Effectiveness of Rice Procurement Program and the Determinants of the Farm Level Stocks of Rice in Bangladesh[i]

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Abstract

Domestic rice procurement program serves the dual purposes of building rice stocks for the public food grain distribution system and of providing income support to farmers. Government of Bangladesh provides a support price higher than the cost of production. However, we examine the effectiveness of rice procurement program and analyse the factors influencing farm level rice stocks, to understand the household level food security. In doing so, we use Household Income and Expenditure Survey 2010 data, historical and field survey data. We find that government stock and market price were negatively correlated with domestic procurement but the planned distribution was positive correlated with it. Results also show that annual household income including farm income increased due[ii] to procurement program. Moreover, stocks at the farm level vary positively with respect to own price but negatively with respect to consumer price of coarse rice.

Keywords: Rice procurement program, farm level stock, effectiveness, Bangladesh

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1. Introduction

In Bangladesh, as per defined public policy documents, domestic rice procurement serves the dual purposes of building rice stocks for the public food grain distribution system and of providing income support to farmers. To fulfill the later the government provides a support price higher than the cost of production of rice in order to ensure that farmers do not produce at a loss. Higher prices, however, are in conflict with the objective of keeping prices low enough so that the low-income consumers can afford to buy food. This conflict can be avoided through higher government subsidies, but these have budgetary implications for the country and can reduce investment in public goods essential for long-term growth. Subsidies have also implications for market distortion. Inefficient use of relevant goods and services or resources results in higher environmental consequences. For example, input subsidies may help poor farmers to keep cost of production down but the overuse would reduce soil quality and harm biodiversity. There are also evidences of leakages; subsidies benefit wealthy farmers instead of poorer farmers.

Besides having an impact on the government budget, procurement prices of rice that are much higher than market prices, in turn, favor rent seeking opportunities leading to further increase in costs for the government. Since the bulk of rice that is procured is bought from millers or other traders (Ali, 2010), any rents would disproportionately benefit millers and traders.

Apart from that, the timing of the announcement of the procurement price is also an important decision. Announcement of the price in advance of planting would allow the government some influence over the area planted, it could encourage investment by farmers and greater use of inputs, and it could improve prices when farmers engage in distress sales before harvest. But advance announcement of a price of course may make it more difficult to defend the price at the time of actual procurement.

However, given the budgetary pressure in one hand, and potential misuse of public resources on the other, the National Food Policy Plan of Action (2008-2015), recognises the importance of evaluating the effectiveness of the program and if needed, enhancing the effectiveness of the program and providing effective support to producer prices, while ensuring stable prices for the consumers. Formulating optimum policy that benefits both producers and consumers is always

poses serious challenges for the policy makers. But it is not yet identified what works better for the betterment of farmers who are the major suppliers of agricultural produce.

Given the above backdrop, this study attempts to assess the effectiveness of the rice procurement program and to identify the factors associated with the farm level rice stock in Bangladesh. Since national level rice storage capacity is limited and involves huge public investment, so stock at farm-level might help in reducing pressure at government storage, hence understanding the stocks and factors associated with farm-level stock are important and have huge implications for farm-level food security in Bangladesh. For assessing the program effectiveness the paper examines how the program objectives are met-up, this is done by using farm level, historical and Nationally Representative Household Income and Expenditure survey data - this is unique of this paper. The remainder of the paper is organised as follows. Following introduction, a brief review of literature is presented in section 2. Section 3 provides data which is followed by a conceptual note on stock calculation and econometric models in section 4 and section 5. The results and discussions are presented in section 6. Last section concludes.

2. Literature Review

Quasem (1979) finds that government procurement program of paddy benefited the intermediaries more than the farmers because of the mechanism of procurement proved little incentive to farmers for selling at the procurement centers. The study indicates that all size groups sell paddy immediately after harvest; about half of them buy back in the lean-season at a higher price. Islam (1982) finds that the procurement policy failed to achieve all the objectives of the program such as building rice stocks and supporting farmers' income. The author makes suggestion for its effective use such as, (a) the procurement centers should be re-arranged in order to cover the surplus rice growing areas, (b) it should give more emphasis on Boro rice which represent important growth points so far as food grain production in Bangladesh is concerned, (c) the procurement should introduce more flexibility regarding the minimum size of a lot that can be purchased, the moisture content, and the system of price payment, (d) the procurement price should be fixed at a sufficient high level so that it can create incentive for increased production, (e) the procurement drive should start immediately after the harvest, a delay in this respect may cause shortfall in the procurement target.

Akter (1990), finds that both net sellers and net buyers benefit from a buffer stock scheme with either a constant mean price or a modestly increasing price over the paddy season. Net buyers as well as consumers are losers from a stabilised price higher than average price over the paddy season. Osmani and Quasem (1990) identified several factors contribute to the unsatisfactory performance of the domestic rice procurement program in the past. Excessive commercial imports in public sector particularly in good harvest years used up effective storage capacity leading to a failure in the procurement program in the next harvest. Moreover, the procurement program itself limits the access of the farmers so that they are obliged to sell to the private traders at a lower price. Inadequate number of procurement centers, institutional impediments, collusion between the traders and the officials are other notable shortcomings of procurement program in Bangladesh. The authors find that a sizeable share of procurement was from large farmers and traders, not small and medium farmers. Shahabuddin (1991) states that domestic procurement of rice is one of the several public policy instruments, which has been using as a price stabilising mechanism for years. But this mechanism has been found largely ineffective in maintaining the stability of market prices as the government has not followed a consistent framework that involve setting a target price range. In developing a consistent framework for stabilising price in Bangladesh this study suggested a shift from the current practice of quantity planning to that of price-based planning of the food system.

