.

Results revealed that none were aware of the rules and regulations of the procurement program. Moreover, no farmers sold their rice to the procurement centre directly. It was found that they sold rice to the middleman like bepari, paikar, faria or near the village market at a lower price. However, farmers perceived that the procurement price is higher than the actual market price. The farmers believed that the government procurement program was better for them, but the middlemen still benefited since farmers could not sell their rice directly to the procurement centre. So, the government procurement program could not fulfil the expectation of the farmers. Most of them believed that changing enterprise could increase their farm income. Still, farmers would not switch to another enterprise from rice instead of lower market price. They would produce the same amount of rice next year because of their home consumption. Similar findings were reported by the study of Rosenberg et al. (2014) on farmers' perception of local food procurement in Mississippi.

4. Conclusion

The public procurement program intends to support farmers, but various factors reduce its impact on prices received by farmers and their income. This study was conducted to assess the supply response to rice production and assessing financial risk and farmer's perception of the government procurement programs in Bangladesh. The results revealed that present production was significantly affected by the last two years of production. Rainfall and exchange rate also had significant effects on rice production. Farmers' actual return from the rice was lower than the expected return, which indicates the presence of financial risk in rice production. This risk is more in Aman rice compared to Boro rice production. The middlemen gained the actual advantage of the procurement program because they purchase rice from the farmers and sell it to the government procurement centre. As a result, farmers were getting a lower price than the procurement price. Furthermore, farmers did not know the rules and regulations of the procurement program. The procurement program could be useful if market prices and procurement prices are positively associated. The government can support farmers by purchasing rice directly from them. Effective intervention should be ensured to improve the rural rice market so that the financial risk of rice production can be reduced. Moreover, the farmers should be informed with proper and accurate rules and regulations of the procurement program.

Conflict of interest

The authors hereby declare that there is no conflict of interest.

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