Shahabuddin (1992) indicates that since both domestic procurement and open market sales are essentially seasonal operations influenced by seasonal factors, a more disaggregated approach using seasonal data is considered more appropriate to estimate the quantities of grains to be procured during harvest season and sold in the lean season to achieve the floor and ceiling price targets. Such a consistent derivation of quantity targets would not only contribute towards the preparation of a more realistic food budget but would also assist in a better targeting of policy instruments for reducing both the inter and the intra year fluctuation of food grain prices. Chowdhury (1994) mentions that domestic rice procurement is a relatively small source, accounted for 20%, of the Public Food Distribution System (PFDS) throughout per year during the 1980s. The study finds that farmers' share to public procurement is very little so that the financial coverage is too limited to ensure farmers' participation in procurement. Moreover, there was collusion between the procurement functionaries, basically government officials, and the traders. However, the study states that procurement program has an independent and positive

effect on rural rice prices. However, the effect is very small, and it does not necessarily mean that the program is 'farmer-friendly'. Rice procurement, however, is a cost-ineffective program.

Dorosh and Shahabuddin (1999) finds that the average wholesale price of Aman rice at harvest was above the procurement price in five of the last six years, resulting in an average of only 8.9% fulfillment of procurement target. On the other hand, procurement price of Boro rice was excessively higher in three out of four recent years. This results an extra government cost and a windfall profits to those who are fortunate enough to sell at the procurement centers. Moreover, procurement prices substantially above market prices encourage rent-seeking behaviour and add to the potential for corruption of public officials connected with procurement. The determination of procurement prices at the level of price support is then a critically important task in order to ensure adequate production incentives to the farmers, while at the same time minimising costs to the public exchequer.

Shahabuddin and Islam (1999) evaluates effectiveness of the domestic procurement program in terms of participation of farmers, traders and millers and problems faced by them in the process of both paddy and rice procurement. They find that the participation of farmers, especially small and medium farmers in the domestic procurement program is disappointingly low (only 10%). To increase farmers' participation in the procurement program they suggests to reorganise procurement program at Local Storage Depot (LSD) to minimise unofficial payments to both officials/staff and labourer, to initiate procurement program soon after harvest, to minimise irregularities in weighing, to create temporary storage at LSD premises to prevent damage of farmers' paddy due to inclement weather, etc. Dorosh *et al.* (2001) observes that Boro procurement has been much more reliable than Aman procurement. Procurement of Boro exceeded 80% of the target on 9 out of 13 years and failed at least 60% of the target in only one year. Aman procurement, on the other hand, exceeded 80% of the target in only 2 out of 12 years, and failed to reach 60% of the target in 8 out of 12 years. In these eight years, Aman procurement averaged only 18.5% of the target. Major irregularities in choosing the farmers to buy paddy are reported by Reza (2001). The major problems in supplying rice to the procurement centers are illegal payment, taking extra amount, and unnecessary harassment. Based on the views reported by the farmers, traders and millers, the author suggests for early start of procurement, stopping corruption and bribing, establishment of a procurement center at

the village level, setting the procurement price higher than the market price, directly receiving the paddy/rice after arrival at the procurement center, increasing the duration of procurement.

Khan and Jamal (1997) find that in most developing countries of the world, large-scale public food procurement and distribution systems have become too expensive for the country's governments. Despite high financial and administrative cost of the programs, the degree of seasonal price stabilisation and price support achieved through the activities remain quite low. Using the Bangladesh PFDS as a case study, the research indicates that considerable improvements in price support could be achieved by providing credit to the farmers immediately after the harvest. If the government procurement is reduced by 50% in Bangladesh, and providing 150% of the cost of running PFDS as credit, Bangladesh can improve the farmers' income and achieve better stability of cereal prices at a cost less than one-third of the current costs of PFDS. Dorosh and Shahabuddin (2002) show that relatively high degree of price stability was achieved in the 1990s due to private sector imports that stabilised markets following major production shortfalls. Domestic rice procurement contributes relatively little in raising domestic producer prices at harvest time, involved only a small percentage of farmers, and incurred excessive costs following successful harvests because of setting procurement prices far in excess of market prices. Almost similar results are reported by Sabur *et al.* (2003). The authors report that the lengthy procedures, loss of time and high transportation are the main causes for not selling paddy to the procurement center. Dorosh and Farid (2003) study the economic costs of stock quality deterioration in storage, including the implicit costs to recipients of PFDS. They observe that implicit losses to rice consumers due to quality deterioration were about 1.05 billion Taka in 2000/01, equal to 10.9% of total net outlay on rice of the PFDS.

Dorosh (2009) studies domestic trade policies and government market interventions in a set of South Asian countries in response to 2007-08 international price shocks on domestic markets. The author mentions that the price shock during 2007-08 is a reminder that dependence on international markets will not guarantee price stability, still the governments should not over-react to such events and embrace policies that ultimately result in large costs in terms of slower economic growth and less poverty reduction. Instead, national policies should involve some combination of promoting domestic production and national stocks to prevent very large price increases and reliance on international trade to limit the need for government interventions in most years. Asaduzzaman *et al.* (2009) states that input subsidies and domestic food grain

procurement programs are short term efforts that the government uses to reduce farmers' costs of growing food and/or influence the price of food in the market. The paper opine that a systematic evaluation of government programs like subsidising agricultural inputs or procurement of food grain should be done urgently to judge the effectiveness and cost of the government for each approach. The evaluations should include both the direct costs (e.g., of subsidies on inputs, food grain storage costs, etc.) and the opportunity costs of capital (tying Government funds up in food grain stores) and labour (using government staff to manage input subsidy schemes and food grain stores). Shahabuddin *et al.* (2009) recommends improving the effectiveness of procurement policy and price support to the farmers by introducing a system of open tendering in order to reduce costs and improve the reliability of the program. However, the studies show variable results. This pose a real challenge for policy makers to understand the program effectiveness in terms of how the program delivers in fulfilling its objectives. This is very important since over the time, the implementation of program has been varying and rice production seasons changing - from Aus dominated rice production to Boro dominated rice production. This study however combines different rich databases such as HIES, 2010, long historical databases and field survey data, to examines the effectiveness of the program.

3. Data

The data sources of the study are (i) Household Income and Expenditure (HIES) 2010 survey: HIES 2010 data set is used to analyse the factors affecting farmers stocking behaviour by season. The household survey was carried out by the Bangladesh Bureau of Statistics during February 2010– January 2011. Total sample size of the survey was 12,240, where 7,840 from rural area and 4,400 from urban area. Out of these households 4101 households were rice growers in the survey year. Out of the rice growers, 3245 households produced Boro, 2699 households produced Aman and 784 households produced Aus rice. (ii) Time series data: For estimating relationship historical data such as production, target and actual procurement, opening stock, closing stock, procurement price, market price etc were collected from the secondary sources such as Yearbook of Agricultural Statistics in Bangladesh, Statistical Yearbook of Bangladesh, different issues of Food Planning and Monitoring Unit database and finally (c) Primary data: Primary data for three group of respondents consisting about 800 samples were collected.. The survey covers the Boro procurement season of 2012. The surveys are done with (i) the farmers those who did not sell paddy to Local Storage Depot (LSD) (non-participant farmers), (ii) people

who sold paddy to LSD (participant farmers) and (iii) people who sold milled rice (millers) to LSD. The probability proportion to size is used to identify the sample size from three different categories. A total of 305 non-participant farmers, 181 participating farmers and 296 millers are surveyed. The surveys are done in the districts of Mymensingh, Tangail, Dinajpur and Naogaon, where production of rice is high and the government procures a large share of its total procurement.

4. Stock Calculation

This section discusses how stock is derived from the Household Income and Expenditure Survey (2010) dataset.

The study begins with the following general identity to calculate rice/paddy stock at the farm level.

$$ST_{t+1} = ST_t + Q_t + QR_t + QD_t - C_t - QS_t - QO_t - W_t \qquad (1)$$

Where, ST_{t+1} is the closing stock at the end of time t

ST_t is the beginning stock at time t

Q_t is the net quantity produced at time t (this is net of crop received and paid due to sharing/renting land) at time t

QR_t is the quantity received from others (kind wages etc) at time t

QD_t is the quantity bought at time t

C_t is the consumption at time t

QS_t is the quantity sold at time t

QO_t is the other disposal (seed, feed etc) at time t

Wt is the wastage at time t

By rearranging equation (1), farm level stock equation can be expressed as follows:

$$ST_{t+1} - ST_t = Q_t + QR_t + QD_t - Ct - QS_t - QO_t - W_t \qquad (2)$$

In the neoclassical utility maximisation framework farmers' consumption function can be given as (Akter 1989):

$$Ct = C (Q_t, Y_{ot}, P_t, P_{ot}; Z) \qquad (3)$$

Where the variables Y_{ot}, P_t, P_{ot} represent other income, own prices and prices of related goods respectively. Z variables are exogenous variables that may affect household consumption. If we

further assume that opening and closing stocks are equal then marketable surplus (net production minus net disposal) would be the negative of consumption function (3). However seasonal stock changes should be realistically non-zero as size of production and length of crop seasons are different. In that case stock function would be a net function of production, marketing and disposals as follows.

$$ST_{t+1} - ST_t = ST\ (Q_t,\ Y_{ot},\ P_t,\ P_{ot};\ Z) \qquad (4)$$

Here the Z variable includes exogenous disposals as well as household level fixed factors.

Thus the nature and extent of household level food grain stocks may be dependent on a range of factors related to production, consumption, marketing, and other household level and market level factors (Chowdhury, 1993). The expected signs of the consumption and marketing functions can easily be derived from the neoclassical consumer theory (Akter 1989). However the expected signs of the variables in equation (4) will depend on the relative size of the effects of the variables in consumption and marketing relations. This is because stocks function is the net of both consumption function and its negative counterpart marketing function. So it is difficult to predict the *a priori* sign and size of the relations of the factors, which influence stock holding behaviour.

HIES 2010 data recorded stocks as follows:

$$ST_t = Q_t - C_t - QO_t - Q\ (wastage)_t - QS_t \qquad (5)$$

Where ST is stock; t (2-5) represents season (1=Boro season, 2=Aman season and 3=Aus season); Q is production, which is used for consumption (C), other disposals (QO) such as given to landlord, paid for wages, used as seed and livestock feed and any other kind uses; Q (wastage) represent wastage in the season; and finally QS is the quantity sold.

5. Econometric Models

5.1 Stock Function

The seasonal stock function is as follows:

$$S_{it} = \alpha + \beta_i X_{it} + \varepsilon \qquad (6)$$

Where, S= stock (dependent variable) (i represents farming household & t represents seasons). The explanatory variables X_i are -

        X1=Size of production

X2=Other sources of acquisition (e. g. payments in kind and payment received)

X3=Selling price

X4=Consumer price,

X5=CV in selling price

X6=Main occupation of household

X7=Expenditure quartile

X8=Size of household

X9=Location of household

X10=Usable room spacing

X11=Household faced shock in last 12 months

X12=Household has mobile phone

X13=Household has internet

X14=Access to credit

X15=Farm size

X16=Livestock assets

X17=Tenurial status

X18=Household belonging to surplus or deficit region.

5.2 Econometric Models for Estimating Relationships

The study investigates the relationship between (i) the production deviations from trend (as a proxy for good and bad harvest) and government procurement to examine the extent to which government procurement increases when harvests are good and thus supports farm prices when they most need support, (ii) production deviations from trend and government distribution through market operations, to examine the extent to which government distribution increased when harvest were poor and thus contribute to stabilise retail price, (iii) procurement and planned distribution, (iv) actual procurement and government stock (v) procurement prices with the prevailing market prices. (vi) government stock and price (market price and procurement price) levels.

In order to estimate the deviations the study estimated different trend functions such as linear, polynomial of different order for example 2nd order, 3rd order. Then in fact the trend model is selected based on `best fit` to the data. Trend deviation is obtained by using subtraction. Deviations are calculated from the differences between the observed and the estimated values.

The functions are as follows;

Linear function:	$Y = \beta_0 + \beta_1 t + \varepsilon_t$
Exponential function	$Y = ae^{bt}$
Quadratic function:	$Y = \beta_0 + \beta_1 t + \beta_2 t^2 + \varepsilon_t$
Third order polynomial function:	$Y = \beta_0 + \beta_1 t + \beta_2 t^2 + + \beta_3 t^3 + \varepsilon_t$

Where, Y is the production (price in the other cases) over time, T is the deterministic time trend, n is the order of the polynomial and ε is the error term. The order in the polynomial function were determined based on Akaike information criterion (AIC).

Later, a regression model was estimated as follows:

$$Y_t = \beta_0 + \beta_i X_{it} + \varepsilon_t \qquad (7)$$

Where Y indicates the actual procurement

X_{it} are explanatory variables such as

X_{1t} = Opening government stock at the start of the season

X_{2t} = Planned distribution of current season

X_{3t} = Deviation of production from trend

X_{4t} = Deviation of real (inflation adjusted) market price from average price of past n years (n= 1, 2 or 3) etc. over time.

In estimating the equation, we consider the properties of time series data. In order to estimate the relationship between procurement and market price, the regression model presents in equation (8) is estimated. This was estimated to investigate if procurement price had an impact on market price.

$$P_{mt} = \beta_0 + \beta_i P_{pt} + \varepsilon_t \qquad (8)$$

Where P_m=market price, and P_p=procurement price.

In order to estimate the relationship between government stock and market price, a regression model presented in equation (9) was estimated. It was done to determine if government stock has an impact on market price.

$$P_{mt} = \beta_0 + \beta_i S_t + \varepsilon_t \qquad (9)$$

Where S=government stock.

6. Results and Discussions

6.1 Stock Function: Regression Analysis

Assumptions, Variables and Empirical Model

For empirical estimation, the study follows pragmatic approach as follows:

$$ST_{it} = f(X_{it}) + u_t$$

ST and X variables are summarized here in Table 1. The first three variables are dependent variables in stock regressions in Boro, Aman and Aus rice respectively. They were measured in kg per household and then converted into log. All variables other than dummy variables are expressed in log. Log transformation makes interpretation easy and also reduces the heteroscedasticity problem.

Insert Table 1 here

Independent variables are output measured in kg of respective rice crop (Boro, Aman and, Aus) per household. Stocking decisions for the year are being made based on how much is actually produced in a given crop season. Thus the expected sign is positive; more production would imply a larger amount of stock.

Rice market is reasonably competitive (large number of farmers) to assume that farmers are price takers. According to standard demand theories, consumption depends on prices, limited income and a set of other related limiting factors. As we are analysing cross-section data of a particular season and year, variation in prices received by individual households would reflect other effects than usual price response. Other things may include quality, quantity, spatial and temporal variations etc. So we have used the district level average of selling price of Boro, Aman and Aus rice to represent market price of rice in these three seasons. The district level prices should not be related to quality factors but may pick up spatial variation. So we introduced some regional dummy variables to control for spatial variation. Higher price would reduce consumer demand and farming household as consumer would reduce consumption but as producer would increase marketing. Price effect on stock would be the net effect. The price effect would be positive, negative or insignificant depending on the relative magnitude of home demand and market supply effects. As the food grains are price inelastic we would expect marketing effect of price difference would be higher. So positive elasticity may indicate expectation about future price

changes. If current prices are higher, farming households may stock for future marketing with expectation of further increase in price. The motive may be a speculative one.

We consider the three rice crops are substitutes, so higher price of one would induce farmers to consume more of the other. However they are not available at the same time of the year, though there are overlaps in harvesting time. Higher Aman price means more Aman quantity sold and so with lower stock of Aman, more Boro/Aus quantity will be consumed and so Boro/Aus stock will reduce. In this situation we would expect a negative price elasticity of Boro/Aus stock with respect to Aman price. Higher price effect on consumption may increase the amount of Aman stock and this may also have negative effect on Boro/Aus stock. On the other hand, higher Aman price relative to Boro/Aus means more Boro/Aus quantity consumption rises and so Boro/Aus stock would reduce. In this situation we would expect a negative price elasticity of Boro/Aus stock with respect to Aman price.

Producer selling price may not reflect competitive market price as some farmers may make distress sales. Moreover, quality differences cannot be separated due to lack of such data in the HIES 2010 data set. So we include consumer price of coarse rice in the covariate list. This price would be further free from quality effect as it is the price of coarse rice, though there is a difficulty in the data that the information was collected in two representative weeks and so will not pick up the effect for all three seasons (Boro, Aman and Aus).

Other limiting factors are expenditure quartiles (instead of income/expenditure as continuous variable), household population, probability of shocks, access to information, credit, other assets, farm size, rental market etc. All these constraints add complexity on the straight forward interpretation of the effects.

Estimated Stock Functions

Table 2 depicts stock behaviour of Boro rice. In order to estimate the effects of the covariates, we first considered the statistical properties of the models. Included variables significantly explained the stock variation. Heteroscedasticity was detected by the Breusch-Pagan/ Cook-Weisberg test; Null hypothesis that Ho: Constant variance was rejected at 1% level (Chi^2=626.4). So we present White's heteroscedasticity corrected robust standard errors. Out of 26 independent variables included in the model, 16 variables are significant at 1% level; two other variables are significant at 5% and 10% levels.

The effect of production on stock is positive as expected. A 10% rise in Boro production causes about 3% increase in stock. All stock price elasticities are significant and elastic. Price appears a significant signal for influencing stockholding behaviour of farming households. Positively elastic price elasticity of stock may indicate partly demand effect of price rise and partly future expectation of price rise on stockholding behaviour. It is necessary to include a variable representing future expected price to pick up the effect. One possible variable may be length of season, which may vary between farms (Akter, 1989). Some farmers produce two rice crops, others grow all three rice crops. Some farmers may have access to early varieties and other resources. We also miss the information on beginning stock to identify net stocks for the next season. These variables may be relate to price causing some bias. We recognise this omitted variable problem as we do not have any proxy for these variables.

Insert Table 2 here

Other significant variables are household population size, kind disposal like seed, feed etc, price variability, household has borrowings, farm size, land rental, and spatial dummies. The sign and size of most of them seem plausible. For example, a 10% rise in family population decreases the amount of stock by 3.4%. Consumption increases with increase in population and so stock decreases. The effect of credit is negative and may indicate distress sales due to credit. The higher the farm size the greater is the amount of stock. Stocks are lower in the deficit districts.

Table 3 presents the stock relations for the Aman season. On the statistical properties, included variables significantly explained the stock variation. Heteroscedasticity was detected by the Breusch-Pagan/ Cook-Weisberg test; Null hypothesis that Ho: Constant variance was rejected at 1% level (Chi^2=1695.4). So we present White's heteroscedasticity corrected robust standard errors. Out of 26 independent variables included in the model, 9 variables are significant at 1% level; other variables are not statistically significant at 5% or 10%.

There are differences between Boro and Aman with respect to effect of prices. Boro stocks vary positively with respect to own price, whilst Aman stocks vary negatively with respect to own price. Boro stocks vary negatively with respect to consumer price of coarse rice, whilst Aman stocks vary positively with respect to consumer price of coarse rice. This is difficult to explain this opposite relationship with the given data. Also, as we mention earlier, price in cross section data may not reflect true price effect but price varies due to other factors like quality. Quality

effect is not possible to control with the given data. Further analysis with other data is necessary to confirm the relationship. Consumer price for coarse rice controls for quality and still we see opposite relationship in Boro and Aman seasons. This needs some clarifications and justification. This may be due to the variation of farming households' expectation about the price changes beyond the season. Also we are unable to control for the exact timing of marketing the crop within a season. There may be variation in the proportionate distress sales between seasons.

Other significant variables are expenditure quartiles, farm size, kind disposals such as seed, feed etc, and spatial dummies. The sign and size of most of them appear plausible. For example, farmers in the upper expenditure quartiles have higher stocks. Richer farmers stock more, may be to avail the opportunity to generate profit from better timing of sales.

Aus season results of stock behaviour are presented in Table 3. Included variables significantly explained the stock variation. Here also heteroscedasticity was detected by the Breusch-Pagan/ Cook-Weisberg test. So we present White's heteroscedasticity corrected robust standard errors. Here 5 variables are significant at 1% level, 2 variables are significant at 5% level and 2 variables are significant at 10% level.

The relation of stock with production is consistent in all three seasons. For a 10% increase in production, Aus stock rises by 1.6%. In the case of Aman, the increase was slightly higher than Aus and in the case of Boro the rate of change is even little higher. Own price elasticity of stock is not significant in this case. Other significant variables are top expenditure quarter, free room space available in the house, shock, farm size and location. The sign and size of these variables appear consistent.

Thus, stocks depend on the amount of harvest consistently in all seasons. Prices have mixed effects, further investigation is necessary to confirm the result. There are many constraints that farmers consider in keeping stocks other than production and prices. So policy makers must think about measures to ease farm level possible constraints/ a range of factors in order to help farmers to make competitive decisions regarding stocks.

We reiterate that if farmers store grains when their price is low and sell when their price is high, then price fluctuations will be reduced (Newbery and Stiglitz, 1981). In this case it is less necessary for the government to operate a buffer stock scheme to stabilise price, which may not guarantee income stabilisation and therefore food security. From this analysis, we see that

farmers' stocks are responsive to production and prices but their behaviour is constrained by a number of factors like access to credit in some seasons. As far as stabilisation of income is concerned it may be more important to direct the policy towards reducing farm level constraints. In this study we are unable to identify the effect of storage on price stability and therefore farmers' income due to lack of data on timing of sales. A complete study requires time series data on prices and marketing along with timing of sales and purchases. We consider this a fertile ground for future research.

6.2 Results of Estimated Relationships

Procurement model: In both cases of Boro and Aman rice government stock contributed negatively to actual procurement. However, in both Boro and Aman rice, the results are not statistically significant, but the coefficient implies that when government stored substantial amount of grain then actual procurement decreased due to insufficient godown capacity.

Public Food Distribution System (PFDS) is an instrument for ensuring availability of cereal food at easily affordable prices especially for the people who lives below the poverty line. The Government procures and stocks food grain which is then released every month for distribution through the PFDS network. Therefore, if government planned to distribute large amount of food grain then DOF will have to procure large amount of paddy/rice. However, the relationship estimation results show that planned distribution has positive relationship with procurement in both the Boro and Aman rice cases, but the result is statistically significant only in Boro case, as Aman procurement has a very small portion in total procurement.

To examine the extent to which government procurement increases when harvests are good and thus supports farm prices when they most need support, we have estimated the relationship between production deviations from trend (as a proxy for good and bad harvest) and government procurement. The sign is positive in Boro price which means that when harvest was good actual Boro procurement was increased. However, the result is not statistically significant so we cannot make firm conclusion. But in the case of Aman, the sign is negative and statistically significant. Though it was not expected, it is not surprising. Total procurement in Aman season was very low. Zaman (2003), found that during 1977-2000, except for four to five years period, the support price of Aman rice was lower than the prevailing market price in all the years studied. Moreover as one the objectives of government procurement is to ensure food security for all

households as well as providing incentives to farmers, hence, government emphasises on Boro production for achieving self-sufficiency in food grain. Therefore, if harvest was even good in Aman season, then decreased actual procurement of Aman is not a shocking result.

The deviation of market price from last 32 years average market price is also taken as explanatory variable. The sign of coefficient is negative in both the Boro and Aman seasons which means that if market price is less than the average past 32 years price then actual procurement increases and if market price is bigger than the average past 32 years price then actual procurement decreases. However, the result is statistically significant in Aman rice only.

As one of the objectives of procurement program is to stabilise the domestic market price by preventing the downward trend of post-harvest food grain price, therefore, the harvest time market price suppose to be lower than the procurement price. In the relationship result it is observed that market price has negative relationship with actual procurement in both the Boro and Aman seasons. If market prices increases then actual procurement decreases.

Insert Table 3 here

Procurement price model: In the case of Boro season, relationship between market price and procurement price is positive and statistically significant at 6% level. It is expected that if procurement price increases then market price will also increase. In Aman season, similar to the Boro, the sign is positive, but not statistically significant. However, one can point out the limitation of the estimated model due to possible reverse causality. The data limitation did not allow the authors to test the reverse causality.

Government stock model: In both Boro and Aman cases the relationships between market price and government stock show negative relationship. In both Boro and Aman rice cases the results are statistically significant at 1% level, which indicates if government stock increases then market price decreases. This is possible because if government stock`s capacity is reach its peak, the procurement decreases which in turn decreases market prices.

Government stock and procurement price model: However, in both Boro and Aman cases the relationship between procurement price and government stock shows negative relationship. From this result it is not possible to draw firm conclusion as the results are not statistically significant.

Results from Field Survey

To fulfill the objective of public rice procurement program as to what extent the current procurement program farmers' income, required calculations have been made and presented in Table 4. The result shows that farm income and annual household income of the participant farmers increased by 7.16% and 5.57%, respectively due to participation in the program.

When we have looked at the income changes by farm sizes, we find that farm income increased by 8.54% and 5.85%, respectively for marginal/small and medium/ large farmers. In terms of the % of the total farm income, marginal/small farmers earned more than the medium/large farmers but in absolute terms, changes in income of medium/large farmers are higher than marginal/small farmers. The corresponding increments of income were 6.74 and 4.45% in annual household income. This indicates that, by participation in the public rice procurement program, the marginal/small farmers benefitted more than medium/large farmers.

Insert Table 4 here

7. Conclusions

The effect of production on stock is positive as expected. Price appears a significant signal for influencing stockholding behaviour of farming households. Positively elastic price elasticity of stock may indicate partly demand effect of price rise and partly future expectation of price rise on stockholding behaviour. In both Boro and Aman seasons, relationship between market price and procurement price is positive and the results are statistically significant. Farm income as well as annual household income of the participant farmers increased by 4.03 and 3.03%, respectively as they sold their certain amount of paddy to procurement centers. So, the study concludes that the procurement program supports farmers indirectly through market mechanism as market price and procurement price are positively associated. Purchases by the government at support market prices along with demand from other agents push market prices up to benefit the poor farmers who usually make distress sales at harvest. This is further supported by our findings that the quantity procured is inversely related to market prices, which implies that when the market price is low government procures more and pushes prices up. In this way, not only the participating farmers but also all farmers get benefit.

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Table 1: Variables prepared from the HIES 2010 to estimate stock functions

Variables	Definitions	Mean	Std
lnboroST	Log of Boro stocks	1.8792	2.8249
lnamanST	Log of Aman stocks	0.8547	2.0381
lnausST	Log of Aus stocks	0.1930	1.0019
lnboroQ	Log of Boro production	5.6117	2.9961
lnausQ	Log of Aus production	1.2072	2.5140
Lnprdboro	Log of Boro price (hh selling price, un-husked grain)	2.6761	0.2951
Lnprdaman	Log of Aman price (hh selling price, un-husked grain)	2.7442	0.1593
Lnprdaus	Log of Aus price (hh selling price, un-husked grain)	2.0641	1.1388
lnprdC	Log of consumer price coarse rice (two weeks ave.)	3.4160	0.0540
Lntdisboro	Log of other disposal (seed, feed, etc.) Boro	2.4587	2.6969
cvprC	Coefficient of variation of consumer price	4.0702	3.4517
cvprAMBO	Coefficient of variation in hh selling price	37.919	30.626
lnamanQ	Log of Aman production	4.3339	3.2232
Lntdisaman	Log of other disposal (seed, feed, etc.) Aman	1.9419	2.4058
exquart_2	Expenditure quartile 2 =1	0.3207	0.4668
exquart_3	Expenditure quartile 3 =1	0.2892	0.4534
exquart_4	Expenditure highest quartile =1	0.1266	0.3325
Lnmem	Log of family size	1.5245	0.3882
Lnrspace	Log of usable room spacing	5.8788	0.6342
shock_1	Household faced shock in past 12 months	0.2295	0.4205
mobile_1	Household has mobile phone=1	0.6367	0.4810
internet_1	Household has access to internet=1	0.0037	0.0604
Lnmedu	Log of highest level of education in household	1.7433	0.7892
credit_1	Household has access to credit=1	0.3750	0.4842
livestoc~1	Household has livestock=1	0.9012	0.2984
fzoplnd_2	Small and medium farm=1	0.6257	0.4840
fzoplnd_3	Large farm=1	0.1709	0.3765
Lnrtin	Log of rented/shared in land	2.3601	2.1297
Lnrtout	Log of rented/shared out land	0.8272	1.6971
mrs_1	Household location (urban area=1)	0.1134	0.3171
mrs_3	Household location (=1)	0.0156	0.1240
DSdistrict	Rice surplus district=1	0.6535	0.4759

Table 2: Estimated stock relations for Boro rice

Variables	β_i		
	Boro	Aman	Aus
lnboroQ (Boro production)	0.296*** (0.013)	-	-
lnamanQ (Aman production)	-	0.187*** (0.012)	-
lnausQ (Aus production)	-		0.161*** (0.020)
Lnprdboro (price of Boro, un-husked)	2.406*** (0.500)	0.481 (0.403)	0.054 (0.171)
Lnprdaman (price of Aman, un-husked)	-3.102*** (0.604)	-2.060*** (0.455)	-0.582*** (0.194)
Lnprdaus (price of Aus, un-husked)	1.509*** (0.341)	0.262 (0.252)	0.119 (0.076)
lnprdC	-4.617*** (0.858)	1.698*** (0.612)	0.464 (0.318)
Lntdisboro	0.117*** (0.020)	-	-
Lntdisaman	-	0.075*** (0.020)	-
Lntdisaus	-	-	0.013 (0.035)
cvprC	-0.069*** (0.012)	-0.013 (0.008)	-0.001 (0.004)
cvprAMBO	0.011*** (0.001)	0.000 (0.001)	0.000 (0.001)
exquart_2	0.047 (0.103)	0.020 (0.069)	-0.035 (0.031)
exquart_3	0.115 (0.114)	0.276*** (0.082)	0.002 (0.040)
exquart_4	0.249 (0.197)	0.561*** (0.165)	0.180** (0.094)
Lnmem	-0.343*** (0.116)	-0.052 (0.084)	-0.015 (0.042)
Lnrspace	0.371*** (0.070)	0.051 (0.050)	0.040* (0.024)
shock_1	0.008 (0.096)	-0.108 (0.069)	-0.085*** (0.030)
mobile_1	0.148* (0.089)	0.077 (0.063)	-0.007 (0.033)
internet_1	-0.673 (0.674)	-0.419 (0.480)	-0.097 (0.060)
Lnmedu	-0.027 (0.054)	-0.020 (0.038)	-0.021 (0.018)
credit_1	-0.287*** (0.081)	-0.052 (0.060)	0.017 (0.029)
livestock_1	0.399*** (0.127)	0.034 (0.089)	0.069** (0.032)
fzoplnd_2	0.223** (0.094)	0.148*** (0.058)	0.046* (0.028)
fzoplnd_3	0.543*** (0.142)	0.745*** (0.111)	0.200*** (0.055)
Lnrtin	-0.055*** (0.021)	-0.002 (0.016)	-0.010 (0.007)
Lnrtout	-0.018 (0.026)	-0.004 (0.020)	-0.002 (0.009)
mrs_1	0.029 (0.182)	-0.186 (0.150)	-0.092 (0.082)
mrs_3	-0.851*** (0.300)	-0.011 (0.238)	0.045 (0.126)
DSdistrict	-0.564*** (0.089)	-0.389*** (0.068)	-0.087*** (0.034)
Cons	11.872*** (2.680)	-2.491 (1.989)	-0.658 (1.146)
R^2 (Prob > F =0.0000)	0.235	0.186	0.204

Note. White's heteroscedasticity corrected robust standard error are used for test statistics; values in parentheses are robust S.E.

Table 3: Results of the regression models

Equations (Dep. variable= actual proc. in 000'mt)	Coefficient	T value	P>|t|
Boro			
Constant	482.27	1.37	0.182
Government stock	-0.038	-1.42	0.168
Planned distribution	0.930***	5.14	0.000
Deviation of production from trend	142.27	1.21	0.236
Deviation of real market price from average price	-232.16	-1.41	0.170
Market price	-0.239	-0.94	0.356
Aman			
Constant	393.70**	2.15	0.041
Government stock	-0.012	-1.00	0.326
Planned distribution	0.145	0.56	0.582
Deviation of production from trend	-150.35***	-3.53	0.002
Deviation of real market price from average price	-151.47**	-2.07	0.048
Market price	-0.165	-0.81	0.424
Equations (Dep. variable= market price)			
Boro Rice			
Constant	473.24***	2.77	0.010
Procurement price	0.378*	1.89	0.068
Aman Rice			
Constant	427.31**	2.65	0.013
Procurement price	0.295	1.47	0.153
Equations (Dependent variable= market price)			
Boro			
Constant	912.95***	17.56	0.000
Government stock	-0.075***	-3.96	0.000
Aman			
Constant	733.54***	21.54	0.000
Government stock	-0.043***	-3.51	0.001
Equations (Dep. variable= procurement price)			
Boro Rice			
Constant	848.28***	15.53	0.000
Government stock	-0.017	-0.84	0.41
Aman Rice			
Constant	818.19***	23.98	0.000
Government stock	-0.019	-1.53	0.137

Table 4: Extent of support on farmers' income

Particulars	Farm types				
	Marginal/ small	Medium/ large	All	t	P>|t|
a. Paddy sold to procurement center (PC) (quintal/farm)	16.76	28.21	22.65	4.141***	0.000
b. Value of paddy sold to PC in procurement price (Tk/farm) [ax Tk 1800/quintal]	30171	50783	40762	4.141***	0.000
c. Value of paddy sold to PC in market price (Tk/farm) [ax Tk 1434/quintal]	24037	40457	32474	4.141***	0.000
d. Cost of selling paddy to PC (Tk/quintal)	59.89	64.50	62.26	0.782	0.435
e. Cost of selling paddy to nearby market (Tk/quintal)	84.43	69.86	76.58	2.446**	0.016
f. Total cost of selling paddy to PC (Tk/farm) [a x d]	1133	1950	1552	2.635***	0.009
g. Total cost of selling paddy to nearby market (Tk/farm) [a x e]	1112	1546	1335	1.888*	0.061
h. Net margin of selling paddy to PC (Tk/farm) [b- f]	29039	48834	39210	4.186***	0.000
i. Net margin of selling paddy to nearby market (Tk/farm) [c-g]	22924	38912	31139	4.151***	0.000
j. Incremental margin of selling paddy to PC (Tk/farm) [h-i]	6115	9922	8071	4.128***	0.000
k. Farm income (Tk/farm/year)	105337	290486	200469	7.366***	0.000
l. Average annual household income (Tk/farm/year)	168978	359303	266770	4.387***	0.000
m. Share of incremental margin of selling paddy to PC in farm income (% of k)	8.54	5.85	7.16	2.198**	0.029
n. Share of incremental margin of selling paddy to PC in annual household income (% of l)	6.74	4.45	5.57	2.601***	0.010
o. Incremental margin of selling paddy to PC (Tk/quintal) [j/a]	368.47	358.59	363.40	1.044	0.298